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Purposeful Integration of Literacy and Science Instruction in a 4th Grade Immersion Program

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in a 4th Grade Partial Immersion Program

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ABSTRACT

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Though learning content in a second language (L2) requires additional time, students in immersion classes are expected to keep up with the curricular pace of traditional classes. One possible way to secure sufficient time for both language and science content learning is to integrate language arts instruction with core curricular content. This action research study investigated the effectiveness of purposefully integrating literacy instruction with the Utah Core Standards for science with 53 fourth-grade French partial immersion students in Utah. The purpose of this study was to discover how such a model might affect students' French reading skills, science knowledge, and attitudes about their immersion experience. Findings revealed statistically significant differences between pre- and post-tests on some measures of student performance, and yielded pedagogical implications regarding the development of reading fluency, science proficiency, and student engagement.

Keywords: immersion education; content-based instruction; integration of content; elementary; French

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CHAPTER 1

Introduction

Immersion education is a form of bilingual education, founded on the principle of content-based learning, or learning a second language through the vehicle of content instruction. In an immersion classroom, students learn new knowledge about the world in which they live in while also learning the second language. In fact, immersion teachers are responsible for following the same core curriculum as a traditional teacher, whether that be multiplying fractions or explaining how a cactus can survive in the desert.

Although the core curriculum provides a ready-made context for language instruction in an immersion classroom, the curricular pace makes it difficult for teachers to build the necessary target language skills and simultaneously address core content within the time allotted for instruction, especially in cases where students struggle to understand the target language. There are many different models of immersion education. These models vary in a variety of ways, including when students begin the program, how much time is spent in the target language at each grade level, which core content is taught in the target language, students' language background, and whether students have one or two teachers throughout the day.

The state of Utah's Dual Language Immersion model is a partial immersion model in which half of the day is taught in English and the other half in the target language throughout the entirety of the program. This is accomplished with two team teachers: one teaching the English half of the day, and the other teaching during the French half (Watzinger-Tharp & Leite, 2017). In terms of subject matter taught, the target language teacher is responsible for dividing students' instruction in French among several different subject areas. For example, in fourth grade, instructional time is divided as follows: 25% French language arts, 16.5% science, and 8.5% math (Roberts, 2016) (see Figure 1).

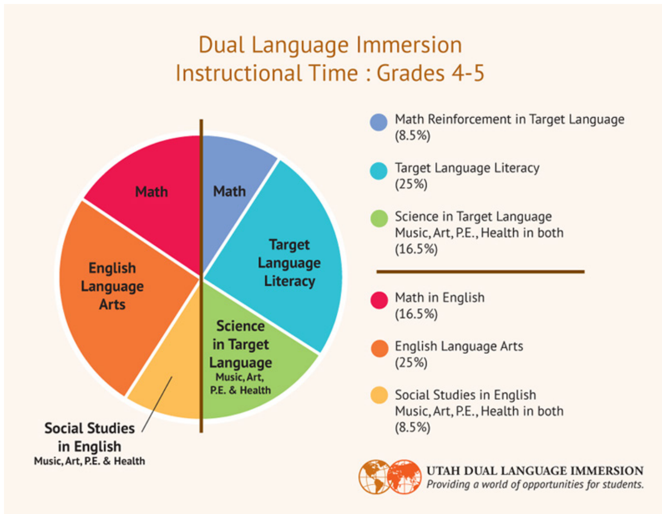

Figure 1. Utah dual language immersion instructional time: Grades 4-5 (Roberts, 2016).

After subtracting the time required for physical education, library, computer skills, dance, art, music, junior achievement, author studies, assemblies, and switching classes, target language teachers in Utah only have about two hours per day to cover all the requisite curriculum. This scarcity of time on task, or the time that students are actively learning, means that lessons can become condensed and rushed. This is particularly true with concepts that require learners to first learn large quantities of new vocabulary in the immersion language in order to understand the new information. For example, before students can discuss the advantages of animal adaptations, they need to learn vocabulary for adaptations specific to certain species. Thus, in order to effectively teach their students, immersion teachers need to approach teaching the content in a different way (Snow, Met, & Genesee, 1989).

One way to overcome time limitations is to integrate the core content area subjects that need to be taught with the French language arts program (Snow, 2002) - in other words, teaching reading and writing through math, science, or history. For example, instead of teaching vocabulary for the stories the students will read for the French language arts curriculum, and then separate vocabulary for the science program, a potentially more effective approach would be to select science-related texts in French and extract key vocabulary. These key vocabulary words would include words that foster better understanding of science concepts, as well as high frequency words that appear in texts of other genres. This is known as “academic language” (Zwiers, 2014). Research suggests that academic language is one factor that prevents learners from accessing and comprehending subject matter content and from comprehending language typically used in formal and professional settings (Zwiers, 2007). However, successfully streamlining two separate curricula is not a simple matter.

Although many teachers would probably agree that literacy integration could improve their content teaching, there are several key factors that impede its implementation. Limited time to plan, prepare, translate, and design materials is a significant challenge for immersion teachers (Walker & Tedick, 2000). Given that research-based materials grounded in authentic texts are not readily available, if literacy and content integration is to happen in Utah DLI instruction, it will be because these types of materials are hand-crafted by teachers to address district- and state-level curricular demands. However, because teachers have limited time for preparation, teachers have to sacrifice time from their personal lives in order to develop something new. Many teachers in non-immersion elementary school programs recover planning time by sharing ideas and materials during Professional Learning Community (PLC) meetings. However, although teachers are required to participate in PLCs, doing so seldom helps them prepare lesson materials, because everything that might be shared would still need to be translated and adapted for DLI. In other words, Utah DLI teachers rarely get the chance to collaborate and share ideas with others who teach the same curriculum in the same language as they do, as they are usually the only immersion teacher in their building and sometimes, their entire district. This makes motivating teacher change particularly problematic. Furthermore, there is scant research that explores the extent to which literacy content integration models can provide a quality educational experience for students in partial immersion programs, and if so, what type of program design is effective (Cammarata & Tedick, 2012).

Purpose of the Study

This mixed methods action research study explored the use of an integrated literacy unit based on the science core standards from the state of Utah, and examined its effects on French reading fluency and comprehension, science knowledge, and students' overall enjoyment of the experience. In order to examine these effects, the curriculum was first developed, incorporating Utah's 4^{th} grade English Language Arts standards as the basis of the French literacy objectives whereas the 4^{th} grade science standard of Utah Environments was used as the theme of these lessons. Next, students were assessed in French reading fluency and science knowledge as to determine their starting proficiency. After which, the 12-week integrated unit was taught to two partial French immersion classes, and reading and science posttests, a questionnaire, and interviews were conducted.

CHAPTER 2

Review of Relevant Literature

The following chapter will explore several issues that affect language and content development in immersion education. These issues include: the role that content-based learning plays in immersion education, the unique part that literacy plays in providing learners access to content, special challenges that at-risk students face in partial-immersion programs, and the ways in which time limitations affect effective teaching and learning. Additionally, this chapter will examine the pedagogical challenges of preparing students to read and communicate about science texts.

Content-Based Learning

Immersion education is founded on the principle of content-based learning, or learning a second language through the vehicle of content instruction. Content is defined as “any material that is cognitively engaging or demanding for the learner, and extends beyond the target language” (Met, 2007, p. 2). In Utah’s partial immersion model, known as “Dual Language Immersion” (DLI), language arts programs follow this loose definition of content. In the state of Utah, fourth through sixth grade French immersion DLI teachers are responsible for teaching 75 minutes of French language arts instruction four times a week, 45 minutes of science instruction three times a week, and math reinforcement for 20 minutes four times a week (Roberts, 2016). Although on paper the time allotted to teachers appears sufficient, many teachers struggle to cover all of the content required with their students in practice.

One challenge of this model is that the content contained in the various culturally authentic textbooks used in DLI programs may not align with the core content mandated by the state’s curriculum. For example, the fourth grade French language arts textbook provided by the state has a chapter on ecology which aligns with core science standards in France, but not in the U.S. In addition, science texts related to the state's core content are not used to teach language arts in the target language, even though teaching science content is the target language (TL) instructor's responsibility in fourth through sixth grades. In summary, the integration of literacy and core content has not yet been fully implemented in Utah's Dual Language Immersion curriculum model. This is problematic because literacy development is essential to meeting the core academic needs of immersion students.

Literacy is the key. Many students enter upper-elementary school with reading deficiencies which lead to academic failure. In 2001, 37% of fourth-grade students in the United States could not read at a high enough level to complete their grade-level work (U.S. Department of Education, 2001). In fact, students are four times more likely not to graduate from high school on time if they are not reading proficiently by third grade (Hernandez, 2011).

Just as literacy is the key to unlocking content knowledge in one's native language, teachers who teach in progressive language immersion programs need to ensure students' success by helping them acquire literacy in their second language as well (Cummins, 1998). Several researchers have agreed that reading difficulty is a primary reason students are exiting immersion programs (Fortune, 2010; Halsall, 1994; Obadia & Thériault, 1997). Notwithstanding, a large portion of immersion teachers are underprepared to face the literacy challenges their students may encounter in their native language, let alone in their second language (Lachance, 2017). This may be due to factors identified by Cammarata and Tedick (2012) in a phenomenological study of immersion teacher struggles that many immersion teachers confront, such as: limited immersion-specific teacher preparation, planning time constraints, limited instructional time, unrealistic district expectations for content coverage juxtaposed with the lack of accountability for target language acquisition. It is therefore essential that immersion teachers and administrators have appropriate training and materials available in order to increase learners' ability to acquire content knowledge through reading (Allington, 2002; Richardson, Morgan, & Fleener, 2012).

The immersion situation. Students in any type of class can be at risk of academic failure, but this risk is compounded in an immersion class where the literacy skills and content are being taught in students' second language (L2). However, in recent years, Genesee (2007) has concluded that most at-risk students can succeed in French immersion equally as well as if they were taken out of the program. Nonetheless, even if students leave an immersion program before third grade, they may still miss the benefits of early reading interventions that would otherwise have helped them to catch up to their peers (MacCourbey, Wade-Woolley, Klinger, & Kirby, 2004). Therefore, students that fall behind in early immersion classes risk not making grade-level benchmarks whether they stay in or exit an immersion program.

To ensure the synchronous development of both literacy and content knowledge taught in students' L2, teachers often need to provide students with the language skills for communication about a given topic as they teach each concept, which takes more time (Curtain & Dahlberg, 2010). As students' progress through the program and concepts become increasingly abstract, acquisition of academic content knowledge through the target language can become an even greater challenge, especially for struggling learners. Because many immersion programs need to find a way to solve this time issue, integrating literacy with content-based knowledge curriculum could possibly give teachers that precious time they need to properly teach all students.

Even if based on sound theories, implementing such an integrated program presents many challenges: 1) limited materials, 2) no model of how to create and implement an integrated unit, particularly in a 50-50 immersion context, 3) DLI program constraints such as limited planning time, frequent turnover of teachers and guest teachers from abroad, very little collaboration time with other DLI teachers, and the ever-pressing problem of how to modify instruction to help struggling learners (Watzinger-Tharp & Leite, 2017). Consequently, teachers who wish to experiment with this type of unit planning must rely on what has been discovered about literacy education and science education in general education contexts. The next section will reference research-based models of teaching reading and science and how those can be tailored to teach the Utah Core Science Standard of Utah Environments in a fourth grade DLI classroom in Utah.

Literacy and the Science Curriculum

One possible solution for the difficulty of teaching literacy and science within the time constraints of an immersion classroom is to infuse the teaching of reading and writing with the core science standards dictated by a particular district or state instead of treating language arts as separate from science. According to the National Academy of Sciences (2012), "Reading, interpreting, and producing text are fundamental practices of science in particular, and they constitute at least half of engineers' and scientists' total working time" (p.74). Thus, by incorporating elements of literacy into subject areas like science, students gain more practice with reading and writing skills while better preparing to be future professionals.

Strategies for teaching science. One of the primary challenges of teaching science and literacy simultaneously is that scientific texts are often difficult to understand. Four factors contribute to this difficulty. First, unfamiliar jargon and complex sentence structure may obscure meaning. Second, the need to know the precise meaning of words to understand a particular concept requires a different reading method than narratives. Third, the texts are often multimodal, or a mix of words, tables, and graphs (National Academy of Sciences, 2012).

Finally, immersion students will be reading these texts in a second language. In addition, the functional benchmark for fourth grade in the Utah DLI model is Novice High on the ACTFL Proficiency Guidelines for Reading (ACTFL, 2012). This indicates that these students are only prepared to comprehend reading in their L2 in familiar or concrete situations, which is often not the case in scientific texts.

Preparation for scientific texts. Research in cognitive psychology asserts that students' age correlates with their ability to function cognitively, noting that students of ages 7 to 11 generally function at the *concrete operational stage* (Piaget, 1964). This means that learners can begin using logic, though only when related to concrete objects. This complicates students' abilities to comprehend genres such as expository texts that often use abstract and unfamiliar language to address topics with which learners have little prior knowledge or experience (Best, Ozuru, Floyd, & McNamara, 2006). Therefore, when children are learning their first language, they generally encounter texts of a concrete and narrative style genre first, followed by more academic texts (Baker & Stein, 1978). Accordingly, some researchers have suggested that providing students a foundation of topics and vocabulary in a familiar reading setting would be a key building block to successful scientific text comprehension and creation (Chen, 2006). Furthermore, one promising strategy for overcoming these obstacles in immersion education might be to introduce students to scientific themes and vocabulary by the reading of narratives.

Learn like a scientist. Some researchers have noted that scientists do not only learn by reading, but also through experimentation and inquiry (Doris, 1991). Teachers can cultivate similar professional skills during science instruction by creating inquiry-based lessons in which students find answers to questions by testing their own theories and giving priority to evidence that guides their understanding instead of just relying on a teacher to give them the "right" answers (NRC, 2000). Such lessons are most effective when they foster “productive disciplinary engagement” (Engle & Conant, 2002). This type of engagement is manifested through the generation of ideas, asking questions, explaining and justifying ideas, and challenging others’ claims (NRC, 2007). Lessons that purposefully attend to productive disciplinary engagement may also facilitate students’ language development by providing opportunities for interpersonal interaction and collaboration. For instance, Long’s (1996) Interaction Theory suggests that students’ language development progresses as they participate in similar collaborative activities such as interpersonal speaking, listening, asking for clarifications, and negotiating meaning. Thus, it is possible that the coupling of scientific argumentation and interaction theory could result in students making simultaneous gains in both science and their second language. Just as research-based science curriculum is paramount to student learning, decisions made in the development of the literacy program are equally influential.

Considerations in Teaching Literacy

Partial immersion teachers face three primary challenges when it comes to developing an affective literacy curriculum. The first is developing student reading and content comprehension simultaneously; second, scaffolding texts to support knowledge acquisition; and third, supporting different types of communication.

Simultaneous Challenges. One of the biggest problems that immersion teachers face is that their students must acquire an understanding of academic content from texts written in a target language they are still learning (Cammarata & Tedick, 2012). This presents two principle challenges for immersion teachers: comprehension and production. As students read unfamiliar vocabulary in unfamiliar contexts, they often have a more difficult time with reading comprehension. This lack of understanding not only hinders students’ reading development, but their overall lexical development, which becomes a compounding problem as expectations of listening, reading, speaking, and writing become more demanding throughout their immersion schooling. Immersion research suggests that though large amounts of input result in high levels of communicative language, the level of linguistic accuracy is lower than expected (Swain, 1985). Lyster (2007) and Swain (1988) attribute this to the tendency of immersion teachers to focus more on content than language development. To combat this tendency, after comprehension is achieved, a shift should be made to focus on form (Lyster, 2015) in order to ensure the proper language acquisition of immersion students. Thus, many researchers in the field support the principle of Form-Focused Instruction (FFI). Three of the most promising components of FFI include: (1) noticing and metalinguistic awareness activities, (2) guided practice, and (3) opportunities for production practice. The success of FFI in K-12 as well as university settings support the use of FFI as a tool for correcting fossilized errors of second language learners (Lindseth, 2016; Lyster, 2004; Saito & Lyster, 2012).

Scaffolding texts. When using texts as a vehicle for content knowledge acquisition, it is important to scaffold the texts so that learners can successfully access and discuss content, as well as demonstrate their learning. Some studies suggest that scaffolding can also lower frustration levels, thus improving students' motivation and enjoyment (Guthrie, 2004). Research on reading comprehension suggests several principles that can provide guidance to teachers' scaffolding efforts. These include dividing lessons into pre-reading, during-reading and post-reading phases (Gibbons, 2002), asking learners to read with a purpose, and giving learners specific tasks to do while reading (Skehan, 1996).

Modes of communication. In addition to attention given to text scaffolding, consideration must also been given to the mode of communication that students will be practicing. The *World-Readiness Standards for Learning Languages* specify three modes of communication which should be emphasized throughout any unit of study in a foreign language class: interpretive, interpersonal, and presentational (NSFLEP, 2013). Students will be able to participate in each of these modes as they interpret meanings from texts, discuss what they are learning with peers, and then present what they learned in an interactive activity or in writing (Adair-Hauck, Glisan, Koda, Swender, & Sandrock, 2006). When this process is repeated throughout a unit, it enables students to be more prepared to use their language skills as they practice functioning in these communicative capacities in the target language.

One way to foster this type of student interaction during literacy activities is a peer reading program, or reading instruction in which students help their peers by reading and completing reading-related tasks in partnerships. Several studies suggest that peer reading programs aide struggling readers by increasing motivation to read, providing social support, and improving reading fluency (Fuchs, Fuchs, Mathes, & Simmons, 1997; Hodson, 2011). For example, in a study where seventh-grade boys peer tutored fifth-grade boys, Hodson (2011) found that as boys had the chance to read with other boys in French immersion, their motivation to read in French increased as reading became more of a social activity. In another peer reading program called Peer-Assisted Learning Strategies (PALS), pairs of students provided reading support to one another (Fuchs, Fuchs, Mathes, & Simmons, 1997). All levels of students who participated in the program showed reliably greater scores on their post-tests as compared with their pre-tests, which was not the case for the non-PALS students. Thus, incorporating peer tutoring into a reading program could be a beneficial strategy for improving students' reading progress.

In summary, immersion teachers must address the dual challenge of developing both second language literacy skills and academic content knowledge. Teachers must often rush their lessons in order to get through the required material in both subjects, and rarely have time to do spiral teaching, or systematically repeat concepts already taught in order to improve student knowledge retention. One possible solution to this problem is to integrate the literacy and science curricula to provide more time on task, as well as to deepen student acquisition of knowledge and skills in both content areas. However, models for integration are scarce, as are high quality materials to support teaching in this way, especially in Utah's DLI programs. This is in part due to the relative newness of partial immersion programs in the United States, the additional time needed to integrate subjects, and the lack of experts in immersion pedagogy who can develop such materials. Though an integrated literacy and science unit is a plausible solution to many of the problems immersion teachers face, we do not yet know the influence that an integrated unit would have on DLI learners' achievement in reading skills and science knowledge in Utah. Therefore, the purpose of this study is to find out how participating in a unit that integrates carefully scaffolded texts with communicative, inquiry-based science tasks may influence 4th grade French dual language immersion students' biliteracy development and understanding of science content knowledge.

CHAPTER 3

Methodology

The study will be guided by the following research questions:

1. How effective is the purposeful integration of literacy and science content instruction in teaching student reading skills as measured by the Indicateurs Dynamiques d'Habiletés Précoces en Lecture (IDAPEL)?
2. How effective is the purposeful integration of literacy and science content instruction in teaching student science knowledge as measured by Granite School District's science benchmark measures?
3. How effective is the purposeful integration of literacy and science content instruction in providing students with a positive dual immersion experience as measured by a questionnaire, classroom observations, video recording, and interviews?

Participants

This study was conducted with two fourth-grade French dual language immersion (DLI) classes of 58 total students at an upper middle class, suburban elementary school in a large city in Utah. All aforementioned students participated in the unit developed as part of this study, though findings are reported based only the data collected from the 53 of them (28 girls and 25 boys ranging in age from nine to ten years old) who consented to be participants. Six students spoke a language other than English at home, and two were heritage speakers. It is also noteworthy that there were four sets of twins in this particular group of students. In the school in which this study took place, every two weeks, the morning and afternoon classes switched the time that they had French instruction, which served to even out student behaviors and teaching expertise.

Curriculum. The curricular unit which served as the context for this study was developed based on Utah's Science Core Standard 5, Utah Environments. Key science objectives embedded in this standard required students to: (1) describe the physical characteristics of Utah environments, (2) explain how common plants and animals in Utah adapt to their environments, (3) classify Utah plants and animals, and (4) observe and record the behavior of Utah animals (Utah State Board of Education, 2002). In addition, the unit targeted five different skills using diverse topics from the fourth-grade Standards for English Language Arts: narrative reading, informational text reading, writing, speaking and listening, and grammatical language (Utah State Board of Education, 2002), although in French.

Curricular adaptations. For the purpose of this study, the language arts and science curricular content, which is usually taught separately, was restructured and integrated into a single unit. The main components of this integrated unit consisted of narrative stories with science themes, narrative book club booklets, scientific text reading, presentational writing, and interactive, inquiry-based lessons which combined science and literacy instruction. Each of these components is explained below.

Narrative stories with science themes. Narrative stories were chosen that covered science-based content specific to each objective of the unit standard (see appendix D for a complete list). Along with content, other factors in choosing the specific books included: reading level, illustrations, and students' ability to relate to characters in the books. Before each book club began, the teacher prepared students with varied activities such as an introduction to key vocabulary, picture walks, and whole class guided reading activities. Preceding the reading of a scientific text, students were instructed on formal schemata in regards to this genre. Students' attention was drawn to elements of the texts that may help them predict what they are going to learn such as titles, subtitles, illustrations, and charts. Following the brief introduction of each text, students participated in a book club.

Narrative book club booklets. Next, students were given the chance to choose a partner with whom they would work together on a given book club. While students worked with their partner, the teacher worked with small reading groups at a back table. A teacher-made booklet was developed for each text to scaffold student-led work. All of these booklets were customized, drawing on specific details from each of the individual stories in ways that reinforced the targeted standards-based science and language arts content embedded in the unit. However, all of the booklets were structured so that they engaged students in a similar series of tasks for each story. First, students made predictions about the text. Second, students performed a task that focused on text comprehension. Third, students looked through the text for scientific information that could be gleaned from the story. Fourth, students focused on the form of the text in order to work with a highlighted grammatical structure that appeared repeatedly in the text.

Scientific text reading. After completing the narrative story booklets in pairs, students read scientific texts about the same topic that had been introduced in the narrative text, and then completed various graphic organizers (see appendix E for a complete list of these texts).

Presentational writing. Students completed two different writing compositions during the unit. They first wrote a creative story about an animal in a Utah environment, and next an informational text about a national park in Utah. These presentational writing assignments mirrored the interpretive reading students had done for both narrative and scientific texts in that they followed the genre patterns while the content focused on similar scientific themes.

Inquiry-based lessons. Interactive science lessons were also infused in the unit of study. These lessons asked students to question their own knowledge and learn independently through their own discovery. For example, students role played desert plants, and if they did not have environment specific adaptations, they experienced the “life or death” results observed by actual plants according to their conditions.

The unit was carefully designed to address fourth grade students’ developmental maturity (Piaget, 1964) and need for scaffolding (Skehan, 1996), while deepening their content knowledge (NRC, 2000). In addition, linguistic ability (ACTFL, 2012), specific strategies for increasing language proficiency (Lyster, 2015), and reading comprehension through peer tutoring (Fuchs, 1997) were put in place.

Data Sources

Data for this study was collected from five different sources: reading tests in French and English, a district science benchmark test, a student questionnaire, classroom observations, and video recordings.

DIBELS/IDAPEL Reading Test. *The Dynamic Indicators of Basic Early Literacy Skills (DIBELS)* test is administered individually to all students enrolled in the elementary school three times per year to measure English reading fluency, accuracy, and comprehension. This tri-yearly benchmark serves to make certain that struggling readers receive the early interventions needed to ensure they are reading at grade level by the end of third grade. The DIBELS data were collected at the beginning and end of the study in a classroom with five students working one-on-one with a team of reading specialists. Likewise, the *Indicateurs dynamiques d'habiletés précoces en lecture test (IDAPEL)* is designed to measure these same aspects of reading, but in French. Students took the IDAPEL in the hallway with their teacher around the same time as the English reading test. No more than five students from each class were tested per day to ward against tester fatigue which could have posed an instrument decay threat to internal validity.

These tests measured students' average growth in both English and French reading skills, and allowed for English and French reading growth pattern comparisons to be made. Reading scores were analyzed through paired *t* tests to assess student growth from before and after the unit was taught. In addition, a Pearson correlation was calculated between student French reading and English reading growth.

Science knowledge test. Granite School District has made optional pre and post benchmark tests for each science concept. Students in this study took the benchmark test for Standard 5, Utah Environments, on Chromebooks in their classroom at the commencement and conclusion of the unit. This online assessment is aligned with the Utah Core standards that Utah public schools follow in order to prepare learners to take the Student Assessment of Growth and Excellence (SAGE) test at the end of the year. Data from these tests assess the growth of science knowledge about Utah environments based on the material taught. Student scores were analyzed through paired *t* tests to assess student growth before and after the unit was taught.

Questionnaire. Students completed a questionnaire in simple French on Qualtrics containing 12 multiple choice questions and two short answer questions. The questions asked students to rate the degree to which they learned from reading stories, scientific texts, their partner, and from class activities on a scale of 1 to 4. In addition, it asked students to express what part of the curriculum they most enjoyed, to rate activities in order of enjoyment, and to explain why they liked or disliked these assignments. Questions were read aloud to students with very low reading proficiency. Student responses were added in order to reveal overall student attitudes for quantitative questions. Qualitative questions were analyzed using open-coding that revealed patterns and themes in their responses.

Videotaped observations. Observation data came from two sources: video recordings and in-person observations. Video recordings were collected during these same full class periods by a member of the research team on the sixth, eighth, ninth, and twelfth weeks of the study. These recordings were used to provide a more complete and reliable picture of how students engaged with the content and the materials, as well as how their interactions influenced uptake. For each week during which video recordings were collected, a representative sample of videos were chosen from both the morning and afternoon classes and transcribed. Student dialogue was then coded and analyzed based on evidence of "productive disciplinary engagement" (NRC, 2007).

Interviews. A purposive sample of three struggling readers, four average readers, and three strong readers were chosen as interview participants. Students were separated into these three categories based on their French reading pretest scores, and then a computer program was used to select the random sample of students who were interviewed from each level. A semi-structured interview protocol containing open-ended questions gave students a chance to more fully explain what they liked or did not like about the unit, how they thought the unit helped them learn about science, and whether or not they thought the unit increased their reading and writing skills. To strengthen the validity of students' responses, the interviews were administered privately, by a research team member who was not their teacher, in students' L1, and not during recess. These data were collected to enable the research team to examine whether or not the curricular adaptations that were employed were flexible enough to engage struggling and average learners, as well as learners who excel. Interviews were transcribed and coded question by question based on the original research questions to identify patterns in student responses.

CHAPTER 4

Findings

Language Development

French reading fluency. Students' growth in reading was measured through the IDAPEL test (see Table 1). This test measures reading fluency using timed readings, and reading comprehension using a reading retell task. Results from the reading fluency paired *t* test on words read correctly in one minute indicated that statistically significant growth occurred in French reading fluency from the pre-test (M = 63.28, SD = 22.88) to the post-test (M = 71.11, SD = 23.70), $t(52)$= -6.09, p < .0005 (two-tailed) with a large effect size of .42 (< .14, Cohen, 1988) analyzed using eta squared. In other words, after the 12-week integrated unit, students made significant progress in their French reading fluency. However, when students' performance was examined using a retelling task, no statistically significant growth was found from the pre-test (M = 24.36, SD = 13.45) to the post-test (M = 23.98, SD = 12.42), $t(52)$ = .32, with a small effect size of .002.

Table 1

Student French Reading Growth

Measure	*n*	*M*	*SD*	*t*	Eta Squared
Fluency Pre-test	53	63.28	22.88	-6.09*	0.420
Fluency Post-test	53	71.11	23.70	-6.09*	0.420
Comprehension Pre-test	53	24.36	13.45	0.32	0.002
Comprehension Post-test	53	23.98	12.42	0.32	0.002

*p < .0005

The broad picture of student growth provided by the French reading test data in Table 1 was reconfirmed by questionnaire, observation, and interview data. For example, in the questionnaire given to students after the completion of the unit, 97% of learners responded that reading in French was easier for them than at the beginning of the unit. In addition, observation data and field notes indicated that students required less teacher assistance and asked fewer questions about task instructions and word meanings when completing the reading booklets at the end of the unit as compared with at the beginning. However, because students worked with different partners to complete the four different reading booklets throughout the unit, it was not possible to compare changes in the quality of work of individual students. Though individual student progress could not be measured, these reading booklets demonstrated consistent patterns in learners' performance that corresponded to their reading levels in French. For instance, low readers' reading responses often consisted of a list of (not always accurate) words that included frequent repetition of ideas, whereas middle readers responded in short sentences, but often did not fully explain their ideas. By contrast, high readers completed the reading tasks completely, correctly, and in full sentences. Thus, although students worked with different partners while completing the booklets, their personal reading levels clearly impacted the quality of their individual responses to the tasks in the reading booklets.

Whilst the test data and the booklet analysis provided insight into student progress and how that progress was manifested, interview data revealed why students thought their reading skills had improved. The most consistent response was that the "book club" (i.e., reading stories and scientific texts with a partner, guided by the reading booklets or other tasks) helped them improve. Although students did not comment on changes in their reading fluency, and although there were no statistically significant differences in students' retell scores, student's interview comments indicated that they believed their reading comprehension had improved. For example: "They're really helpful. They help you understand more" (low level reader). Another student credited his progress in reading comprehension while participating in book club to the fact that tasks in the reading booklets required repeated readings.

> It makes you go back and read it, and I really like that kind of stuff because then it's like you're kind of into that world. You know what's going on. One time I just read a book and I didn't really understand it clearly. And so I read it again, and again, and again and I understood it. So, I like that I've gotten better at it, and I like that we do that so I can get better at it (high level reader).

One student specifically mentioned how the formal schemata instruction helped her read scientific texts, "And actually, I think it's [reading scientific texts] easier because it [a scientific text] has the small headings, and it has the title, and I just think that's easier" (mid level reader). Only one out of the seven students interviewed did not think that the reading booklets helped him. "I don't really like 'em a lot because you just sit there at your desk and read the book and try to find facts, but it's kind of hard to understand the words" (mid level reader).

Uptake of academic vocabulary. Another pattern of improvement found in students' language development during the analysis of the video observations was the ability to use new academic language. Students used new vocabulary introduced during the unit to talk about the scientific content, to negotiate the meaning of the content being learned, and to convince others of an opinion. For example, in one conversation transcribed below, a student persuades her partner to accept her opinion about the story direction based on scientific logic. In collaborative activities, students also used this academic language to sound more persuasive. Video observation data of pre-activity instruction revealed that the teacher habitually reminded students throughout the unit that they could sound *très scientifique* (very scientific) if they used the academic language taught. The video data also clearly demonstrated student uptake of this strategy. For instance, after several attempts to be heard, one student who wanted her idea to be the group's choice said, referring to a sentence frame on the board, *À mon avis, cette plante fait* *partie des pins parce que* . . . ("In my opinion, this plant is part of the pine group because . . ."). It is interesting to note that the teacher also observed students using expressions such as *à mon avis* ("in my opinion") and *personnellement, il me semble que* ("personally it seems to me that"), both spontaneously during class to explain their ideas about other academic content, as well as outside of class while working on an optional art project with another student during recess time. The spontaneous use of these phrases, particularly while "at play," offers convincing evidence that the academic vocabulary students are learning in class is actually transferring into their daily oral language.

In addition, this increased use of academic language was found in students' narrative and informational writing. Though each students' story was independently written and unique, the most consistent uses of vocabulary included words from the weekly vocabulary lists such as Utah native animals and environment types. Many students used a variety of sentence frames that were presented as a part of pre-writing activities such as *il était une fois* ("once upon a time"), *qui s'appelait* ("who was named"), *le probleme était resolu* ("the problem was resolved"), and *tout à coup* ("all of a sudden"). Although a large majority of the students used these sentence frames, many misspelled them or twisted them to be more aligned with expressions they know in English, despite the fact that they had accurate examples in front of them.

Increased metacognition. Additional growth in student language development was manifested in their improved ability to ask and answer questions, argue, and coach each other with regard to the accuracy of their language use. The following three examples of student dialogue extracted from transcripts of video observations show each of these metacognitive uses of French that occurred during classroom activities.

Asking and answering questions about accuracy. The first conversation took place after students had read a narrative text together for book club about the classification of animals, and were working to answer the booklet science comprehension questions based on what they had read. The video captured students asking each other for help, followed by both students successfully correcting or helping one another (though one student's question was about understanding the instructions, while the other's questions were about spelling). Student's speech was transcribed verbatim below and throughout the findings section, which includes their grammatical errors. After reading the instructions and not understanding, Student 1 asks:

Student 1: Est-ce que tu comprends ? (Do you understand?)

Student 2: Oui, tu juste écris les similarités et les différences. (You just write the similarities and differences.)

Student 1: Est-ce que tu peux aide moi ? (Can you help me?)

Student 2: Oui ! Le paon a des plumes, et . . . (Yes. The peacock has feathers, and . . .)

[Student 2 gets out eraser and erases the last word "et" (and) on her own paper]

Student 1: *[Student 1 looks at her partner's work as her partner rewrites "et" (and) as "e-s-t" (is) on her own paper.]* Non, e-t. (No, e-t.) [These two words are heterographs, or words that are pronounced the same, but have different meanings and spellings in French. Consequently, they are often confused in the student writing of both native speakers and foreign language learners.]

Student 2: *[Accepts correction and erases again to change what she has written back to e-t]*

Student 1: Est-ce que ça c'est comment tu écris ? (Is that how you write that?)

[Student 2 looks at Student 1's writing, then correctly spells the word out loud. She then erases what she had written and rewrites the word while spelling it out loud.]

Student 1: P-a-t-t-e. Patte. (L-e-g. Leg.) [*When she finishes, she says the word out loud again.]*

From this interaction, it is clear that students were willing (and able) to ask for help from their peers in order to fully understand and complete the task accurately. Moreover, not all of the corrections occurred in response to a peer's question, which reveals both students' sensitivity to inaccuracies and their developing ability to coach one another.

Arguing about accuracy. Although students sometimes corrected each other, they did not always easily accept someone else being right. In the following excerpt from a video observation transcript, two students are collaboratively writing a story about the food chain of an eagle. They not only correct each other's grammar, but also unyieldingly argue about who is right or wrong regarding the pronunciation of the word *aile*, or wing.

Student 1: Quand il voler -- (When he flies--)

Student 2: Pendant qu'il voler -- (While he flies--)

Student 1: Oui, au le, au le -- (Yes, to the, to the--)

Student 2: Il peut pas voler à une autre île parce que, il ne peut pas voler parce que il a cassé son bra. (He can't fly to another island because, he can't fly because he broke his arm.)

Student 1: Il a cassé son aie. (He broke his wing [*mispronounced*].)

Student 2: Non. "Aie ?" Non, "aile." (No. "Wing?" [*pronounced incorrectly like Student 1*] No, "wing." [*pronounced correctly*])

["aile" *means wing, but is a heterograph with the word "elle", or she in French*]

Student 1: "aie" (wing) [*mispronounced*]

Student 2: Non, c'est une "aile". Et il peut pas nager dans l'eau --. (No, it's a wing [*pronounced correctly*]. And he can't swim in the water--)

Student 1: Ha, oui.

Student 2: Parce que il a cassé le aie. (Because he broke his wing.) [*says the word wing wrong like Luke had been miscorrecting*]

This conversation shows the students correcting each other's grammar, vocabulary use, and ideas regarding story flow, but the most substantial element is their ongoing argument about pronunciation. Neither student yields to the other by the end of the conversation or acknowledges who was right. However, when the word in question *aile* ("wing") comes up later in the story, the student who had vehemently opposed the mispronounced word changed her pronunciation so that it matched that of the other student. This conversation demonstrates metacognition in action, or learners' ability to reflect on their language use, and to use that reflection to self and peer correct. This conversational excerpt also provides evidence that students are aware that there are right and wrong ways to speak and write in French, and that some students uptake peer corrections, whether they are accurate or not.

Coaching peers with the aim of increasing their accuracy. Peer correction continues in the next video-captured conversation below. However, in this example, the weaker student does not ask for help, nor do the students argue about the right answer. Instead, the stronger learner coaches her partner in making conjugation decisions as they work together to complete the exercises in their reading booklets.

Student 1: [*Student reads sentence from the booklet out loud*] "C'est la rentrée scolaire, tous les animaux se rend/se rendent en classe." Qu'est-ce que tu penses ? ("It's the first day back at school and all the animals come/comes into the classroom." What do you think?)

Student 2: [*Looks at options and points to "rend."*] Rend ? (Comes?)

Student 1: Non, à mon avis, c'est "rendent" parce que c'est TOUS les animaux. (No, in my opinion, it's "come" because it's ALL the animals.)

Student 2: D’accord. (Ok.)

Student 1: Car c’est plur [*Meaning pluriel (plural).*] (Because it’s plural.) *[Both students mark the right answer.]*

Student 1: [*Points to the next question*] D’accord, est-ce que tu veux de lit ? (Ok, do you want to read?)

Student 2: D’accord. “Comme il ne connaît personne, il reste/restent à part…” (Ok. “Since he didn’t know anyone, he stay/stays by himself.”)

Student 1: Donc est-ce que ***il*** est pluriel ou singulier ? So, is he (il) plural or singular?

Student 2: Singulier.

Student 1: Donc, “reste.” (So, “stay.”)

In this conversational excerpt, Student 1 acted as the coach, not giving all the answers, but instead invited her partner to think about how to make the right choice. It is noteworthy that Student 1 asks Student 2 questions she thinks Student 2 *can* answer which will also, in turn, lead Student 2 to make the right conjugation choices. When Student 1 does give an answer, she explains how she came to that conclusion. By the end of the video from which this excerpt was taken, Student 2 successfully recognizes the third person singular and third person plural conjugation pattern (not depicted in the dialogue above). It should be mentioned that these two students were best friends, which could account for the ease of interaction during the coaching effort. Nonetheless, this conversational exchange demonstrates that students’ growth in metacognitive awareness extended well beyond the occasional incidental application of these skills to encompass intentional, goal-oriented, and strategic uses as well.

In summary, quantitative data demonstrated statistically significant growth in reading fluency, while qualitative analysis of video data regarding students’ literacy development indicated clear uptake of academic language and improved metacognitive awareness and linguistic accuracy (as demonstrated by peer/self-correction).

"Productive Disciplinary Engagement" in Science

Findings regarding students' growth in science revealed that learners made gains in three main areas: general science knowledge, conceptual understanding, and creating and defending scientific theories. Their growth in these areas seemed to follow patterns similar to those noted in their literacy development: namely, learners made statistically significant gains in their knowledge and understanding of targeted science concepts, which were clearly visible in their "productive disciplinary engagement" with the targeted content. In other words, learners clearly demonstrated their uptake of science-related language and content in the questions they asked, the ideas they generated, and the ways in which they explained, justified, and challenged one another's ideas and claims. This engagement was evident in learners' speaking, writing, and collaboration, as well as in the corrective feedback they provided to one another.

General science knowledge. Students' science knowledge growth was examined using a district-made online test. The paired *t* test analysis conducted with the science test scores indicated that there was a statistically significant increase in science knowledge from the pre-test ($M = 10.49$, $SD = 2.28$) to the post-test ($M = 12.25$, $SD = 2.13$), $t(50) = -6.41$, $p < .0005$ (two-tailed). The eta squared statistic (.45) indicated a large effect size. This reveals that students can achieve significant growth in science using an integrated, literacy-based curriculum.

Growth in general science knowledge within low-, middle-, and high-performing groups. In order to explore the rate at which students' science knowledge progressed, students' scores on the science pretest were listed in numerical order, and then divided according to equal percentages in order to form low, middle, and high-performing groups (i.e., 33% of the students were placed in each group). Although students at each level showed growth, and growth at each level had a large effect size, only students in the low and middle groups demonstrated statistically significant growth in science knowledge (see Table 2). The lowest group made the most statistically significant growth from the pre-test (M = 8.43, SD = 1.53) to the post-test (M = 11.04, SD = 2.36), $t(22) = -5.61$, $p < .0005$ (two-tailed), and the eta squared statistic (.59) indicated a large effect size. However, the growth displayed by the middle group had an even larger effect size (.64).

Table 2

Student Science Growth Divided by Science Pre-test Data

Measure	*n*	*M*	*SD*	*t*	Eta Squared
Science Pre-test: All students	51	10.49	2.28	-6.41*	0.45
Science Post-test: All students	51	12.25	2.13		
Science Pre-test Low	23	8.43	1.53	-5.61***	0.59
Science Post-test Low	23	11.04	2.36		
Science Pre-test Middle	11	11.00	0.00	-4.22**	0.64
Science Post-test Middle	11	12.64	1.29		
Science Pre-test High	17	12.94	0.66	-2.07	0.21
Science Post-test High	17	13.65	1.12		

Note: $*p < .05$ $**p < .001$ $***p < .0005$

Relationship between pre-test reading levels and growth of students' science knowledge. In addition, the science growth of low, medium, and high groups divided according to their scores on the reading fluency subtest was also examined. This was especially important because there was an emphasis on learning science content by reading in the target language for this particular curriculum. Table 3 displays the science growth made by each reading group during the unit. Although each reading group made progress in science, the low reading group and the high reading group were the only ones who made statistically significant growth in science. The high reading group made the most progress in science from the pre-test (M = 11.29, SD = 2.23) to the post-test (M = 13.59, SD = 1.39), $t(16) = -5.61$, $p < .0005$ (two-tailed). The eta squared statistic (.66) indicated a large effect size, three times larger than the middle reading group's effect size.

Table 3

Student Growth in Science Based on Reading Pre-Test Level

Measure	*n*	*M*	*SD*	*t*	Eta Squared
Low Reader Science Pre-test	18	9.39	1.98	-3.90**	0.37
Low Reader Science Post-test	18	11.28	2.27		
Middle Reader Science Pre-test	16	10.88	2.31	-2.08	0.22
Middle Reader Science Post-test	16	11.94	2.02		
High Reader Science Pre-test	17	11.29	2.23	-5.61***	0.66
High Reader Science Post-test	17	13.59	1.37		

Note: $*p < .05$ $**p < .001$ $***p < .0005$

In addition to the formal pre- and post-science assessments, students were given teacher-made formative assessments for each science objective during the unit. These assessments were structured using state made science proficiency scales, which break each objective of the Utah Environments Unit into four segments that progressively build toward the final science proficiency goal. These formative assessments employed a variety of methods to obtain information about students' ability to apply science content knowledge. A few examples included classifying pictures, creating models of different biomes, and describing plant and animal adaptations. To pass each assessment, students needed to score 75% or higher. If they did not, they were given a chance to study, to receive small group instruction, or both so that they could better understand the concept before retaking the assessment. An average of 94% of the students participating in this study passed the 12 assessments, showing that they had achieved the desired objective.

Students' self-perceptions of growth in general science knowledge. Another indication of students' science progress was their own opinion about their scientific growth. When students who were interviewed were asked if they had gotten better at science, every student responded positively, though they did not all give the same reasons for thinking they had improved. Two out of seven students explained that they thought they were better at science because of the success they had experienced on their formative science quizzes. For example, one student said, "I think that when we did the science tests, I did better than I did [on] the pre-tests." When asked to provide a rationale for why they were better at science, students consistently gave specific examples of projects and activities in which they had participated that they felt demonstrated their learning. Representative examples include responses such as: "Because we write reports about different . . . national parks, and the life cycle." Another student explained,

> And another thing that we did in science was when we were doing stuff about animals, she let us watch a video about it and we could watch the video, and then see how the animals adapted to their place where they live, and then we could write down our observations when she paused it.

It should be noted that patterns in students' responses indicated an awareness of the instructional context (in this case, animals), the targeted science content (i.e., animal life cycles, habitats, and adaptations), and the specific pedagogical strategies and learning tasks (e.g., we could write down our observations when she paused it) that contributed to their learning. It is particularly noteworthy that learners' responses to interview questions explicitly highlighted integrated connections between language arts and science curriculum, such as "we could write down" (a literacy task) "our observations" (a science task) "when she paused it" (an instructional strategy).

Conceptual understanding and scientific reasoning. Researchers were interested in whether or not students' metacognitive awareness about their own learning, and their ability to cite specific examples of the conceptual content they were learning, transferred into an actual ability to apply that knowledge to other tasks. For example, students might be able to recite the characteristics of various animal classes, but until they are observed making classification decisions based on that new information, it remains unclear if they have acquired more than solely a conceptual understanding of the topic. Video observations provided an impressive source of evidence of the uptake of targeted science content, and revealed that students were, indeed, able to apply what they had learned to another task. For example, the following conversation was captured while students worked in groups of four to classify plants based on a classification system they generated collaboratively.

Student 1: Ces plantes *[pointing to several plant specimens lying on the table]* sont dans le même groupe et ces plantes *[gesturing to several other plant specimens on the table]* sont dans le même groupe parce qu'ils vivent presque dans le même, sp . . . euh ("These plants are in the same group and these plants are in the same group because they live in about the same . . .uh")

Student 2: Space

Student 1: Oui, euh parce que si tu regardes là *[student shows the back of the plant specimens to peers, indicating the map of Utah on the back of the specimen and the dots on the map that show where the plant lives]*, il n'y a pas beaucoup de feuille qui vivent là, et ils plus vivent là et là.

("Yes, uh, because if you look here, there aren't a lot of leaves that live there, and there are more that live there and there.")

Student 2: Où il vit *[points to the information on the back of the plant, then flips back to show the plant side]* affecter ça. [*student again points to the plant*] ("Where it lives affects that")

Student 1: Oui, oui. ("Yes, yes")

Student 2: Ils sont adaptés d'où ils vivent. ("They are adapted to where they live.")

Student 1: Oui, parce qu'il y a beaucoup de différents places où ils vivent. Euh, et comme si ça vivent là, ça c'est le désert, il n'y a pas beaucoup de plantes dans le désert. Oui, juste ces deux. ("Yes, because there is a lot of different places where they live. Um, and like if that lives there, that is the desert, and there aren't a lot of plants in the desert. Yes, just these two.")

In this discussion, Student 1 was explaining to Student 2 (who was from a different group) why his group put each of the plants in their respective categories. Student 2 agreed with Student 1 and helped him to verbalize and clarify his reasoning. Note that in Student 2's first attempt to explain, he used very simple language, whereas his second attempt demonstrates uptake of academic language and improved sentence structure. Both of these students applied what they had learned from the previous science objectives about biomes and adaptations to justify their classification decisions. Along the same lines, the following example occurs while a group of students was trying to reason through the classification of various animals based on images contained on different cards. One student used what she had learned from reading a scientific text about amphibians during a jigsaw activity the class had previously completed in order to make a conclusion during this activity about the scientific class of the snail on her card.

Student 1: L'escargot vit, quand je suis dans le groupe amphibien il dit que tous les amphibiens vit dans l'eau et la terre, mais l'escargot vit juste dans la, sur la terre. ("Snails live, when I was in the amphibian group they said that all amphibians live in water and land, but snails live only in the, on the land.")

These representative examples provide clear evidence that students were able to reflect on, analyze, and use what they had learned during previous portions of the unit in order to collaboratively construct a clearer understanding of science concepts and content that were subsequently introduced. However, as was the case with literacy, students were not always in agreement regarding the outcomes of their peers' final conclusions about the science content in question.

Scientific argumentation. General science knowledge, in combination with conceptual understanding, prepares students to do what scientists do best: create and defend theories. The video data that follow captured students creating a story about ecological imbalance. During this exchange, students argue about the direction of the story, but one student manages to convince his group of the scientific logic behind his decision.

Student 1: Tout les serpents sont malades. ("All of the snakes are sick.") *[Spells the end of the word serpent in French]* E – N – T [Idea for the problem]

Student 2: Car tout les plantes sont pois . . . a le poison sur le. ("Because all the plants have pois...poison on them.") [Reason for the sickness]

Student 1: Car on a mangé les plantes avec de poison. ("Because we ate the plants with poison.")

Student 3: *[Reads aloud what he is writing]* Car il y a ("Because there is…")

Student 1: De poison sur le. ("Poison on it")

Student 3: [*Student speaks aloud what he is writing*] Quand le rat-kangourou mange -- ("When the kangaroo rat eats--")

Student 1: Mais on parlait sur les serpents, pas les rats kangourous. ("But we're talking about snakes, we're not talking about kangaroo rats.")

Student 3: Oui, mais quand le rat kangourou mange le plant, oui ? ("Well, but kangaroo rats eat plants, yes?")

Student 1: Oui

Student 3: Et quand il mange beaucoup de plantes, il y a de poison et le rat kangourou est mort. ("And when they eat a lot of plants, there's a lot of poison, and then the kangaroo rat dies.")

Student 1: Et après le serpent mange le rat-kangourou. ("And after, the snake eats the rat kangaroo.")

After the opposition of Student 2, Student 1 explained his reasoning step by step, checking along the way to ensure that the other students still agreed with his logic up to that point. Student 2 showed his acceptance of the idea by using Student 1's logic to finalize the plot and conclude the story. In this discussion, Student 2 displayed impressive conceptual understanding of science content, and a sophisticated ability to explain and justify that understanding to his partners.

The literacy-related findings of this study indicated that students frequently negotiated the accuracy of their French writing or speech. In these examples, we also see students negotiating meaning around the science content. This negotiation, or linguistic collaboration, played a large role in how the students experienced the unit. For many, the peers with whom they worked with had a large impact on their enjoyment of or dissatisfaction with the assignments.

Student Perceptions of the Learning Experience

What helped students learn. Students were asked on the Qualtrics questionnaire what activities they thought helped them to learn the science content. It was found that 76% of students thought the hands on activities helped them learn the most, followed by 71% that thought the scientific texts helped them learn about Utah environments. In addition, more than half of the students agreed that their partner and the environment stories helped their scientific uptake.

Table 4

Students' Perceptions of What Helped Them Learn

Survey Item	Percentage That Responded Extremely or A Lot
The activities that we did helped me learn about Utah environments.	76%
The scientific texts that I read helped me learn about Utah environments.	71%
My partner helped me learn about Utah environments.	56%
The environment stories that I read helped me learn about Utah environments.	53%

What students enjoyed. Students' perceptions of the unit were analyzed through a Qualtrics questionnaire, field notes, and interviews. The data revealed that students had a wide range of preferences when it came to what they liked most about the curriculum, though the majority of students mentioned the interactive activities as one of their top three favorites (see Figure 2).

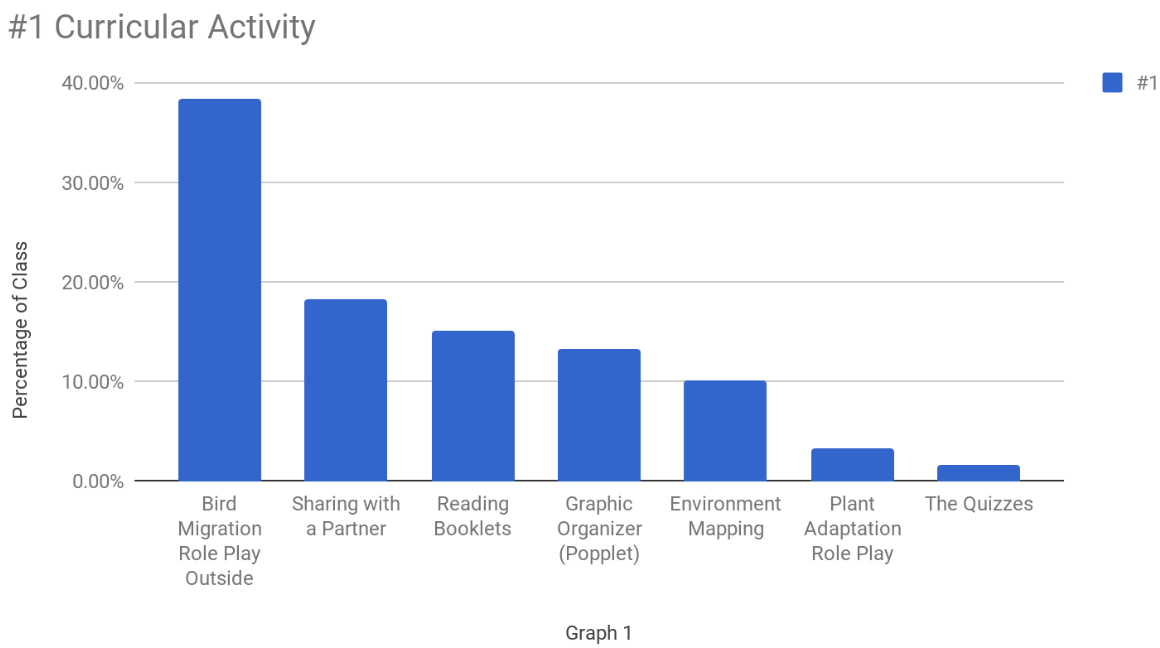

Figure 2. *Curricular activities presented from most to least enjoyable, based on students' questionnaire responses*

Factors that influenced student enjoyment. An open-ended follow-up Qualtrics question asked students to identify why they liked their favorite activity. Four main themes surfaced explaining their preferences: the activity was interesting (21%), there was movement involved (14%), the student felt successful doing it (14%), or the activity was social in nature (10%). These preference patterns were reconfirmed by students' responses to open-ended survey questions and interview questions about the unit. Certain activities piqued students' interest, such as the animal observation activity this student describes: "I just thought it was fun to watch the other animals be themselves when they are out in their own little place. And how, I thought that was also really interesting that some of the animals fought for fun . . ." Other students mentioned liking a specific activity because they were successful at it, as this student explained on the questionnaire: *"J'aimais les évaluation car je comprends et car c'est très intéressant" (*"I liked the quizzes because I understand and because it's very interesting.") Another important factor learners raised was that opportunities for social interaction made activities more enjoyable. While talking about the reading booklets in an interview, one student said, "And it was really fun because it was informational, and it was just fun working with friends."

The most popular activity, the Bird Migration Role Play, provides a useful example of how these distinct factors (i.e., individual interest, physical participation, situational success, and social satisfaction) that converged to affect students' perceptions of the learning experience. As the title of the activity suggests, bird migration provided both the conceptual context and the academic content for the learning experience. Learners' primary task was to "migrate" from an area on the playground that had been designated as their "nesting environment" to their "winter environment." Throughout the role play, students had to "fly" back and forth between these two environments, suffering losses and surpluses depending on the weather and human made circumstances. When asked to talk about the activities that helped them learn, approximately half of the students interviewed commented enthusiastically on this activity, as in this representative response:

> I think that she could let us do a little bit more of science, because **the science that she does is so fun**. Like once, she did a bird activity, and...we also got to eat Pringles with it, because our Pringles were our beaks, and we would be birds migrating. And she would take away plates because the plates were water land, and the birds have to migrate to water land. **And two people can be on a plate at once, and if you're not on a plate, you have to go stand with the other birds that didn't survive** because of all the things that could go wrong in migrating. **We found it out by doing it ourselves.** Like, one of them was someone built a Walmart over a big part of water land, so she took away five plates; or, it's been really hot, so she took away two plates. So there's all these things that

> could go wrong when you migrate, when birds migrate. And, **I just thought that was really fun to do science that way. I think it actually did help me learn more French, because the more science that I did, the more French that I learned about [emphasis added by the research team].**

This student's response illustrates that the activity engaged learners in physical, mental, and social ways that resulted in both a personal sense of accomplishment and an improved understanding of academic content. Students also commented on their emotional engagement:

> And there's this bird one uh, migrating, and she put out plates and you have to go there to survive the winter. And you like put chips in your mouth so it looks like a duck and when you flap your arms that was really funny. We all understanded it, so yeah.

Other data sources, such as observations and field notes, provided further evidence of students' emotional engagement. For example, when students "died" during the simulation because of the negative environmental impact of human actions such an oil spill or new construction, they made a show of it by "dying" dramatically. The teacher anecdotally observed, "I knew that students really enjoyed the activity if I could hear them planning to recreate it at recess, ask to do it as a fast finisher, or ask to do it again in class." One of the most interesting things about findings from the interview data was that in most cases, students didn't simply remark that they enjoyed the activities because they were fun. In most cases, they also indicated that the tasks had affected their learning. However, students did not enjoy all of the activities they completed during the unit equally.

Factors that negatively affected student enjoyment. Students' reasons for why they disliked specific activities on the Qualtrics questionnaire were predictable. The most repeated themes were frustration because of difficulty (39%), disinterest (19%), and partner problems (12%).

Difficulty and disinterest. In student interviews, it was mentioned several times that students did not like feeling slower than others while working, particularly if it meant they had to stay inside during recess because they had not finished their work. For example, one student expressed her anxiety at not being as fast as the others on the reading booklets, “They’re fun, but sometimes people are ahead of you [and] you get a little stressed because you want to go to recess and she’ll pull you in from recess cuz you have to finish it.” A similar reaction was noted among students who did not pass an evaluation and had to participate in a small group re-teaching session during their recess break as a result: *Cetait dur et stressant* (“It was hard and stressful”). In terms of disinterest, many students noted that certain activities simply did not capture their personal interest. For example, *Je n'aime pas le Poplets parce que c'est pas plus interessant pour moi.* (“I do not like the Popplet because it is not very interesting for me.”)

Partner problems. Regardless of which activity students were participating in, if they had a problem with a partner, they perceived it as a negative experience. Students’ frustrations included disliking their partner, wishing for more variety in partners, and feeling there was an unfair imbalance in the workload during partner work: *Car mon partenaire ne fait pas beaucoup et j'ai 2X le travaille.* (“Because my partner doesn’t do much and I have two times the work.”)

In short, three principal factors seemed to affect students’ engagement, enjoyment, and development in both positive and negative ways: (1) individual interest in the assigned topic, text, or task; (2) structured opportunities for physical and social interaction with content and peers; and (3) the extent to which learners experienced a feeling of success in conjunction with the activity.

CHAPTER 5

Discussion

Findings from this study revealed that learners made statistically significant improvements in reading fluency and understanding of science content, demonstrated uptake of academic language, and showed improved confidence in their reading abilities and personal enjoyment of learning. This suggests that the strategic integration of literacy and science into a single curriculum can yield positive learning outcomes while saving time for teachers to teach concepts at a deeper level, though such integration takes careful planning, time, and resources.

Three factors appeared to play a key role in facilitating student success and enjoyment: 1) backwards design (Wiggins & McTighe, 2011) and formative assessment, 2) collaborative tasks that demanded negotiation of meaning, and 3) scaffolding.

Backward Design of Curriculum

Organizational framework. Part of the success of this curricular unit may be attributed to the fact that it employed a backwards design approach (Wiggins & McTighe, 2011) to structure students' literacy development. In other words, it used the science proficiency scales provided by the state (see Appendix C) as an organizing framework to ensure that the learning objectives within the curricular unit progressively built upon one another. This careful articulation enabled the instructor to divide lesson objectives into "bite-sized chunks" (Spiro, 1991), and facilitated the continuous formative assessment of students' uptake. As a result, the instructor was able to consistently monitor students' learning, to identify what needed to be retaught each day, and to continuously adjust the pace at which new information was slowly added in conjunction with learners' emergent needs. The fact that 94% of the students passed the formative assessments suggests that organizing curriculum based on proficiency-scales and integrating a wide variety of formative assessments can be powerful, especially for the struggling students who received small group instruction which enabled them to improve their scores.

Curricular structure. In addition to the contributions made by the state's science proficiency scales, the unit was also strategically grounded in interpretive tasks based on concrete, narrative texts with the goal of progressively preparing learners to subsequently engage with more informational, scientific texts. These narratives, in conjunction with the interactive activities that followed, appear to have solidified students' uptake of targeted content by anchoring students' learning in concrete, familiar contexts and personal experiences with the material (Chen, 2006; Piaget, 1964). Other key design features of the curricular unit included purposeful acknowledgement of the need for social support during book club activities, and explicit attention to the developmental importance of play as a tool for learning in elementary-aged children (Vygotsky, 1978) in the integration of interactive activities and simulations. These features of the curricular structure appear to have made linguistic and content-related input more comprehensible to learners by enabling them to obtain explanations and clarifications from one another.

Collaborative Tasks

In addition to backwards design, another crucial contributing factor to student progress in French and science proficiency according to the findings was the collaborative design of tasks. Three benefits observed from students' participation in collaborative tasks included frequent opportunities for students to negotiate meaning, to engage with disciplinary content in productive ways (such as argumentation), and to become more aware of issues related to linguistic accuracy.

Negotiation of meaning. One of the most important contributions of collaborative tasks was the communicative practice they provided learners in negotiating meaning with others. This type of communication gave students practice using increasingly sophisticated linguistic skills needed to develop proficiency at higher levels (such as argumentation and justifying responses with evidence). Though the concept of negotiation is most often thought of as a way to understand "what" someone else is saying, students in this study were also observed negotiating meaning around the accuracy of various scientific concepts, as well as that of French grammar.

Productive disciplinary engagement (through argumentation). As learners discussed the accuracy of language and content, they often disagreed with one another. Argumentation is a sign that students are productively engaged in a science lesson (Engle & Conant, 2002). It may also contribute to improved cognitive processing of content and of language due to the fact that it provides learners with frequent opportunities to practice negotiating meaning around content and requires the integration of linguistic skills, content knowledge, and cognitive skills. Though discord may seem undesirable in the classroom, this is precisely the type of activity that equips students with the skills that real scientists use to defend and explain theories to colleagues or the public (NRC, 2000). The repeated opportunities to form and defend their ideas, opinions, and hypotheses about science as they worked in groups gave learners both the linguistic practice and academic language needed to become more persuasive. For example, students were observed using concrete examples from their personal lives to make stronger claims for their ideas when explaining their rationale for decisions to others. Frequent opportunities for "pushed output" (Swain, 1985) in the target language may have supported learners' uptake of academic vocabulary observed during this study.

Uptake of academic vocabulary. Throughout the study, students were repeatedly observed using new academic vocabulary that had been introduced during the unit. Given that numerous studies have suggested that uptake of scientific learning is frequently reflected in linguistic behaviors such as argumentation (NRC, 2000), immersion teachers should facilitate and welcome this type of behavior. Students' use of new academic vocabulary appears to be correlated with the heavy amounts of exposure to academic content through textual input. Their use of new academic vocabulary signals that they may be increasingly able to understand scientific vocabulary and to use it to access scientific information as they read science-related stories and scientific texts. In addition to textual input, students' use of content vocabulary may be attributed to frequent reminders of not only the words to use, but also how this type of language made them sound more sophisticated and scientific. As a result, students learned that language has social power, which may have motivated them to use more academic vocabulary when they wanted to be persuasive with their peers. In so doing, learners practiced various uses of language necessary for moving to higher levels of language proficiency.

Impact of cognitive processing on academic content and linguistic development. Although often invisible, critical thinking skills and content knowledge are also essential contributors to the development of linguistic proficiency. Yet teachers may not think about the fact that students must cognitively process both language and academic content in order to understand them. This is particularly true in the case of science, where targeted learning outcomes require learners to acquire both scientific knowledge and scientific reasoning skills. Findings from this study indicated that when learning tasks explicitly required the use of critical thinking skills, and when such thinking was carefully scaffolded in conjunction with language and content, targeted academic content seemed to become more accessible to learners. This may be due, in part, to the fact that collaborative tasks such as justification and argumentation require learners to use language in cognitively complex ways. Iteratively justifying, defending, and clarifying their ideas and opinions about scientific content may have supported learners' cognitive processing of the academic content by encouraging them to repeatedly examine it from different perspectives and enabling them to progressively refine their understanding. These types of learning tasks also seemed to generate “productive disciplinary engagement” (Engle & Conant, 2002) because in order to successfully complete them, learners must integrate linguistic skills, content knowledge, and critical thinking skills.

Concern for accuracy. One consequence of productive disciplinary engagement in this study was that as students completed tasks collaboratively using the provided scaffolding, they became increasingly more concerned with their accuracy. This may have been tied to the fact that other students could interject corrections at any time. Students’ awareness of language was further heightened by activities in which they were asked to find errors in their own work, or in the work of their peers. When students had scaffolded opportunities to practice such correction, it became a more spontaneous part of their dialogue while working collaboratively on other tasks.

Scaffolding

Scaffolding student performance through instructions, models, corrective feedback, and assessment previews. One of the most consistent patterns of enjoyment reported by students occurred when they felt successful in doing an activity. However, students in this study displayed a wide range of interests in different types of activities, suggesting that they have different strengths, weaknesses, and interests. In turn, these interests appeared to influence the kinds of activities in which they experience feelings of success. These findings are congruent with research that shows that personal interest heavily influences both learners’ reading comprehension ability and motivation (Brantmeier, 2006), and indicate that ensuring sufficient variety in the content, structure, and types of learning tasks is important. Given that only a variety of learning opportunities is likely to adequately meet the needs of an entire class, activities need to be planned at the beginning of the unit, and teachers need to be willing to plan learning experiences outside of their normal teaching pattern. Teachers also need to ensure that tasks are scaffolded well enough that learners are likely to experience success when completing them. In other words, many teachers who plan day to day within limited time constraints may find it difficult to ensure that unit variety, cohesion, and proper supports are in place. Findings from this study suggest that backward design may help teachers overcome these obstacles.

Video observations enabled researchers to identify several factors that facilitated students' successful completion of tasks. These included giving clear instructions, modeling tasks to provide students with visual representations of what was expected of them, and structuring tasks to draw learners' attention to specific concepts. These strategies, coupled with opportunities to work with partners, enabled learners to complete many activities without teacher help. When students found the right answers or learned something new, the task became a pleasure. For instance, several students mentioned that while watching videos on their Chromebooks, they liked how the video stopped to ask them questions about what they had just heard. Students did not understand every word of the videos, but the self-checking questions enabled them to receive immediate feedback on their understanding of key principles, which guided them to understanding. Finally, students knew what to expect from the formative assessments, as they were shown to the students before each lesson was taught. Knowing what would be expected of them gave students a clear target to work towards during the lesson, which helped them to be more prepared and led to greater success in test results.

Simultaneous scaffolding of language, content, and cognitive processing during learning tasks. The teacher's careful attention to scaffolding and sequencing the presentation of linguistic input to make it more comprehensible to students may have also had the desirable, but unintended effect of making the conceptual content more comprehensible for them as well. For example, the teacher used concrete representations of abstract science content, such as images, sound effects, and physical actions, to improve learners' linguistic comprehension and production of the academic language associated with the science curriculum. She also frequently paraphrased definitions of academic vocabulary in French. These attempts to ensure linguistic clarity through physical representations of conceptual content, extra examples, and verbal clarifications may have inadvertently exposed students to a greater quantity of higher quality science input. Furthermore, by selecting desired linguistic behaviors based on targeted science content, the teacher ensured that learners would have to think critically, which may have inadvertently improved their linguistic output. These claims are consistent with the findings from this study in which, students showed statistically significant growth in French reading progress and science knowledge uptake. More specifically, when students were placed in equal percentage groups based on their reading scores, and then their science growth was analyzed, the low reading group and the high reading group showed statistically significant progress in science. Though the science growth for the high reading group may be expected, as they may have had a stronger capability to comprehend content-based texts, the growth for the low reading group was surprising because their comprehension is limited by their reading skills. These findings reaffirm the power that a carefully designed and scaffolded curriculum may have on students' linguistic and content progress. The success of slowly building proficiency in science demonstrated in this study suggests that Krashen's (1983) i+1 hypothesis, originally developed for language acquisition, can be applied successfully to the acquisition of content knowledge as well. Additionally, opportunities to think critically appear to have facilitated learners' metacognitive awareness.

Scaffolding metacognition. Students enrolled in immersion programs have the advantage of growing up speaking a second language without the inhibitions of older language learners. One disadvantage, however, is that they often do not self-monitor their accuracy, inasmuch as their main goal is communication (Swain, 1985). However, discussions about the accuracy of their language use naturally surfaced when students worked collaboratively on their assignments. It is likely that these behaviors were linked to the explicit opportunities to focus on form that were intentionally infused into the curriculum based on Lyster's (2015) Counterbalance Theory. Student reading booklets incorporated this theory after they had made three separate passes through the texts. During the fourth reading pass, excerpts or themes were pulled from the text and formatted for students to notice grammatical forms, participate in guided practice or grammatical drills, followed by communicative practice which incorporated the focused linguistic structure. Corrective feedback came from peers as they worked together and eventually through a whole class review of the highlighted structure. Although the intent of the theory is to describe a process for structuring teacher instruction in order to improve learners' linguistic accuracy, video observations of students' work in pairs indicate that they seem to have internalized the approach and are leveraging it to guide the metacognition of their peers when confronted with the need for error correction. Students' ability to self and peer correct their own language accuracy throughout the study was impressive, especially at this stage of nine- and ten-year-old cognitive development.

Pedagogical Implications

When considering the development of immersion curriculum, student learning may be positively impacted by: 1) preparing students for expository texts through the reading of narrative texts with similar subject matter, 2) carefully designed and scaffolded collaborative tasks, and 3) mindful partnering.

Using Narrative Texts to Scaffold Expository Reading

Many immersion teachers agree that pre-reading activities, especially in regard to vocabulary, increases student comprehension and confidence while reading. However, instead of teaching the vocabulary in isolation, having students read texts in familiar formats that are set in concrete, relatable contexts prepares learners both linguistically and conceptually for the new content to be learned. However, students at this age often struggle to retain and recall what they have learned in the past. In order to facilitate uptake from reading and retention of content, students also need opportunities in which the use of their new knowledge is essential for the completion of a new task. The ability of students in this study to remember and then apply previously learned concepts may be due to the fact that their learning was carefully structured so that it slowly progressed from concrete narratives to more abstract informational texts, and also progressively shifted from passive reception of input to interactive activities that facilitated cognitive processing through pushed output.

Well-scaffolded Collaborative Tasks

The way in which students communicate while learning may also play a vital role in student learning. Findings from this study suggest that well-scaffolded, collaborative tasks open vast possibilities for the uptake of both language and content. While discussing decisions with others, students may be able to develop their metacognition, practice supporting and justifying their ideas, and increase their content knowledge. However, the development of collaborative tasks without explicit scaffolding to direct students in how to discuss linguistic and content based material may prove unfruitful. Collaborative tasks are most impactful when learners have been adequately prepared step-by-step to extract information from texts independently. Student independence also enables the teacher to pull small groups of students aside for reading practice and science re-teaching sessions. Small focus groups are crucial for struggling students, who may get lost in whole class instruction or disengage cognitively as they rely solely on their partner to do the work. In a small group, these students' needs can be more carefully addressed as additional explanation can be more freely requested and more quickly given. When properly prepared, students in this study progressively became more independent readers as they gained confidence through successful reading practice.

Mindful Partnering

Learning is a social process (Vygotsky, 1978), especially in immersion programs where so much emphasis is placed on communication. Consequently, partnering also plays a crucial role in learning and student enjoyment in that working collaboratively in small groups can provide the social support that learners need. However, findings from this study revealed that a single system of partnering does not work for all students. A possible explanation for why only 56% of students thought that their partner helped them learn may be that only about half of the students were satisfied with their partner in general. Picking partners in a variety of ways and flexibly grouping students may increase the likelihood that all students experience positive partnering at some point in the unit. Findings also suggest that teachers should guide students to unlock the social power implicit in the use of the academic language they are learning as they participate in the carefully planned collaborative tasks. Because partnering affects the way students feels about themselves, their comfort in communication, and their completion of the task, one could say that partnering affects almost every facet of the learning process.

Limitations

A number of factors may limit the applicability of these findings to other settings. Although the principal investigator of this study was also the students' teacher, which presents potential for biases, care was taken to mitigate these factors by involving other members of the research team in the decision-making processes associated with collecting, selecting, and analyzing data. Also, because the Utah model is unique and because of the school's high socioeconomic status (only 17% of the student population qualified for free or reduced lunch at the time the study was conducted), the applicability of the findings to other settings may be limited. In terms of internal validity, consideration was giving to the following areas: instrumentation, history, and participant characteristics (such as when the students started the partial immersion program, since some students started in second grade instead of first grade). To avoid instrumentation threats to validity, the principal investigator completed a specific training in order to become certified to score IDAPEL tests properly. In addition, as stated previously, only ten French reading tests were given per day for about six days so as to avoid scorer fatigue for the reading test.

Future Directions

Based on the quantitative and qualitative data collected, there is substantial evidence that students' reading skills and science knowledge may be increased while using a purposefully integrated literacy and science unit. Hence, this type of curriculum development merits further investigation, especially using an experimental research design in order to increase internal validity. The following questions may be helpful in focusing research during such curricular exploration: 1) How do different task designs and the scaffolding embedded within them influence learners' uptake of academic language and science content in narrative and expository texts? 2) How do collaborative tasks affect students' concern for accuracy, critical thinking, and argumentation skills? 3) How does social satisfaction correlate with student learning in immersion education? 4) How does drawing students' attention to academic language influence their ability to recognize its social impact on their peers?

Conclusion

Though research in numerous fields advocates the many cognitive benefits of immersion education, significant struggles remain for teachers and students alike as they do their best to teach and learn all that is required. The most obvious challenge is the struggle to maintain an equitable balance between the development of academic content knowledge and target language skills. This study offers evidence that integrating literacy and science content into a single curriculum could simplify this balancing act in ways that produce positive academic and affective outcomes for students. However, many immersion programs do not yet have established teacher education methods or high quality induction programs for international guest teachers that can support them in doing so. Furthermore, in order to develop and implement such a curriculum, immersion teachers need better access to high quality models, well-scaffolded research-based materials, and effective professional development. Consequently, additional research in these areas would enable teachers and administrators to take steps to ensure the availability of necessary materials to guide successful curricular integration and ensure improved student outcomes. This challenging, yet rewarding, task could prove instrumental in producing transformative change in the lives of the many students who pass through immersion education. As summarized by Cheng, Cao, & Zhang (2016), "integration leads to innovation, and innovation finally leads to development"

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APPENDIX A

Student Survey

Q1 Pour chaque question, coche la case qui te correspond.

	Extrêmement (1)	Beaucoup (2)	Un peu (3)	Pas du tout (4)
A quel point aimes-tu lire ? (1)				
A quel point as-tu aimé les histoires qu'on a lues à propos des environnements ? (2)				
A quel point penses-tu que les histoires qu'on a lues t'ont aidé(e) à comprendre les environnements de l'Utah ? (3)				
A quel point penses-tu que les textes scientifiques qu'on a lus t'ont aidé(e) à comprendre les environnements de l'Utah ? (4)				
A quel point penses-tu que les activités qu'on a faites t'ont aidé(e) à comprendre les environnements de l'Utah ? (5)				
A quel point penses-tu que ton partenaire t'a aidé(e) à comprendre les environnements de l'Utah ? (6)				
Après cette unité des environnements, est-ce que la lecture en français est plus facile pour toi ? (7)				

Q2 Quel genre de texte as-tu trouvé le plus intéressant ?

- Les histoires (1)
- Les textes scientifiques (2)

Q3 Pourquoi ce genre de texte est-t-il le plus intéressant pour toi ? Coche **tout** ce qui te correspond.

- C'est plus amusant (1)
- C'est plus informatif (2)
- J'aime les illustrations (3)
- J'aime les photos (4)
- C'est plus facile à comprendre (5)
- Il ressemble à ce que je lis en anglais (6)

Q4 Classe les activités de 1 (l'activité que tu aimes le plus) à 7 (l'activité que tu aimes le moins).

_______ Les livrets (1)
_______ La localisation des biomes et leur caractéristiques physiques sur les cartes d'Utah (2)
_______ Le popplet (3)
_______ La migraine de la migration (4)
_______ Les plantes incroyables du désert (5)
_______ Quand on peut partager ce qu'on a appris avec un nouveau partenaire (6)
_______ Les évaluations (7)

Q5 Pourquoi l'activité 1 était ta préférée ?

____
____
____

Q6 Pourquoi l'activité 7 était la moins intéressante ?

____
____
____

Q7 Fais glisser le curseur.

	0 10 20 30 40 50 60 70 80 90 100
Pendant quel pourcentage du temps en classe est-ce que tu savais quoi faire ? (1)	

English Translation of Questionnaire:
Q1 For each question, check the box that best applies to you.

	Extremely (1)	A lot (2)	A little (3)	Not at all (4)
How much do you like to read ? (1)				
How much did you like the stories we read about environments ? (2)				
How much do you think the stories that we read helped you understand Utah Environments? (3)				
How much do you think the scientific texts that we read helped you understand Utah Environments? (4)				
How much do you think the activities that we did in class helped you understand Utah Environments? (5)				

How much do you think the partners you worked with helped you understand Utah Environments? (6)				
After this environment unit, is reading in French easier for you? (7)				

Q2 Which genre did you find the most interesting?
- The stories (1)
- The scientific texts (2)

Q3 Why was this genre more interesting for you? Check **all** that apply.
- It's more fun (1)
- It's more informative (2)
- I like the illustrations (3)
- I like the pictures (4)
- It's easier to understand (5)
- It's similar to what I read in English (6)

Q4 Order the activities from 1 (the activity that you liked the most) to 7 (the activity that you liked the least).

_______ The booklets (1)
_______ Mapping biomes and their physical characteristics on a map of Utah (2)
_______ The Popplet (3)
_______ The migration migraine (4)
_______ Incredible desert plant activity (5)
_______ When we shared what we learned with a new partner (6)
_______ The quizzes (7)

Q5 Why was activity 1 your favorite ?

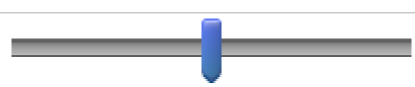
____

Q6 Why was activity 7 your least favorite ?

____

Q7 Move the cursor.
0 10 20 30 40 50 60 70 80 90 100

During what percentage of the time in class did you know what to do? (1)



APPENDIX B

Student Interview Script

How are you doing today? My name is Madame Montgomery and I'm your teacher's teacher! What's your NAME?

We are going to talk about the things you are learning in your French class this year. The things you tell me will help us to make French classes better for other kids in Utah.

I don't want to forget any of the important things you tell me, so is it okay with you if I RECORD this and take some NOTES as we talk?

1) What have you LEARNED in Madame Overvliet's class this year?
    a) Do you think you understand more about SCIENCE? (What makes you think so?)
    b) Do you think you've gotten any better at FRENCH? (What makes you think so?)
        - Tell me about some of the things you CAN DO in French now that you couldn't do before this year.)
    c) Do you think you've gotten any better at READING? (What makes you think so?)
        - What do you think about the READING BOOKLETS you've been doing?)
    d) Do you think you've gotten any better at WRITING? (What makes you think so?)
2) Tell me about the work that is usually EASY for you to do in Madame Overvliet's class.
3) Tell me about the work that is usually HARD for you to do in Madame Overvliet's class.
4) What does Madame Overvliet do that HELPS you learn/makes your work easier?
5) Do you UNDERSTAND Madame Overvliet's instructions in French? Her explanations?
6) What ADVICE could you give to Madame Overvliet that might help her teach you better?
7) Is there anything else you want me to know?

Thank you SO much for talking to me!

APPENDIX C

Science Proficiency Scales

Les Environnements de l'Utah

Les 4 niveaux	1	2	3	4
Décrire les caractéristiques physiques des déserts, des forêts, et des zones humides en Utah.	Je peux identifier un désert, une forêt, et une zone humide d'Utah selon ses caractéristiques physiques sur une photo.	Je peux identifier et comparer 3 caractéristiques physiques d'un désert, d'une forêt, et d'une zone humide d'Utah.	Je peux localiser plusieurs déserts, forêts, et zones humides communs en Utah.	Je peux réaliser un schéma détaillé d'un désert, d'une forêt et d'une zone humide, et expliquer pourquoi certaines plantes et animaux sont mieux adaptés à leur biome.
Décrire comment les plantes et les animaux qui se trouvent en Utah s'adaptent à leur environnement.	Je peux identifier des espèces communes de plantes et d'animaux dans chaque biome en Utah.	Je peux associer les caractéristiques physiques des plantes et des animaux communs en Utah qui leur permettent de vivre dans leur environnement.	Je peux décrire les caractéristiques des espèces communes de plantes et d'animaux dans chaque biome en Utah et énumérer les caractéristiques physiques qui leur permettent de vivre dans leur environnement.	Je peux utiliser une chaîne alimentaire pour décrire les interactions entre les plantes et les animaux dans différents environnements en Utah. Je peux décrire les actions menées en Utah pour protéger les espèces en voie de disparition.
Utiliser un système de classification simple de classer les plantes et les animaux en Utah.	Je peux classifier certaines plantes et animaux communs en Utah dans des groupes simples, par exemple les vertébrés et les invertébrés ou les arbres et les herbes.	Je peux classifier les plantes et les animaux communs en Utah en utilisant un système de classification réalisé en groupe.	Je peux classifier les animaux régionaux en Utah en utilisant le système de classification. Je peux expliquer comment cette méthode est utilisée par un scientifique.	Je peux classer les plantes et les animaux régionaux en Utah en utilisant une clé dichotomique. Je peux expliquer comment cette méthode est utilisée par un scientifique.

Observer et noter le comportement des animaux en Utah.	Avec de l'aide, je peux observer le comportement des animaux de l'Utah et le représenter sur un schéma.	Je peux observer, comparer, et décrire le comportement des animaux de l'Utah et le représenter sur un schéma.	Je peux observer, comparer, et décrire le comportement des animaux de l'Utah et le représenter sur un schéma. Je peux comparer les similarités et les différences de comportement selon la classe animale. Je peux identifier comment les mammifères en Utah sont adaptés à la survie en hiver.	Je peux observer, comparer, et décrire le comportement des animaux de l'Utah et le représenter sur un schéma. Je peux comparer les similarités et les différences de comportement selon la classe animale. Je peux identifier comment les mammifères en Utah sont adaptés à la survie en hiver et décrire comment ces adaptations les aident.

English Translation of Proficiency Scales

Utah Wetlands, Forests, and Deserts					
		The Level 1 Student:	The Level 2 Student:	The Level 3 Student:	The Level 4 Student:
Range	V.1 Describe the physical characteristics of Utah's wetlands, forests, and deserts.	Identifies a wetland, forest, or desert based on its physical characteristics from a visual representation.	Identifies and describes two physical characteristics of Utah wetlands, forests, and deserts.	Locates and compares Utah's wetlands, forests, and deserts using multiple examples of physical characteristics. Creates a basic model of wetlands, forests, and deserts.	Creates a detailed model of wetlands, forests, and deserts and explains why certain plants and animals are suited to those regions.
Range	V.2 Describe the common plants and animals found in Utah environments and how these organisms have adapted to the environment in which they live.	Identifies common plants and animals that inhabit each of Utah's environments.	Describes characteristics of common plants and animals in specific Utah environments and lists physical features that allow them to live in these environments.	Describes interactions between the plants and animals in Utah environments. Explains the effect elevation has on plant and animal life.	Uses a food chain to describe interactions between the plants and animals in Utah environments. Describes steps being taken to protect endangered Utah species.
Range	V.3 Use a simple scheme to classify Utah plants and animals.	Classifies familiar Utah plants and animals into simple groups, such as vertebrates and invertebrates or tree/shrub/grass.	Classifies Utah plants and animals using a simple classification scheme, such as a dichotomous key.	Classifies unfamiliar Utah plant and animals using a simple classification scheme, such as a dichotomous key. Explains how scientists use these schemes.	Classifies familiar and unfamiliar Utah plants and animals using a cladogram. Explains and evaluates how and why scientists use classification schemes.
Range	V.4 Observe and record the behavior of Utah animals.	With support, observes the behavior of Utah animals and records data in a pre-made graphic organizer.	Observes, compares, and describes the behavior of Utah animals and records data in a pre-made graphic organizer.	Observes, records, and describes the behavior and adaptations of Utah animals. Compares the similarities and differences between amphibians and reptiles. Sorts insects and spiders using classification schemes. Identifies animal adaptations that help Utah mammals survive the winter.	Explains animal adaptations that help Utah mammals survive the winter, and analyzes how these adaptations are beneficial.

https://www.schools.utah.gov/File/364be017-a75d-4bc9-9e67-bcacdfe22607

APPENDIX D

List of Narrative Texts

Text	**Recommended Age Level (for Native Speakers)**	**Related Science Objective**
Guiberson, B., & Lloyd, M. (1992). *Hôtel cactus*. Paris, France: L'Ecole des loisirs. ISBN 9782211019415	8-11 years old	Physical Characteristics of Utah
Gautier, D. (2012). *Le très Haut-Savoyard.* Chambéry, France: Boule De Neige Editions. ISBN 2918735183	3 years old and up	Physical Characteristics of Utah
Corentin, P. (1990). *L'Afrique du Zigomar.* Paris, France: L'Ecole des loisirs. ISBN 9782211037204	4 years old and up	Physical Characteristics of Utah
Kanao, K. (1992) *A chaque tortue sa carapace.* Paris, France: L'Ecole des loisirs. ISBN 2211013422	6-9 years old	Animal Adaptations
Swallow, P. (2012). *Marmotte sort de son ombre*. Markham, Ontario, Canada: Scholastic Canada. ISBN 1443116858	2-7 years old	Animal Adaptations

Les sciences naturelles de Tatsu Nagata Le castor. Paris, France: Seuil Jeunesse. ISBN 2020892707	6-9 years old	Animal Adaptations
Godkin, C. (2012). *L'Ile du loup, fable écologique.* Paris, France: L'Ecole des loisirs. ISBN 2211209262	8-11 years old	Ecological Balance, Food Chain
Stehr, G., & Glasauer, W. (2000). *Mais où est donc Ornicar ?* Paris, France: L'Ecole des loisirs. ISBN 2211056377	3-5 years old	Animal Classification

APPENDIX E

List of Scientific Texts

Text	**Recommended Age Level (for Native Speakers)**	**Related Science Objective**
Levesque (2004). L'eau, la source de vie. In *Fascinants déserts* (p. 18). Paris, France: Groupe Fleurus. ISBN 2215052821	N/A	Physical Characteristics of Utah
Kalman, B., & Smithyman, K. (2007). C'est quoi une forêt ? In *La forêt* (pp. 4-5). Montrouge, France: Bayard Presse. ISBN 2895790124	6-10 years old	Physical Characteristics of Utah
Kalman, B., & Bishop, A. (2007). Terres humides In *Les terres humides* (pp. 4-5). Montrouge, France: Bayard Presse. ISBN 2895790140	6-10 years old	Physical Characteristics of Utah
Levesque (2004). Faune Amérique du Nouveau Monde. In *Fascinants déserts* (pp. 48-49). Paris, France: Groupe Fleurus. ISBN 2215052821	N/A	Animal Adaptations

Nolwen (2016) *Découvrez les plus vieux arbres du monde* (p. 2). Retrieved from : https://www.consoglobe.com/plus-vieux-arbres-du-monde-cg/2	N/A	Animal Adaptations
Les oiseaux du grand lac salé, materials translated from the Great Salt Lake State Marina	N/A	Animal Adaptations
Einspruch, A (2012). Les papillons. In *Animaux migrateurs* (pp. 22-23). Paris, France: Gallimard Jeunesse. ISBN 2070644561	9-11 years old	Animal Adaptations
Collectif (2013). *Encyclopédie des animaux* (pp. 22-23, 110-111, 160-161, 184-185, 200-201, 252, 266). Paris, France: Gallimard Jeunesse. ISBN 2070654257	9-18 years old	Animal Classification