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The Impact of Teacher Beliefs on Integrated Unit Design

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The Impact of Teacher Beliefs on Integrated Unit Design

By

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Plan B Project

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Abstract

Teacher beliefs are personal constructs that develop over a lifetime and are influenced by a teacher’s personal experiences, experience with schooling and instruction, and experience with formal knowledge. A teacher’s belief system has a greater impact on their practice than their subject matter knowledge, which translates into the design of classroom materials. This study was conducted to explore the impact of my teacher beliefs and understanding of three-dimensional learning on the development of a theme-based, integrated, standards aligned unit. Teacher beliefs can be changed through the implementation of authentic professional learning communities (PLCs). PLCs are defined as the ongoing collaboration of educators in recurring cycles of collective inquiry and action research to improve student achievement. Throughout the study, a reflective process was used to identify my core teacher beliefs: the use of high quality text, integration, collaboration, understanding by design, and place-based principles. Findings indicate that curriculum development and collaboration are challenging, but worthwhile, and deeper understanding of my beliefs was essential to my persistence throughout the process.
Dedicated to my husband, Jacob, my parents, my teaching colleagues, and all of my students—past, present, and future.
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Chapter 1

Introduction

Every teacher starts their career with a set of beliefs or personal philosophy of what constitutes good teaching. Most teachers probably have a copy of a teaching philosophy that they wrote in a pre-service education course gathering dust in their files or taking up space in the digital universe. In spite of the fact that they may not be in the forefront of their daily thoughts, these beliefs are not forgotten, rather they have evolved over the course of their teaching practice and continually influence the formation of their teacher beliefs.

How do a teacher’s beliefs influence the decisions made in their classroom? With the adoption of the Common Core State Standards (CCSS) or CCSS-aligned standards in 42 states (Common Core State Standards Initiative, 2017), elementary teachers are working to implement these English-Language Arts (ELA) and Mathematics standards in their classrooms. In addition, as of June 2017, 18 states have adopted the Next Generation Science Standards (NGSS), while 12 states, including Wyoming, have adopted similar standards. This provides a unique opportunity for teachers to reflect on their belief system and how it influences their teaching practice as they evaluate current teaching strategies and materials, while investigating new or previously unknown strategies and materials.

According to Coleman, Pimental and Zimba (2012), there are three “core shifts” that should direct the implementation of the CCSS literacy standards (pp. 9-10):

1. Building knowledge through content-rich nonfiction
2. Reading and writing grounded in evidence from text, both literary and informational
3. Regular practice with complex texts and its syntax and vocabulary

Grant, Fisher and Lapp (2014), with their call for an increase in science instruction at the
elementary level due to the demands of the CCSS and the NGSS, confirm these shifts. *A Framework for K-12 Science Education* (National Research Council [NRC], 2012), the document upon which the NGSS are based and hereafter referred to as The Framework, was used to guide the discussion and selection of science concepts, practices and ideas in this study, since Wyoming had not adopted the NGSS. However, the 2016 adoption of the Wyoming Science Standards (WSS), which are modeled on the NGSS, was the final lens used to design and teach the integrated unit plan. The Framework, NGSS, and WSS describe three dimensions: the Disciplinary Core Ideas (DCIs) otherwise known as the science content, the Crosscutting Concepts (CCCs) which encompass the big ideas that cross disciplines, and the Science and Engineering Practices (SEPs) or processes of doing science. These three dimensions must be incorporated into the overall design of any integrated ELA and science unit if students are going to make sense of the phenomena and apply the knowledge in new ways (Krajcik, 2015).

**Statement of the Problem**

“I am not a curriculum developer!” has been the refrain of several of my colleagues over the past few years. They say this with frustration as we work to develop a curriculum map or research how to teach the essential skills our students will need to be successful both in the short-term, on the state-mandated tests, and for college and their careers, in the long-term. There are many resources, but how do we determine which ones will work best for our students? Yes, the CCSS and WSS dictate the content, big ideas, strategies, and skills our students need to know by the end of the year, but how do we ensure that they learn it all? What guides a teacher as they make decisions about their teaching?

Every practicing teacher has developed his or her belief system over years spent in (and out) of the classroom. It is an amalgamation of ideas learned while teaching, observing the
teaching of others, attending professional development, reading current research, surfing the Internet or reflecting on their teaching. Their teacher belief system may be along a continuum between completely rigid and constantly metamorphic.

In the wake of the No Child Left Behind (NCLB) Act, the amount of science instruction in many elementary classrooms has been visibly reduced (Griffith & Scharmann, 2008; Marx & Harris, 2006; Mundry, 2006). The daily schedule of some classrooms studied, showed a noticeable lack of instructional time set aside for science and social studies, in favor of additional time for mathematics, reading and writing instruction (Mundry, 2006; Banilower et al., 2013). Since the enactment of NCLB and the increased reliance on high-stakes tests, a number of studies (Griffith & Scharmann, 2008; Gorard, 2009; Perry & McConney, 2010; Williams, 2010; Queenan, 2011) report a disparity between the amount of science instruction students in Title 1 schools receive in comparison to students in non-Title 1 schools. Title 1 schools receive federal funding based on a high number or percentage of low-income students. With the replacement of NCLB by the Every Student Succeeds Act (ESSA), which requires the adoption of content standards and testing in math, reading/language arts, and science, Title 1 schools will need to figure out how to increase the time spent on science instruction. This conundrum is a reality at my school where each academic day has thirty minutes allotted for science, social studies, or health instruction.

**Addressing the shifts for CCSS implementation.** In order to meet the demands of Coleman, Pimental, and Zimba’s (2012) first shift of building knowledge through content-rich informational text, elementary teachers will need to find ways to integrate specific content into existing literacy blocks. This will allow elementary schools, including Title 1 schools, to ensure increased time spent in science (and other non-core elementary subjects), while continuing to
target the reading and math needs of students. Integrated units will permit students to master the ELA CCSS, while engaging with high quality text to make sense and develop their conceptual understanding of the content. In this way, the overall design of any integrated ELA and science unit must incorporate all three dimensions of the WSS.

According to the CCSS, students will need to spend 50 percent of their time reading informational text by the time they enter the fourth grade (National Assessment Governing Board, 2008). This will require a shift in the proportion of literature and informational text being taught in elementary classrooms. Jeong, Gaffney, & Choi (2010) found that fourth graders in their study spent only 22% of written language instructional time interacting with informational texts and at least half of this time was spent reading to answer worksheets and round robin reading. In addition, other studies (e.g. Young & Moss, 2006) highlight the absence of informational text in elementary classroom libraries. To meet the demands of Coleman, Pimental and Zimba’s (2012) second shift, elementary teachers will not only need to increase the amount of informational text used in the classroom, but find effective strategies for reading and writing instruction using informational text.

The final shift described by Coleman, Pimental and Zimba (2012), is in response to the CCSS’s call for an increase in the complexity of the text used for reading and writing instruction. Students will need to “read and comprehend informational texts, including history/social social studies, science and technical texts, at the high end of the grades 4-5 complexity band independently and proficiently” (National Governors Association, 2010, p. 14). Teachers will need to tread carefully when increasing the amount and complexity of texts because, “students often begin to lose interest when having to read science textbooks or scholarly articles that contain unfamiliar, multisyllabic words and complex sentences that require extensive
background knowledge to comprehend the language” (Grant, Fisher, & Lapp, 2014, p. 131). In addition to content, teachers must also plan to teach students how to read complex text, understand new vocabulary, and think critically about what they read.

How will elementary teachers fit all of this complex, informational text into their reading instruction time, while at the same time, ensure that their students are spending 50 percent of their time in literature (e.g. stories, dramas, and poetry)? An elementary classroom that allotted a portion of the year’s language arts time for integrated literacy and content instruction, specifically science, seems like an ideal environment to implement research based teaching strategies. In this way, an integrated classroom could provide an environment for students to master their reading skills (e.g. asking questions, exploring text, and summarizing), while making sense of phenomena and designing solutions to problems.

**Purpose**

The purpose of this study was to examine the literature on teacher belief and three-dimensional learning and use it to identify how these theories influence teachers’ decisions. This understanding of teacher beliefs was used to identify my personal teacher beliefs, guided my review of the literature on those beliefs, and the identification of specific ways in which it impacted my teacher beliefs. Once these impacts were identified, I reflected on ways that my teacher beliefs influenced the development of a theme-based, integrated, standards-aligned unit.

**Research Questions**

The research questions used to guide this study were:

1. What does the literature say about teacher belief and three-dimensional learning?
2. How do my teacher beliefs and understanding of three-dimensional learning impact my development of a theme-based, integrated, standards aligned unit?
Chapter 2

Literature Review

Introduction

The reason it's difficult to learn something new is that it will change you into someone who disagrees with the person you used to be. And we're not organized for that. The filter bubble and our lack of curiosity about the unknown are forms of self-defense. We're defending the self, keeping everything "ok" because that's a safe, low maintenance place to be. The alternative is to sign up for a lifetime of challenging what the self believes. A journey to find more effectiveness, not more stability (Godin, 2017).

Whether you are trying to persuade a family member that their political candidate does not have their best interests at heart or are coming to the realization that you may not be using best practice in your classroom, confronting personal beliefs is a difficult task.

What Are Teacher Beliefs?

While the impact of teacher beliefs on classroom practice is still a theme in the literature, much of the current work is grounded in the work of Nespor (1987), Pajares (1992), and Richardson (1996), who suggest that a teacher’s beliefs have a greater impact on their practice than their subject matter knowledge. To define the difference between beliefs and knowledge, Pajares (1992) states that, “belief is based on evaluation and judgment; knowledge is based on objective fact” (p. 313). Teacher beliefs are personal constructs that develop over a lifetime and are influenced by a teacher’s personal experiences, experience with schooling and instruction, and experience with formal knowledge. “Beliefs, unlike knowledge, are propositions held to be true by the individual, can be non-evidential, based on personal judgment and evaluation, and are drawn from critical episodes and prior experiences” (Roehrig & Luft, 2004, p. 1510). Preservice
teachers enter college with a belief system that is grounded in their experiences as students. These belief systems influence how and what they learn during the program and can be challenging to alter during the course of the program. This inability to change one’s belief system is not isolated to new teachers. Guskey (1986) found that professional development for practicing teachers was usually unsuccessful at changing teacher beliefs and practices unless the teachers agreed to pilot something new and saw positive achievement results. Guskey concluded that changes in teacher belief followed changes in their practice.

What Can Change Teacher Beliefs?

Professional learning community. Professional learning communities (PLCs) are defined as the ongoing collaboration of educators in recurring cycles of collective inquiry and action research to improve student achievement (Solution Tree, 2017). Educators in a PLC school take collective responsibility for the learning of all students, not just the children in their classroom. They work as collaborative teams to create and administer common formative assessments, which are tied to their guaranteed and viable curriculum, a system where the essential standards are identified, adequate time is allotted for instruction, teachers ensure the essential content is delivered, and all students are given sufficient time to learn the content (Marzano, 2003). The results of the common formative assessments are then used to identify students who need additional support and enrichment. In addition, teachers use this data to identify instructional strengths and weaknesses within the team and use this information when making future instructional decisions, such as having the teacher with greatest success teaching an intervention group for students who are not proficient at the targeted skill (DuFour & Reeves, 2016).

Furthermore, as a PLC, educators use four critical questions to guide their team’s work:
1. What do we want students to learn? (This is defined as the “essential standards” – meaning: The guaranteed content in our curriculum)

2. How will we know if they have learned it? (As evaluated using team-developed common assessments)

3. What will we do if they have not learned it? (Meaning setting up a system of systematic interventions)

4. How will we provide extended learning opportunities for students who have mastered the content? (By paying attention to and developing enrichment opportunities)

(DuFour & Reeves, 2016, p.70, parentheses added)

Teachers may simultaneously belong to multiple collaborative teams within one PLC (school or district wide). These collaborative teams can be a variety of sizes (e.g. grade level teaching team or whole school staff) and they, “may include members who share common students, areas of responsibility, roles, interests, or goals” (Learning Forward, 2017, para. 7).

The implementation of PLCs for school improvement is a widely accepted strategy with support from the literature (Brodie, 2013; Darling-Hammond, 2013; Dufour & Dufour, 2012; McLaughlin & Talbert, 2006). However, many schools engage in what DuFour and Reeves (2016) describe as “PLC Lite”, which entails many activities that do not impact student achievement. Levine (2011) found that when schools rush to implement the PLC process, they may not take the time to develop the resources (e.g. norms, shared objectives, trust, respect for experienced teachers) and, in turn, “reduce[s] experienced teachers’ willingness and ability to change” (p. 31). In fact, a number of studies (e.g. Dooner et al., 2007; Trotman, 2009; Smith & Wohlstetter, 2001) have found that teachers are often frustrated by the networking/collaboration process because they have not been properly guided by their principal or trainers in the process.
and have PLCs that, “are devoid of the sophisticated discourse and disciplined inquiry necessary for instructional improvement” (Woodland, 2016, p. 506).

To avoid the trap of “PLC Lite” and to meet the new ESSA definition of professional development, PLCs will need to look at ways to assess their effectiveness. The Teacher Collaboration Assessment Rubric (TCAR) is one of forty-nine assessment tools available in the Rutgers Center for Effective School Practices report Measurement Instruments for Assessing the Performance of Professional Learning Communities (Blitz & Shulman, 2016) for education professionals to evaluate the effectiveness of their PLCs. The TCAR is built on the Goodlad’s (2004) DDAE model (dialogue, decision, action, and evaluation), which are key components of the PLC process. TCAR gives evaluators a tool that assesses the four components and teams can use their results to adjust their collaborative work.

Thirty years have passed since Guskey (1986) reported that professional development alone did not change teacher beliefs, yet high-quality, ongoing professional development was required for teachers in school wide Title One programs under NCLB (Department of Education, 2002). These professional development opportunities were often disjointed sessions with little to no follow-up. Under ESSA, professional development is defined as “activities that … are sustained (not stand-alone, 1-day, or short-term workshops), intensive, collaborative, job-embedded, data-driven, and classroom focused.” (S. 1177, Section 8002, page 295, paragraph 42). This new vision of professional development seems to take into account both Guskey’s (2002) Model of Teacher Change (Figure 1) and professional learning communities.
What Are The Gaps in Understanding Teacher Beliefs?

According to both the Wyoming State Board of Education (2016b) and The State of State Science Standards (Lerner et al, 2012), the content and rigor of the 2008 Wyoming Science Content and Performance Standards received an F. In addition, the 2012 National Survey of Science and Mathematics Education (Banilower 2013) found that elementary classrooms average about 20 minutes of science education per day. However, Wyoming fourth grade students scored above the national average on the 2015 National Assessment of Educational Progress (NAEP), with only two states scoring higher (Wyoming Department of Education, 2016). This suggests that Wyoming educators are succeeding, in spite of the previous standards and the national push to focus on math and reading. Is this due to their beliefs and resulting classroom practices? In spite of Wyoming teachers’ prior success on high stakes tests during an era of poor quality standards, Wyoming teachers and administrators should still take the next three years to evaluate their beliefs about science education, its place in the classroom, and the needs of their teachers. This is important as they work to fully implement the new standards by the 2020-2021 school year (Wyoming State Board of Education, 2016). In their 2014 case study, Boesdorfer & Lorsbach suggest that studying teachers’ orientation, or beliefs, toward science teaching and the connections to their teaching practices could help inform of professional development for NGSS.

This study is my attempt to identify my own teacher beliefs and reflect on how they influence the design of a theme-based, integrated, standards-aligned unit.

**Three-dimensional Learning Model**

_A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas_ (NRC 2012) posited that in the teaching of scientific literacy the three dimensions, Crosscutting Concepts (CCCs), Disciplinary Core Ideas (DCIs), and Science and Engineering Practices (SEPs) must all be incorporated. These three dimensions were then combined to create each performance expectation within the standards in the NGSS and WSS. It has since been referred to as the three-dimensional learning. The National Science Teachers Association, Bybee (2013), Krajcik (2015), and Houseal (2015 & 2016) stress the importance of creating or adapting classroom materials to integrate the three dimensions. Two tools have been published to help educators determine whether their materials align with the NGSS and fully integrate the three dimensions, the Educators Evaluating the Quality of Instructional Products (EQuIP) Rubric (Achieve and National Science Teachers Association, 2014) and Houseal’s Model of Three-Dimensional Learning (2015 & 2016). Houseal suggests using the Model of Three-Dimensional Learning to complement the EQuIP Rubric when evaluating lessons for use in the classroom.

**Methodology**

**Action research.** Action research is a methodology used in a number of fields (e.g. healthcare, urban planning, organization development), however, in education, Action research specifically refers to a disciplined inquiry done by a teacher with the intent that the research will inform and change his or her practices in the future. This research is carried out within the context of the teacher’s environment—that is, with the students and at the school in which the teacher works—on questions that deal with
educational matters at hand. (Ferrance, 2000, p. 1)

Action research may be conducted independently, or in a collaborative team at the grade, school, or district level. Conducting research with a collaborative team would be most in keeping with the PLC process.

Action research is a cyclical process (Figure 2), where the researcher must first, identify a problem and pose an investigable research question. Ferrance (2000) suggests teachers focus on a question, “that is meaningful and doable in the confines of their daily work” (p. 10). Teachers can make this work more meaningful by identifying their personal beliefs prior to posing their research questions (Sagor, 2000). Next, the teacher must identify at least three sources of data collection (e.g. journals, anecdotal records, assessments) to allow for triangulation, or using multiple sources to look for common themes, before taking action. Once the data have been collected, teachers will sort and review these data to answer two questions:

1. What is the story told by these data?
2. Why did the story play itself out this way? (Sagor, 2000, p. 6)

Once the story/theme has been identified, teachers may reflect, return to the literature, and/or look for, “connections and disconnections within and between the up-close-and-personal and the bigger picture” (Bradbury, 2015, p. 752) prior to making the plan for their new action. With this information, a new action should be planned to address the research question and begin the cycle again.
Autoethnography. One method of qualitative data collection and analysis in action research is to use autobiographical journaling and reflection (Noffke & Somekh, 2009), or autoethnography, to, “retrospectively and selectively write about epiphanies that stem from, or are made possible by, being part of a culture and/or by possessing a particular cultural identity” (Ellis et al., 2010, p. 3). The autoethnographer must analyze their experiences and determine how they apply to other members of the culture. Without this connection to the greater culture, there is little relevance to the work outside of personal growth. Criticisms of autoethnography include a strong focus on self, the danger of fictionalizing accounts of events, and the therapeutic, rather than analytic, aspect of the work (Mendez, 2013).
Chapter 3

My Teacher Beliefs and Integrated Unit Design

To answer my research questions, this chapter has been divided into two parts: (a) the identification and literature review of my teaching beliefs and (b) the design of the integrated unit. The research questions used to guide this study were:

1. What does the literature say about teacher beliefs and three-dimensional learning?
2. How do my teacher beliefs and understanding of three-dimensional learning impact my development of a theme-based, integrated, standards aligned unit?

Literature Search and Identification of Beliefs

The initial literature search was conducted using the following search terms: teacher belief, beliefs about teaching, three-dimensional learning, and professional learning communities. Prior to and throughout the unit design process, I reflected upon and composed a detailed account of my teacher beliefs. Once my thoughts were down on paper, I coded them into common themes that could be researched in the literature. Constant comparative analysis was used to analyze the qualitative data. Constant comparative analysis is “an iterative and inductive process of reducing the data through constant recoding” (Fram, 2013, p.3). It was described by Glaser and Strauss (1967) as a method for coding data when developing a theory about themes or phenomena within a social unit. In this case, the process is illustrated in Figure 3. To start the study, I journaled about what I thought was important for my students and myself. Then I studied my notes, found common themes within my journal entries and reviewed these themes in the literature. After reflecting on this new understanding of the literature, I made decisions for the next steps in my teaching and work. This reflective process was repeated throughout the study as I planned the unit, gathered materials, taught the unit, and wrote this
What Are My Beliefs?

A number of beliefs were identified through my journaling, however, five stood out as my core teacher beliefs. These were the use of (a) high quality text, (b) integration, (c) collaboration, (d) understanding by design, and (e) place-based principles. These will be described in greater detail the next sections.

High quality text. According to Sutherland (2008), “high-quality text must be cognizant of its intended readers in that it uses examples, language, signaling words, and organization that invite them into the text and support their sense making” (p. 168). Despite the fact that Appendix A of the CCSS is a compilation of text that the authors of the standards deemed exemplars of complex, high-quality text, there is no method included in the standards for teachers to determine the quality of the text of their own choice.

Since most available text found online or in the library does not have a specific grade
level assigned to it, many teachers use Lexile measures to ensure the text they select for a given lesson or activity is at an appropriate level for their students. Lexile measures are split into two categories: reader and text. The reader measure is determined by a student’s performance on a reading text, such as the Proficiency Assessments for Wyoming Students (PAWS) or the Northwest Evaluation Association (NWEA) Measures of Academic Progress (MAP) test.

The text measure is determined by,

Split[ing the text] into 125-word slices. Each slice is compared to the nearly 600-million word Lexile corpus – taken from a variety of sources and genres – and words in each sentence are counted. The sentence length and difficulty of the vocabulary is examined throughout the book. These calculations are put into the Lexile equation. Then, each slice’s resulting Lexile measure is applied to the Rasch psychometric model to determine the Lexile measure for the entire text (MetaMetrics, 2017a, para. 1).

Teachers can use the reader and text measures to match students with text at their reading level. MetaMetrics, the organization behind Lexile, has modified their Lexile ranges based on the 2012 revision to Appendix A of the CCSS to a “Stretch” Lexile range of 740-1010 as appropriate when selecting text for fourth and fifth grade readers (MetaMetrics, 2017b). Teachers can use the Lexile Analyzer (https://www.lexile.com/analyzer/) to upload and analyze any text. Within a few seconds, the site will display the Lexile measure for the text. If the text is above the reading level of a student or the grade level, the teacher may use a tool to simplify the text (e.g. https://rewordify.com/). Simplifying the text can be a cumbersome and time consuming process, therefore teachers may choose to search for substitute texts.

Integration. Following the adoption of NCLB in 2002, and the increased pressure to focus on math and reading for high stakes testing, teachers moved away from content area
integration (Musoleno & White, 2010). The education community, however, started calling for more integration (Conderman & Woods, 2008; Drake & Burns, 2004; Pratt & Pratt, 2004; Wragna, 2009) to increase science (and other non-core subject) instruction time, student engagement, and student achievement.

In *Meeting Standards Through Integration*, Drake and Burns (2004) discuss three approaches to creating an integrated curriculum: (a) multidisciplinary integration, (b) interdisciplinary integration, and (c) transdisciplinary integration. In the multidisciplinary approach, the selected standards are organized around a theme and discipline specific skills and knowledge are taught and assessed. The interdisciplinary approach is planned around interdisciplinary skills (e.g. literacy, critical thinking, numeracy, research skills), rather than specific disciplinary content knowledge. The teacher acts as the facilitator of learning in both the multidisciplinary and interdisciplinary approaches. However, the students are the leaders in transdisciplinary integration, where students work to answer their own questions in a real life context. For example, in project-based learning students use their disciplinary knowledge and interdisciplinary skills to find a solution to a local problem.

Rarely does teacher implementation of integration perfectly align with one of the three approaches previously described (Lam et al., 2013, Applebee et. al., 2007). Lam et. al. (2013) showed that the interdisciplinary approach was more likely for teachers whose schools adopted integrated curriculum for core subjects, however, some teachers did choose a multidisciplinary approach. Regardless of the integration approach, all integration should be standards-based (Drake, 2012).

Pratt and Pratt (2004) stress that, “although there can be many desirable outcomes of the integration of two or more disciplines, including more efficient use of instructional time and
increased student understanding of the connections between the disciplines, it is important not to lose sight of one overarching goal: the desired outcomes of both disciplines must be achieved, maintained, and enhanced” (p. 395). To achieve the goals of all disciplines, integration requires careful planning.

**Backward design and the 5Es.** Backward design is a common curriculum planning framework laid out in the book *Understanding by Design* (Wiggins & McTighe, 2005). The framework has three stages: identifying the desired results, determining what evidence will be collected to show student understanding, and planning the lessons.

In *Translating the NGSS for Classroom Instruction*, Bybee (2013) demonstrated how to use the Biological Sciences Curriculum Study 5E Instructional Model (Bybee et. al., 2006) and the NGSS to apply backward design (Figure 4). The Biological Sciences Curriculum Study 5E Instructional Model is based on constructivist learning theory, which says that people construct their own meaning of the world through experiences and reflecting on those experiences (Brooks, 1999). In the five stages of the 5E model students:

- *engage* in activities to activate background knowledge and connect to the content
- *explore* concepts and practices through a common experience
- *explain* their conceptual understanding and demonstrate their skills
- *elaborate* by extending their understanding through new experiences
- *evaluate*, or reflect on, how their understanding has changed and are evaluated by the teacher on their attainment of the performance expectations (Bybee, 2006)

The reflection on their learning by students in the *evaluate* stage is often a missing component in descriptions of the 5Es. The instructional model was originally designed with the intent that each of the five components in every lesson, however, the use of the model has evolved over the past
thirty years. The current thinking is that each of the 5Es should be incorporated into each chapter or unit as a whole (Biological Sciences Curriculum Study, 2014a; 2014b).

![Diagram](image)

**Figure 4.** The backward design combined with the 5E instructional model. Adapted from “Translating the NGSS for Classroom Instruction” by R. W. Bybee, 2013. Copyright 2013 National Science Teachers Association, p. 60.

**Place.** The literature (Smith, 2002; Sobel, 2004) shows that students are more engaged in what they are learning if they are able to connect it to their lives and their community. Smith (2002) identified five themes in the place-based literature: cultural studies, nature studies, real-world problem solving, internships and entrepreneurial opportunities, and induction into community processes (participation in the decision making process). These themes show that place is not just about connecting to the natural environment, but to wherever the students are based.
Standards

In 2011, a committee of Albany County School District One (ACSD1) teachers and administrators created a CCSS-aligned report card and companion document to focus teacher instruction on those standards the committee deemed essential based on current research. Teachers in ACSD1 were expected to use the complete list of CCSS standards when designing classroom instruction, however, the essential standards were required to be taught to mastery.

With the adoption of the WSS in 2016, ACSD1 teachers and administrators began the process of implementing the new science standards in all grade levels. Therefore, at that time, ACSD1 teachers were in different stages of familiarizing themselves with the standards and there was not a district plan for instruction and integration of standards into other content areas at this time.

Study Setting

At the time of this study, my school was a Title 1 elementary school with a typical enrollment of around 400 students in PreK through fifth grade. Approximately 50% of those students participated in the free and reduced lunch program. Laramie, Wyoming is home to the University of Wyoming, artisans, technology startups, civic and conservation organizations. The Laramie River runs through the historic town that sits between the Snowy and Laramie Ranges, the backdrop of an amazing landscape. Yet, many of my students had never explored these local treasures or spoken to local experts. How could I help them connect their learning to the place that they live?

Integrated Unit Design

The process used to design the integrated unit is illustrated in Figure 5. This design
process incorporated my personal teaching beliefs and my understanding of the literature on integration, backward design, the use of high-quality text, place, and three-dimensional learning.

![Integrated Unit Design Flowchart](chart.png)

**Selection of Standards.** Three CCSS standards, deemed essential for fifth graders in ACSD1, were selected for the integrated unit (Table 1). Prior to this study, my teaching team invested over two months of instructional time on a single reading standard, RI.5.2 (summary of nonfiction text) and at that time, chose passages primarily for text quality, not for specific content or to enhance science or social studies instruction. My motivation for selecting RI.5.2 (summary of nonfiction text) was to design an integrated unit that gave purpose to the work of summarizing nonfiction text. The selection of the second reading standard, RI.5.5 (compare and contrast structure of two or more texts) pushed me to find a variety of informational text. The
large amount of informational text required for this unit, provided ample opportunity to compare
and contrast text structures. Although “provide a list of sources” is the only piece of the standard
that has been deemed essential by ACSD1, the writing standard W.5.8 (gather relevant
information from sources) partners with RI.5.2 (summary of nonfiction text) to provide a
summary of the text as students take notes or incorporate the information into other work.

Table 1

Standards Selected for the Integrated Unit

<table>
<thead>
<tr>
<th>Common Core State Standards - English Language Arts</th>
</tr>
</thead>
<tbody>
<tr>
<td>RI.5.2 Determine two or more main ideas of a text and explain how they are supported by key details; summarize the text.</td>
</tr>
<tr>
<td>RI.5.5 Compare and contrast the overall structure (e.g., chronology, comparison, cause/effect, problem/solution) of events, ideas, concepts, or information in two or more texts.</td>
</tr>
<tr>
<td>W.5.8 Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, provide a list of sources.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Wyoming Science Standards</th>
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</thead>
<tbody>
<tr>
<td>5-LS2-1 Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.</td>
</tr>
</tbody>
</table>

Since we were just starting our district work on the WSS, none of the standards had been
deemed more “essential” than others, thus my selection was not constrained to a list of essential standards. I chose to use WSS 5-LS2-1 (model the cycle of matter through an ecosystem) for the integrated unit because my background in life science made it a comfortable fit and my students showed interest in the topic.

**Unit layout.** Once the standards were selected, I created parallel lists of lesson topics for the instruction of summary writing and the movement of matter within ecosystems. With this
list, I was finally able to visualize the unit and begin the unit planning process. Figure 6 is an example of the first page lesson 3 within the unit. This section provides the essential questions, a unit summary, and a list of lessons within the unit to make the sequence apparent to the teacher.

The unit summary was based on the parallel list of lesson topics and provided a description of the NGSS and CCSS focus for each lesson. The unit consisted of five multi-day lessons (see Figure 6) each of which addressed one step in the progression toward proficiency of the key unit standards, RI.5.2 (summary of nonfiction text) and 5-LS2-1 (model the cycle of matter through an ecosystem).

**Ecosystems: Interactions, Energy, and Dynamics**

**Essential Questions:** How is a food web model useful in representing interactions in an ecosystem?

**Unit Summary:** The purpose of this unit is to integrate the instruction of nonfiction summary and the movement of matter among plants, animals, decomposers, and the environment. This will be done through a series of multi-day lessons in which students participate in discussions, hands-on activities, and readings on ecosystem components and the movement of matter within systems. The integrated language arts instruction will use the selected nonfiction texts to write summaries using the main idea and key details.

- **Lesson 1**
  - NGSS – identify abiotic factors of ecosystems.
  - CCSS ELA - identify the main idea of a nonfiction text.
- **Lesson 2**
  - NGSS – identify biotic factors of ecosystems and create energy pyramids.
  - CCSS ELA – identify key details and explain how they support the main idea.
- **Lesson 3**
  - NGSS – create food webs using local examples.
  - CCSS ELA – summarize nonfiction text with one main idea.
- **Lesson 4**
  - NGSS – identify components of cycles (e.g. water) and use models to explain how the components are connected.
  - CCSS ELA – identify 2 or more main ideas in a text and explain how they are supported by key details.
- **Lesson 5**
  - NGSS – discuss how the introduction of a new element can alter the interactions in a system, build a model system, and make observations.
  - Performance task: develop a model to explain how matter transfers within the model ecosystem.

*Figure 6. Unit summary page from lesson 3 (see appendix A for the full lesson).*

**Assessments.** In keeping with the backward design framework, I chose assessments that would provide acceptable evidence of learning for both the CCSS and WSS standards. The
Ecosystem Cycles formative assessment probe (Keeley, 2011, see pages 97-102) was selected to be used at the beginning and end of the unit to see if students were able to demonstrate an understanding that both energy and matter cycle through an ecosystem. This performance task was based on the WSS performance expectation (a description of what students can do to meet the standard), which asked students to create a model showing the cycling of energy and matter within their ecosystem. In another part of the assessment, students reflected on and discussed how their thinking changed after they completed the probe the second time.

**Teaching tools.** My collaborative team created a tool that included steps for students to use to identify the main idea and key details of informational text. Students used this tool to organize the information into the summaries they wrote on each article. Other tools helped students with the various aspects of writing informational text.

**Development of lessons.** The National Science Teachers Association has vetted activities and lesson plans for the NGSS standard 5-LS2-1 (model the cycle of matter through an ecosystem), and these were used as the initial inspiration for the unit. It is important to note that the WSS only differ from the NGSS by 5%, thus, the use of NGSS vetted activities was highly appropriate for this work. A selection of these and other available resources were divided into five lessons. Each lesson was framed using the 5E Instructional Model and mapped on the Three-Dimensional Learning Model (Houseal, 2015 & 2016) to ensure that each lesson addressed each DCI (content), CCC (big ideas), and SEP (process) targeted within the unit plan. All ecosystems used in the unit plan were found in Wyoming and were familiar to my district’s students. Each lesson required students to create a model of the ecosystem components targeted within the lesson. Students reflected on the different types of models (map, energy pyramid, water cycle, food web, etc.) used within the unit as part of the unit wrap up in Lesson 5.
Selection of non-fiction text. Locating and vetting nonfiction text was one of the most challenging aspects of the planning process. All text used in the unit had to (a) have accurate science content, (b) be of high quality, and (c) be at an appropriate Lexile for fifth graders. The three criteria in the flowchart were a challenge to meet because there was not a lot of readily available text. I spent countless evenings and weekends searching online, scouring bookstores, digging through library collections, and contacting state agencies for quality nonfiction text that met the three criteria in the flowchart. Because of this work, the text for this unit was acquired through a variety of sources (e.g. Albany County Public Library, Wyoming Game & Fish, ReadWorks, Rocky Mountain Audubon Society, National Geographic Encyclopedia). The Lexile
Analyzer was used to level the text, if the Lexile was not already identified or if I questioned the level. Each text was assigned a Lexile and compiled into a collection for use during the unit.
Chapter 4

Discussion

Overview

This project was my attempt to identify my teacher beliefs and use them to develop and teach a theme based, integrated, standards aligned unit. Through the literature I came to the realization that my beliefs were actually proven research based strategies. Within that context, in this chapter, I answer my research questions and discuss my reflections regarding the process of reviewing the literature and planning and teaching the integrated unit plan. I respond to the second question by discussing how my beliefs were connected to the literature and how they helped me to persist in challenging situations. As I reflected on the impact of my teacher beliefs and the literature on the design of the unit, I discovered that backwards design was far more prominent in the planning process and collaboration was more difficult than expected. In addition, I will examine the limitations of this study, recommendations for future work, and the conclusions drawn from this work.

What did I recognize as I went through the process?

Teacher belief. In Chapter 2, I addressed my first question with a review of the literature on teacher belief. These beliefs are a set of personal constructs developed over the course of a teacher’s lifetime and are based on their experiences with schooling and instruction. Guskey (1986) found that the structure of teacher preparation programs and professional development influence whether teachers make changes in their beliefs. Therefore, a theoretical way to change the belief systems of pre-service and in-service teachers is to create a system that facilitates their reflection as a community to come to a common belief system.
The beliefs (and their theoretical grounding) identified in my early reflection (backward design, place, high-quality text, collaboration, and integration) were all shaped by my coursework and practice as a teacher candidate. While I do not know what kind of teacher I would have become without the University of British Columbia’s Bachelor of Education program, I recognize that this experience changed my belief system. I entered the Middle Years Cohort with a plethora of content knowledge and a belief system that had evolved over years of lecture-style education. Thankfully for my future students, my faculty mentors treated every class as an opportunity to lay a foundation of pedagogical understanding, teacher reflection, and collegial collaboration. All members of the cohort held bachelor’s degrees in a content area (e.g. science, math, English, and kinesiology) and this program was an additional bachelor’s degree in education. Our faculty mentors created a classroom environment that, “engender[ed] in beginning teachers a strong sense of professional inquiry and appreciation of the importance of research in understanding teaching and learning” (UBC, para. 2).

**Changing teacher belief.** The PLC movement to reform U.S schools is working toward facilitating the change of teacher beliefs. However, changing the culture of a school is not a simple or quick process. During our district’s professional development on creating PLCs in our schools, we were warned that this process takes time to set up, become efficient, and get teacher buy-in. After four and a half years of implementing the PLC process at my school, we are slowly shifting the culture. As a whole school PLC, we have modified our schedule to allow for more collaborative time and developed our norms, mission statement, vision statement, and common goals. Over this time period these have been modified as we have learned/gained more in-depth understanding. This change has been both complicated (and assisted) by staff turnover and changes in grade level team composition. For example, this past year there was a significant
amount of turnover due to retirements and relocations of teachers to other states. When we hired new teachers at the beginning of last year, our interview team made it clear that we were a PLC school and sought to hire teachers who were open to using data and collaboration to drive decision-making regarding teaching and learning. The change in staff increased our staff buy-in as a whole, but we also used valuable time to educate the new teachers about the system and culture we are working to create.

**Teaching the Unit**

The unit was taught over the course of four weeks. This time was disrupted by field trips, two early release days, and a teacher absence for professional development. Despite the disruptions, the students remained engaged during the entire unit.

As discussed in Chapter 2, the Framework laid out the vision of science education and the three-dimensional learning model. Each lesson in the integrated unit was designed to give students the opportunity to use all three dimensions of the WSS (see Figure 7). As students developed their understanding of the DCIs (content) *Interdependent Relationships in Ecosystems* and *Cycles of Matter and Energy Transfer in Ecosystems*, they used the SEP (process), *Developing and Using Models* as they created and revised models of ecosystems. Their final performance task required them to create a model that incorporated pieces of the previous models to show the movement of energy and matter within a Wyoming ecosystem. This was an example of the integration of the CCC (big ideas) *Systems and Systems Models*. In addition, they wrote an expository paper describing the components and interactions shown in the model of their local ecosystem. In this way, the SEP (process) *Obtaining, Evaluating, and Communicating Information* was integrated into the unit, although it was not listed in the original unit plan.

The students understanding of what models are and why we use them became more
sophisticated with the completion of each model. We created our first model, the abiotic components of the Laramie greenbelt, on an early release day and in the rush to finish I forgot to add argon and nitrogen to our depiction of air. This was an embarrassing lapse on my part, but it provided a natural segue to discuss George Box’s quote, “Essentially all models are wrong, but some are useful.” We discussed that this particular model was wrong due to this missing information and the nature of creating a two-dimensional representation of a natural space. By admitting my mistake to the class and modifying it during the next class period, I provided a space (environment of trust) for my students to do the same. With the creation of each new model, my students were looking for ways make their models more accurate and would voluntarily go back to correct their mistakes. It was amazing to see their effort increase with each successive model.

Theoretically, I have always believed in the power of the three-dimensional learning model and attempted to put it into action in my classroom. However, this was the first time I personally saw the impact it could have on my students as they worked to make sense of scientific phenomena.

**Key Insights**

Curriculum development is hard! I believe it is especially challenging when it is done in isolation. Collaboration is amazing, when everyone is invested. As an example, Rodger Bybee (BSCS, 2014) did not create the 5Es by himself, he worked with a team of education professionals at Biological Sciences Curriculum Study to develop and improve the instructional model (Biological Sciences Curriculum Study, 2014a). Collaboration is also DIFFICULT! Yes, it is time consuming, but it is worth the time it takes. There are several issues that need to be resolved for a collaborative team to work smoothly. These include (a) designating specific times
to meet for PLC work (b) establishing norms (rules) for their meetings, (c) an agreement of the amount of time that needs to be committed, and (d) recognition that additional work time may be necessary to meet the team’s goals. No matter how efficiently the team works, these set times may not be sufficient to complete the necessary work. In a case like this, new questions arise such as: What should the team do? Should they honor their time and end the meeting? Or, should they find time in the near future to complete the work?

An example of one of the frustrations I encountered occurred part way through the unit. At that point, my teaching partners asked me what our expository essays should look like. In order to cover all of our essential standards, we had to add 5.W.2 (writing informative/explanatory text) and 5.RI.1 (informational text inference) to the unit. Our school’s instructional facilitators helped us adapt the initial and final lessons to include the two additional standards, but we had not created the writing assessment. Since this unit was to be taught by the entire team, I felt that this should be a PLC conversation and decision, rather than additional work for me. I went to our instructional facilitator for advice and she offered to attend and assist during a our next collaborative meeting. It turned out two of the three of us had already been working on this independently and we were able to agree on the necessary elements before we left the meeting. This was particularly frustrating because we needed the intervention of the Instructional facilitator to address it. I would have preferred to gather our teaching team and take care of it ourselves. This situation made me rely heavily on my own teacher beliefs.

The PLC is the place where teachers should be able to confront their expectations and practices. A collaborative team should establish a culture that welcomes constructive criticism/confrontation, if they are going to keep one another accountable and ensure all students learn at high levels. Confrontation is hard, and I found that I rarely expressed my concern or did
so in a circuitous way. As a teaching professional, it is my duty to attempt to resolve concerns or conflicts and make myself clear to my colleagues, however, when working with a variety of personalities there may be a need for outside intervention, exemplified above.

Despite my frustrations, I still believe in collaboration and the PLC process. Given more time, I think my team could learn to collaborate more effectively. We had not previously taught together and I had the expectation that we would work more closely as a team. A team I had worked with prior had acted as both a sounding board and a motivator when making decisions about teaching and learning in my classroom. While we did not always agree, we shared many of the same beliefs, and challenged one another to raise the expectations in our classrooms. During this project, I found that we as a team were on different locations on a continuum of understanding about what the expectations for collaborative work and we needed to help one another find a middle ground for our collaborative work.

**High-quality text.** A quick Google search the use of high-quality text in literacy education shows that educators and education policy makers believe it is important to use high-quality text when designing our instruction (National Governors Association Center for Best Practices, Council of Chief State School Officers, 2010; Sutherland, 2008; Vick, 2016). However, it is challenging to find a resource that explains exactly what it is that makes a text **high-quality.** This suggests that teachers should simply know it when they see it, which seems like a ridiculous expectation and responsibility to place on classroom teachers. In fact, the section on selecting exemplar texts in Appendix B of the CCSS says that the creators of the standards used texts that were already known to be of merit. In other words, the experts who created the standards did not sift through materials to determine whether or not they were of high quality, but used existing materials instead.
Today’s educators have a vast array of materials they can access, and various sites (e.g. Newsela, TweenTribune, and ReadWorks) are creating and/or adapting text to meet the Lexile (text level) needs of students. However, these texts are often related to current events or are too few to create a body of text on a specific content area. When creating thematic units, teachers need access to large bodies of text on the topics that have already been vetted for quality or they need a good resource that guides them to selection and adaptation (if necessary) of materials they find.

Integration. The key to bringing more science into the classroom is integration. The integration of science content gives purpose to the reading and writing skills students are already learning as part of the CCSS. For example, one of my students was an avid reader and enthusiastic science student, however, she struggled to complete her writing assignments throughout the year. She had difficulty staying on task and would still be working to complete a graphic organizer outlining her product, when her peers were finishing their final drafts. Despite being absent for several days of writing time during this unit, she wrote the longest and most informative research paper in the class, and finished it by the due date. It was clear that she was focused and excited about the material as she worked through the writing process. This may have been the first time she really understood how all of our work in the classroom was connected.

As I looked at my schedule for the 2017-18 school year, I was able to designate thirty minutes per day that could be devoted to science instruction. While I am not accountable for the WSS until 2020-21 (the year that state assessments will focus on science), I need to start piloting units in my classroom to become familiar with all of the 5th grade science standards. This time is only available because our new ELA program, Wit & Wisdom, integrates all strands of the CCSS ELA standards with social studies content. This allows more time for science that it used to share
with social studies. In addition, offering science and social studies during the same day provides my students with more opportunities to practice reading complex text.

**Backward design and the 5Es.** The choice to use backwards design was an effortless decision. My training in backwards design at the University of British Columbia made the process of planning the unit much easier. It was intuitive for me to choose my standards, formative assessments, and a performance task at the beginning of the unit. It felt very unnatural to plan those pieces to fit around an activity or set of activities, the way that units are sometimes developed (Wiggins & McTighe, 2005).

The sequence of experiences and activities is important when planning and implementing units using backwards design and the 5Es (Tanner, 2010). This does not mean that the lessons are unchangeable, but consideration should be given to how changes and omissions of activities and experiences will impact student learning and their ability to complete the performance task. The unit was postponed until April and we were feeling the pressure to complete everything by end of the year. I managed to teach the unit as planned, without making my students feel rushed. However, the other classes were trying to finish up additional projects during this time, and did not teach the unit as it was designed. They taught activities out of sequence or skipped them all together. In addition, the Engage and Explore components of the 5E cycle were often taught while some students were out of the room for Title 1 or special education services. This affected students’ ability to synthesize the concepts because they were not given the same opportunity as their classmates to activate their prior knowledge and confront their prior understanding of the concepts.

I understand that time was limited, but it was very frustrating to have my colleagues pick and choose pieces of the unit. Since we had not discussed the how (backwards design/5Es) and
why (constructivist learning theory) of the unit structure, my teaching partners did not realize how changes they made impacted the implementation, and possibly the student outcomes.

**The value of standards.** I continue to believe that, when used with backwards design and the PLC process, the CCSS and NGSS are valuable tools for teachers and students. Standards help educators to think about how and whether or not students are actually learning what we want them to learn. Therefore, building assessments and units based on them would help. Teachers need to be sure they are teaching to the standards and creating assessments that allow them to assess whether the students have mastered the material or if they need to reteach elements.

In addition, standards are a necessity when working to help with issues of a transient population. The population at my school is highly transient and in the past, students from other states would come in with gaps or be ahead in some academic areas because their state or district curriculum did not match ours. Since the adoption of the CCSS, new students have come into my classroom with a similar set of skills. This makes their transition into a new classroom, often in the middle of the year, much easier.

**Place.** It is worth the time to modify activities and lessons within units to include local examples. This takes time and critical selection of materials. I found that the use of Wyoming examples allowed my students to quickly connect to the material and focus on the concepts rather than worrying about identifying the organisms and landscapes in the activities. Due to time limitations, we were unable to spend time outside exploring the unit ecosystems. However, we frequently referred to our time spent in the field earlier in the year as we prepared for our trip to the Teton Science Schools. In addition, many familiar, local examples provided the students with more associations. This allowed students to make connections between what we were
learning and previous experiences in these ecosystems. As previously mentioned, finding appropriate, high-quality text was a challenge to using local examples, thus, I will continue to advocate for state and local groups to develop text with the new standards in mind.

Near the completion of the unit, I participated in a place-based education workshop given by Teton Science Schools. Prior to this, I thought of place as mostly a connection to the ecology of the area. However, this workshop taught me about two components of place, culture and economy, which were not implicitly present in the integrated unit. Based on this new knowledge, I plan to incorporate all three components of place in my curriculum by using local examples and bringing local experts into the classroom.

**Importance of reflection.** I want my classroom and teaching practices to be adaptive and evolving. I believe it is important to reflect on what went right/wrong in my activities and lessons and look for ways to improve my delivery, classroom management, and classroom practices. I believe that reflection is vital part of my teaching practice.

As I spend more time thinking about the 5Es and using them in the classroom, I believe that some of the experiences were too shallow, particularly the *Evaluate* portion. This is a particularly critical point, because within the 5E models *Evaluate* stands for teacher assessment of student understanding and students’ self-evaluation of their understanding (Biological Sciences Curriculum Study, 2014b). At the end of the unit, students were asked to answer the formative assessment probe a second time and explain how their thinking had changed. Since many of them already had some understanding that both matter and energy cycle through an ecosystem, their explanations of how their thinking changed were not very reflective. For example, “In the begging [sic] I halfway took a guess, but now I’m positive that both energy and matter are in an ecosystem”. This statement shows that while the student recognized that there
was a change in her understanding, the prompt for reflection was not clear or she was unable to write in a reflective manner. In the future, I will work to make this more explicit and give my students more opportunities to reflect on their learning.

**What made me persist?** My beliefs about what I feel is important for my students, in terms of teaching and learning, keep me going. Without these beliefs, it would be easy to give in to the frustration of a challenging class, test score anxiety, or personal stress. The idea of keeping easily distracted or defiant students contained in their desks may sound appealing, but it is far more engaging for the students (and the teacher) to have the opportunity to experience the 5Es. It may be necessary to modify some experiences to fit the needs of students, but it is worth the effort to see them engaged in their learning. However, these moments are when I most need my team, to reflect and brainstorm ways to make the lesson a success for everyone.

**Where do I stand now?**

My core beliefs about how students learn and how I teach have not changed, but my depth of understanding of my beliefs and the literature that backs up these beliefs has changed. It has been seven years since I graduated from University of British Columbia with my teaching degree and in those years my belief in the power of backward design and integration have remained steadfast. My time in Wyoming, as well as working with Micah Herrboldt and Teton Science Schools, has increased my belief in the power of place. My work with Ana Houseal and the Science and Math Teaching Center has shaped my understanding of the three-dimensional learning model, 5E instructional model, NGSS, and WSS. My collaboration with Kate Kniss, my PLC, and district colleagues has increased my understanding of the CCSS and high-quality text. Their willingness to teach and learn with me, has made me into the teacher I am today. These
experiences have validated and secured my beliefs. I look forward to our continued collaboration in the future.

**Limitations**

The action research cycle in this study relied heavily on my journaling, reflection and interpretation of those reflections. While I tried to be objective as I wrote about the process, my self-reporting was both based on memory and colored by emotion. This may have resulted in the omission of details an outside observer would have included and may have led to exaggeration when describing events.

Because the study was focused on my teaching beliefs, I did not interview my teaching colleagues regarding their beliefs and how they influenced our work together. Instead, I often interpreted their actions as visible indicators of their beliefs, which was likely not fair or accurate. Rather, these interpretations, were more grounded in my reactions and beliefs. Therefore, my findings cannot be used to generalize to the greater body of research. However, others may find it helpful to use my study as an example as they make inferences about their own teacher beliefs.

An additional limiting factor was the use of constant comparative analysis to code the data. Each journal entry and annotation described my interpretation of the event or artifact. To code these entries I looked for common themes, however, my bias may have caused me to ignore a number of the variables present in the entries.

In addressing my first research question, I reviewed the literature on teacher beliefs and three-dimensional learning. My review of the literature on teacher beliefs looked at seminal papers and the work they influenced, however, it was not comprehensive. In addition, the body of literature available on the three-dimensional learning model was small because it is a
relatively new concept, it was first argued for in the literature in 2015 (Krajcik, 2015). As educators work to implement the NGSS and WSS, they should continue to study the impacts of three-dimensional learning on student learning.

To answer my second question, I reviewed the literature that informed my teacher beliefs and reflected on how my understanding of those beliefs and three-dimensional learning impact my development of a theme-based, integrated, standards aligned unit. This limited my study because it was focused on my beliefs and what the literature said about those beliefs. These are not the only important principles and practices in teaching, they are simply the ones that were visible through my myopic lens. In addition, I looked at how my understanding, not the collective understanding of other teachers regarding these principles, impacted this work.

**Recommendations**

Based on this work, I urge teachers to identify their current teaching beliefs and revisit the personal philosophies that they undoubtedly wrote as student teachers. In so doing, they may be able to rediscover how their beliefs and practices have evolved through time. Reminding themselves of their beliefs could also:

- Provide a powerful ally in coping with the challenges of classroom teaching.
- Hone independent learning, learning in their PLC, or learning through coursework (Boesdorfer & Lorsbach, 2014).

By understanding their beliefs teachers could also explore where or not what they are doing is best for their students.

In addition, school administrators should seek to understand their own beliefs (and the relevant literature) to guide decision-making and to facilitate the identification of beliefs by teachers. Since teachers they work with will likely fall on a continuum (in terms of both what
they believe, and their understanding of their beliefs), by understanding their own beliefs, administrators may be better prepared to recognize the beliefs of others. In this way, they can better support the learning and collaboration of PLCs.

As administrators work with PLCs and create professional development, they should also recognize that change in beliefs takes time. It would be most helpful if administrators also understand and ensure that PLCs have the structures in place to receive feedback on student progress. This evidence of positive change in student performance can itself propel change in teacher beliefs and attitudes (Guskey, 2002).

As discussed in Chapter 2, Wyoming students scored above the national average on the NAEP science assessment (Wyoming Department of Education, 2016) despite the state standards being ranked as being of poor quality (Lerner et al, 2012). However, three-dimensional learning proposed by the Framework, which was also used to design the WSS, will require teachers to change how and/or what they are teaching (see Figure 8). I recommend that Wyoming teachers and administrators identify their beliefs regarding science learning and instruction to understand the practices underlying this success. In addition, this could yield a better understanding of the weaknesses they need to address in their professional development for the implementation of the WSS (Boesdorfer & Lorsbach, 2014).
Future work on the impact of teacher beliefs during the implementation of the NGSS and the WSS should be conducted. Some Wyoming teachers have been working with the NGSS since their release, however, most teachers in the state are just starting to familiarize themselves
with the WSS. As the standards are implemented, a yearly survey on the beliefs of teachers in both groups could add to our understanding of teacher beliefs. It could also be a tool used by professional development providers to help teachers reflect on this process.

I would encourage teachers to use the Integrated Unit Design Flowchart (see Figure 5) when starting to design integrated units. It is based on current best practices as identified by the literature and in that way is a robust tool for this process. I found it to be useful both as a planning resource and tool to evaluate whether the lessons would give the desired results. The flowchart could be added to or modified to address best practices in other content areas. Research regarding the effectiveness of this tool and eliciting teacher beliefs during the implementation of standards could be a fruitful area of study in the next decade.

**Conclusions**

As teachers implement new standards, in all content areas, I feel that it is important for them to identify their teaching beliefs. Through this process, I discovered that my beliefs were actually research-based strategies. The research tells us that PLCs are an effective tool to improve student achievement (Brodie, 2013; Darling-Hammond, 2013; Dufour & Dufour, 2012; McLaughlin & Talbert, 2006), that the use of place can increase student engagement and interest (Smith, 2002; Sobel, 2004), and that the use of backward design ensures the assessments and lessons target the standards (Wiggins & McTighe, 2005). Based on my work, I found that understanding my teaching beliefs (and the grounding theory) enabled more student-centered choices and confidence, even when my colleagues did not share these beliefs or understanding. In addition, using this same understanding, it may be possible for administrators to be able to assist teachers with curriculum development and collaboration by facilitating their navigation toward a place of common belief and understanding.
References


Biological Sciences Curriculum Study. (2014b, December 9). BSCS on topic: The BSCS 5E instructional model (part 2): How the 5Es evolved over time [Video file]. Retrieved from https://www.youtube.com/watch?v=c242mIDLgUE


Appendix A
Ecosystems: Interactions, Energy, and Dynamics

**Essential Questions:** How is a food web model useful in representing interactions in an ecosystem?

**Unit Summary:** The purpose of this unit is to integrate the instruction of nonfiction summary and the movement of matter among plants, animals, decomposers, and the environment. This will be done through a series of multi-day lessons in which students participate in discussions, hands-on activities, and readings on ecosystem components and the movement of matter within systems. The integrated language arts instruction will use the selected nonfiction texts to write summaries using the main idea and key details.

- **Lesson 1**
  - NGSS – identify abiotic factors of ecosystems.
  - CCSS ELA - identify the main idea of a nonfiction text.
- **Lesson 2**
  - NGSS – identify biotic factors of ecosystems and create energy pyramids.
  - CCSS ELA – identify key details and explain how they support the main idea.
- **Lesson 3**
  - NGSS – create food webs using local examples.
  - CCSS ELA – summarize nonfiction text with one main idea.
- **Lesson 4**
  - NGSS – identify components of cycles (e.g. water) and use models to explain how the components are connected.
  - CCSS ELA – identify 2 or more main ideas in a text and explain how they are supported by key details.
- **Lesson 5**
  - NGSS – discuss how the introduction of a new element can alter the interactions in a system, build a model system, and make observations.
    - Performance task: develop a model to explain how matter transfers within the model ecosystem.
  - CCSS ELA – summarize nonfiction text with multiple main ideas.
<table>
<thead>
<tr>
<th>Connecting to the Common Core State Standards</th>
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<tbody>
<tr>
<td><strong>ELA</strong></td>
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<tr>
<td><strong>RI.5.2</strong> Determine two or more main ideas of a text and explain how they are supported by key details; summarize the text.</td>
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<tr>
<td><strong>W.5.8</strong> Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources.</td>
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<tr>
<th><strong>SUGGESTED PROCEDURE</strong></th>
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<tr>
<td><strong>Day 1: WWF video on Northern Plains Ecosystem or Sagebrush Sea</strong></td>
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<tr>
<td><strong>Weaving the Web - New York Agriculture in the Classroom</strong></td>
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<tr>
<td><a href="http://forces.si.edu/ltop/pdfs/2-5-WeavingTheWeb.pdf">http://forces.si.edu/ltop/pdfs/2-5-WeavingTheWeb.pdf</a></td>
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<tr>
<td>Students will participate in a classroom model of a food web. They will discuss the types of organisms, relationships between organisms in an ecosystem, energy, and matter. The activity will be modified to include Wyoming wildlife and decomposers using the images and descriptions from <strong>A Sagebrush Sea - a high desert ecosystem</strong></td>
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<td><a href="https://wyoming.pbslearningmedia.org/resource/nat15.sci.lisci.sagebrush/sagebrush-sea-a-high-desert-ecosystem/#.WOG0BqIrJ7o">https://wyoming.pbslearningmedia.org/resource/nat15.sci.lisci.sagebrush/sagebrush-sea-a-high-desert-ecosystem/#.WOG0BqIrJ7o</a></td>
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<td><strong>Day 2/3: Ecosystem Reading and Summarizing</strong></td>
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<tr>
<td><a href="http://rockies.audubon.org/conservation/wyoming-habitat-flashcards">http://rockies.audubon.org/conservation/wyoming-habitat-flashcards</a></td>
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| o Whole class will read passages on what an ecosystem is and what the components are.  
o Partners will be given a photograph of a Wyoming ecosystem, along with text on its components.  
o They will work together to read and summarize each text using a graphic organizer to organize their thinking. |
| **Day 4: Create Food Web for Ecosystem & Gallery Walk** |
| o Partners from Days 2/3 will create a model (web) of their ecosystem.  
| o Class will take a gallery walk prior to a Q&A with each group about their web.  
| ▪ Students will complete a gallery walk form that identifies the ecosystem, one thing they learned from the web, and one question they have about the ecosystem.  
| ▪ Food Web Rubric will be used to assess student work. |

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<th><strong>Other Resources</strong></th>
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