Developmentally Appropriate Standards: A Recommendation to Kellogg F.I.E.L.D School

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Plan B Project
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Abstract

This paper analyzes current research and standards in science education, developmental capabilities for critical thinking, and non-traditional education settings. The purpose of this work is to create appropriately sequenced standards bundles for a supplementary science program called the Kellogg F.I.E.L.D program in Palmer, Alaska. To build these 3-dimensional standards bundles, I compared, aligned, and synthesized the existing F.I.E.L.D program standards with the Alaska State Standards, Next Generation Science Standards, and current research in best practices in pedagogy. The pedagogies reflected in standards bundles are Place-based pedagogy, Constructivism, Culturally Relevant Pedagogy, and Framework for K-12 Science Education and Learning. The project’s product is a set of grade-level, 3-dimensional standard bundles with suggestions for unit content.

Keywords: standards bundles, supplementary science program, place-based education, Kellogg F.I.E.L.D, 3-dimensional learning, Next Generation Science Standards, Alaska State Science Standards
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Chapter 1

Introduction

Background

As a teacher, I am continually considering how to meet the needs of every student in my classroom. I am certainly not alone in this, as each year that I have taught alongside educators who work tirelessly to reach the children in their classes. Education is the type of job that you show up for early, get home late, and wake up in the middle of the night thinking of ways that you can reach that one child who just is not catching on. It tends to attract passionate people who want to save the world by making a difference in a child’s life. Through teacher education programs, prospective educators are taught commonly used best practices and pedagogies as they hone their beliefs and values as educators. After graduation, they are thrown into a complex educational system and forced to become creative to survive the constraints that have been set by policymakers and others outside of the classroom.

Currently, in United States (US) education system that I have experienced, teachers spend their planning time analyzing test data, students’ shortcomings, and participating in teacher compliance meetings. They are not able to use this time to investigate recent research in educational practices or research brain development. Compulsory education began after World War II, and at that point, parents could choose between public or private schools. Since then, the US formal education system has been met with many alternatives. These alternatives may focus on religion, culture, family, scientific thinking skills, or understanding the natural world. In this paper, I explore recent research in educational theory that supports an alternative education style,
investigate the impact the brain has on learning, and develop standards for a non-traditional supplemental science program.

To understand the concepts discussed in this paper, the reader needs a basic understanding of the underlying research. Educational researchers have been investigating how people learn since the 1800s, as an example, Ivan Pavlov’s (1928) behavioral theories such as Conditioned Reflex Theory. However, it has been within the past hundred years that researchers have begun investigating cognitive development. Piaget’s (1976) Theory of Cognitive Development kicked this off, and much of the more recent work has built on his theories. In the last 20 years, researchers have been exploring human brain development with more sophisticated tools that have allowed us to watch the brain while cognitive changes are taking place (e.g. Immordino-Yang, 2011) with the impact on learning in mind (e.g. National Research Council [NRC], 2000; NRC, 2018). In addition, in the last century, the idea of best practice has been a highly discussed educational topic (Reese, 2017). The reality is that learning is a complicated process. Recent research discussed in How People Learn (NRC, 2000) and How People Learn II (NRC, 2018) have identified key factors that support learners that will be discussed in Chapter 2.

In this research, there were consistent themes that are fundamental to educational best practices. First, the educator must understand the learner’s developmental capabilities so that they can be appropriately challenged (Vygotsky, 1934). Additionally, educators must offer students the opportunity to engage with materials in meaningful ways. Finally, they must allow time for students to reflect on their learning to build new neural pathways and connect it to information they had already learned (Dewey, 1918; Kolb, 1984; Kuhn, 2008; Kuhn, 2015; NRC, 2018). Thus, the charge to educational institutions is to develop programs that support the
most recent understandings of brain research, educational best practices, and meet the standards defined by cultural expectations.

For this project, I chose to examine the Kellogg Fully Integrated Environmental Learning and Discovery (F.I.E.L.D) school, an educational institution that was constructed on a solid foundation in culture and the educational best practices at the time of its inception. Initially, this school was called *The Louise Farm School* and was designed specifically to support homeschool Kindergartener and first grade students, who attended it as a supplemental program to their homeschooling curriculum. Throughout this paper, I will refer to the program by its current name, the Kellogg F.I.E.L.D program, unless specifically examining or referring to documents from the school’s origination. The needs of the homeschool community dictated many of the original instructional targets and curricula, but over time, these needs have changed without simultaneously evolving the targets or curricula.

The Kellogg F.I.E.L.D program in Palmer, Alaska, is a supplement environmental education program that focuses on serving the Matanuska-Susitna Valley community as an interdisciplinary outdoor-based enrichment program. This program, established in 2009, was designed based on the needs of the community during at that time. Since then, the Kellogg F.I.E.L.D program has expanded from grades K-1 to K-8, offering students’ seasonal learning opportunities that vary in length depending on the season based on student’s age. The age bands focus on the students ages rather than the grade level they are in because of the discrepancy of homeschooling grade-levels. They are not as strict as within the formal US educational system due to fewer restrictions.
Statement of the Problem

Recent educational reform and local to national policies and legislation have pushed the mainstream formal education system into one that encourages teachers and administrators to view children as data points (e.g. No Child Left Behind, 2001; Every Student Succeeds Act, 2015). Schools have been required to follow this route as a means to secure school funding and answer to legislative demands. Because of this a movement toward non-traditional education has developed. *Non-formal* and *non-traditional* education can present in various configurations, but for the scope of this project, I looked at *place-based, environmental education, and experiential learning*, as relevant theories. Australia, Norway, and Sweden are among the most successful school systems in the world (US News & World Report, 2019). In this way, they value adults who are strong critical thinkers (Kuhn & Franklin, 2008), are aware of environmental issues, and comprehend the value of environmentally responsible behaviors (Green, 2012). To this end, these countries have developed environmentally considerate curriculum frameworks based on a keen awareness of place.

It is also critical to align expectations for students at an appropriate developmental level (NRC, 2013). For instance, it would not be considered developmentally appropriate to expect a kindergartener to analyze data at the same complexity as a high school student. Due to the importance of the concepts discussed, educational psychologists, educators and experts in each scientific discipline worked together to create *A Framework for K-12 Science Education and Learning* (hereafter referred to as the Framework; NRC, 2012) to support educators in developing curriculum and choosing learning tasks and expectations that are cognitively appropriate for all K-12 students (Kuhn & Franklin, 2008; Green, 2012; NRC, 2013). The Framework (2012) can be used to create a set of standards that are appropriate for the needs of any school or program.
Purpose of the Study

The purpose of this study was to provide the Kellogg F.I.E.L.D School with developmentally appropriate, thorough, and concise spiraling benchmarks for the age bands. Since the F.I.E.L.D program serves home-schooled students in a supplemental program, the program does not encompass all content standards and the standards are divided by ages rather than grades. The program’s original intentions were to instruct students about concepts within each of the following areas: *Environmental Sensitivity, Nature Studies, Outdoor Pursuits, Farms and Food,* and *Our Shared Alaskan Experience.* The standards I developed were designed to support seasonal educators as they develop targeted curriculum for their students. Due to the variation in the length of their seasonal programs, I designed these benchmarks to meet the needs of their most extended session, 13 weeks, to give them the flexibility to adjust as necessary to meet their needs. The standards were intended to support students’ development, nutritional health needs, and explore the unique cultural and geographical aspects of the local and regional community of Alaska. In the Literature Review, I discuss best practices in educational pedagogies and explore the Next Generation Science Standards (NGSS) and how they can support the development of appropriate standards for a program like the F.I.E.L.D School.

Using the Alaska State Science Standards in conjunction with the Next Generation Science Standards, and supporting literature on best practices, I focused on making the standards as accessible as possible, to ensure that the product continues to be useful through the annual teacher and graduate student turnover that the Kellogg F.I.E.L.D school experiences.
Research Questions

To successfully provide the Kellogg F.I.E.L.D school with the desired benchmarks, I used the following research questions to guide this project:

1. How does *A Framework for K-12 Science Education and Learning* align with Alaska’s current state standards and Louise Farm School/ F.I.E.L.D program’s standards?

2. How can educational best practices and current research, such as culturally relevant pedagogy, PBE, and the FK12 be used to connect Alaska State Science Standards to the current Kellogg F.I.E.L.D program?
Chapter 2

Literature Review

Learning is an extremely complex and multifaceted process. Humans and animals have been learning since the dawn of time, and with that in mind, we have only very briefly researched how information is acquired, retained, and transferred to new situations. In the short amount of time that scientists and researchers have investigated this topic, they have gained many insights, but so much is still left to be discovered. What we know with certainty is that many learning experiences require more than one type of learning and are deeply dependent on the learner (NRC, 2018). Traditional pedagogies often rely on dated educational theory, such as Watson’s Behaviorism Theory (Watson, 1913) or Piaget’s Theory of Cognitive Development (Piaget, 1976), which are not necessarily congruent with the best practices discussed here. In this literature review, I explore best practices in teaching, the Framework (2012), and how place-based and culturally relevant pedagogies can support learners.

Theoretical Framework

First, I discuss combinations of pedagogical methods. When combined these allow learners to construct their knowledge, engage with resources on various levels, and are shown to retain knowledge beyond the original context of instruction (Lee & Anderson, 2013).

Non-Traditional Pedagogies and Best Practices

Culturally responsive pedagogy. In the early 1980s, educational researchers began to explore the impact of cultural misalignment between the school and home lives of students, and
the overall effect it had on educational success. Many terms that have similar definitions arose from this research, such as *cultural synchronization, culturally responsive,* and *culturally compatible* that have similar meanings. However, for this project, I explored *culturally relevant pedagogy.* Culturally relevant pedagogy is a term coined by Gloria Ladson-Billings (1995) that specifically focuses on a student’s need to develop critical perspectives that challenge inequalities as they accept and affirm their cultural identities. This theoretical model relies on three broad propositions about students and teachers.

The first proposition is that the teachers’ conception of self and others is critical in the overall success of students. This means that if the educator believes that all students are capable of academic success, their pedagogy is an art “unpredictable, always in the process of becoming” (p. 478). In this way, they see themselves as part of the community and their teaching a way to give back to that community. In addition, their students are not “permitted to choose failure in their classrooms” (p. 479). Teachers with a culturally relevant pedagogical mindset did not refer to students based on their shortcomings, but regularly evaluated their limitations and made modifications to ensure student success. Ladson- Billings (1995) emphasizes that a sense of community is deliberate but straightforward. While teachers can live in the community, visit for goods, services, or leisure activities, it is by showing a sense of shared community with their students that the investment in success increases.

The second proposition is that social relationships have a large impact on academic success (Ladson-Billings, 1995). Teachers must maintain equitable and reciprocal teacher-student relationships with reciprocity. Ideally, the classroom is a place where a community of learners comes together to collaborate. Students in this environment are responsible for each other’s success and are continually supporting one another as if they are family. In one example,
Ladson-Billings (1995) observed that the teacher modified cooperative learning structures to be a “buddy system,” in which each student paired with another. Students checked each other’s work, quizzed each other for tests, helped each other with make-up work if one was absent. This level of reciprocity and mutuality is a prime example of the familial relationship necessary for students to feel invested in the learning community referenced in the first proposition (Ladson-Billings, 1995).

The third proposition is that the most successful culturally-relevant educators have several common beliefs about knowledge. Ladson-Billings (1995) asserted that it was a shared understanding among culturally relevant educators that knowledge is not static. Accordingly, learning is shared, built, and changed by the learner. These educators must be passionate about knowledge and learning, and capable of providing scaffolding to facilitate learning, while also incorporating multiple forms of assessment (Ladson-Billings, 1995).

The most fundamental aspects of culturally relevant pedagogy are that teachers believe that learning is a journey, that all children can learn and be experts in their way, and that scaffolding within the learning community is the way to make all children succeed. As schools and classrooms have moved towards specific performance standards, culturally relevant pedagogy has remained relevant although it requires teachers to innovate within their F.I.E.L.D to support student creativity.

**Place-based education.** Although mainstream education has become more standardized with the development of performance and content standards (Ravitch, 1995), another side of education has gained momentum as well. The *Environmental Education Framework* supports students’ understanding of environmental sustainability within the “disciplines of science, studies of society and environmental science, or environmental science” (Green, 2008, p. 327).
Many schools are developing an integrated curriculum that includes multiple perspectives on sustainability within academic disciplines (Feng, 2012). This framework encourages participants to take on leadership roles in managing environmental and economic initiatives within their school that guide authentic engagement (Green, 2008). Environmental education frameworks have gained steady momentum in other countries, such as Australia, New Zealand, and parts of Europe, however, it is yet to become as popular in the United States. More commonly found in the U.S. is a congruent framework known as *Place-Based Education*.

Various movements within education seem to support the idea that education should be individualized (Levy, 2008). Because of this, one may wonder where the benefits lie within developing standards or learning objectives. Noddings (2013), a professor at Stanford University, even argued that a consequence of standardizing education is a direct contradiction of at least one of the three main objectives of 21st-century education worldwide: cooperation, critical thinking, and creativity. Noddings argues that by standardizing content, students are no longer given opportunities to pursue their own interests and strengths, therefore taking away students’ ability to be creative and innovative. This perspective on standardized education has valid concerns. However, this view is reflective of rigid standardization, which is often seen when schools rely on specific instructional materials as “curriculum” (Noddings, 2013; Steiner, 2017). The content standards and performance expectations found within the *Framework* and NGSS, discussed later, are not intended to be a defined curriculum. Rather, they are a group of expectations that support opportunities to learn science in various content areas that are not dependent on the teacher’s content knowledge (NRC, 2008). In this way, these standards and expectations are intended to guide the development and grouping of benchmarks that support diverse learning environments.
To better understand what appropriate benchmarks might look like for the F.I.E.L.D school, the basics of Place-Based Education are important to explore. For this project, I define Place-Based Education as “an approach that connects learners and communities to increase student engagement, boost learning outcomes, impact communities and promote understanding of the world around us” (Teton Science School, 2018). TSS’s definition of “place” relies on three main perspectives: Ecology, Economy, and Culture to connect learners to their surroundings, and the impact they have on them. Place-based principles are dynamic components of daily routines, exchanges, and actions in place between the human and more than human world also referred to as ‘place-making’ initiatives (Birkeland, 2005; Comber, 2011; Derr, 2006; Green, 2009; Gruenewald, 2003a; Somerville & Green, 2012b). These daily routines are meant to support learner’s understandings about how the world works and how we fit into that world (Gruenewald, 2003b).

Even though both culturally relevant and place-based pedagogies can be taught within the confines of the standardized education system by thoughtfully building routines and lessons, they are more often found within private schools with value systems that rely on these concepts. This reality has compelled experts to work together to develop standards frameworks for public educators to engage students in scientific literacy embedded into place-based pedagogy (NGSS, 2013, Appendix H; Gruenwald, 2003b).

**Abductive reasoning.** In the early 1900s, Charles Sanders Pierce coined the term “abductive reasoning” to describe the phenomena that often, people must conclude, that although not sure to be correct, are critical to making forward progress (Fann, 1970). This type of reasoning is natural and often implicit. *How People Learn II* (NRC, 2018), a compilation of recent research in learning, gives the example of the dog owner who enters their dining room to
find dog footprints on the tablecloth, a spilled glass of wine, and an empty hotdog bun. Using abductive reasoning, the person is able to assume what occurred (p. 50). This type of reasoning can be incorporated into learning models, which makes learning more efficient while allowing students to make sense of observations from fewer data, better generalize what they have learned, and apply to new situations (Lake et al., 2015, 2017; Tenenbaum et al., 2011). An educational best practice is to use models to teach and explain complex phenomena. This can equip learners with the ability to make accurate predictions about new situations that go well beyond the original experience (NRC, 2018, p. 51). As noted in both the Next Generation Science Standards (NGSS) and Common Core Mathematics Standards, “Models make it easier for learners to describe, organize, explain, predict, and communicate to others what they are learning” (p.54). Models can be visual, physical, or verbal representations of a concept or process.

Although learning through abductive reasoning is essential, it is most effective with guidance. Assisted Discovery Learning is an approach in which the instructor provides a task that is tailored to the level of difficulty that fits the learner and is within the “zone of proximal development” (Vygotsky, 1934; Lui, 2012). Instructors provide the learner with access to critical information, assistance, or examples just before the learner reaches their level of frustration. Experiential Learning, Inquiry-Based Learning, Problem-Based Learning, and Learning by Doing are categorized under the Constructivist Framework and use this approach.

The Constructivist Framework requires that students actively engage with constructing new meanings based on prior knowledge, which is facilitated by learning experiences. In addition, students use meta-cognition and reflect on their previous understandings, changes in knowledge, and how their actions or thoughts impacted that change. In this way, learning occurs
in context so that the new information is relevant and meaningful (Dewey, 1938; Kilpatrick, 1918; Vygotsky, 1934). This contextual learning is supported by what the most current research shows in brain development and the implications for learning (NRC, 2018).

**Learning Progression**

Since 2000, the learning sciences have made incredible advancements. Researchers have begun to investigate how brain development impacts learning (NRC, 2000; Immordino-Yang, 2007 & 2011). They have found that learners are constantly constructing their own brain’s networks as they engage in social, cognitive, and physical situations. In addition, though it was previously assumed that brain development ‘leads the way’ in cognitive development, instead, we now know that it is a reciprocal interaction in which the brain “shapes and is shaped by experience” (NRC, 2000, p.59). In other words, the brain guides the learner’s responses to stimuli, but the experience and the results of the learner’s responses also build new neural pathways that over time become ‘tuned’ to respond to stimuli in specific ways (NRC, 2000). This aggregate of brain research created new cognizance about how the brain develops. These ideas integrate with previously existing theories, such as Vygotsky’s (1934) zone of proximal development. With that in mind, we can explore learning progressions.

Learning progressions, as described in *Learning Progressions: Aligning Curriculum, Instruction, and Assessment* (Duncan, 2009), are “conjectural models of learning over time that need to be empirically validated” (p. 607), and over the last ten years, have been integral to aligning standards, curriculum, and assessment. Learning progressions are characterized by four key characteristics, which were defined by a consensus from a panel discussion on learning progressions. This group operated within the Center of Continuous Instructional Improvement and the Consortium for Policy Research in Education in 2008 (Corcoran, Mosher, & Rogat,
2009). The first characteristic of the learning progressions was on a few foundational disciplinary ideas and practices that support the development of the content as well as inquiry practices. Many researchers argued that this focus was a crucial component in developing scientific literacy (Smith et al., 2006; Songer, Kelcey, & Gotwals, 2009; Schwarz et al., 2009).

The second characteristic of these progressions was that they are bounded by what the student is expected to be capable of by the end of the progression, societal expectations, and the assumption of prior knowledge and skills of the learner (Reiser, Krajcik, Moje, & Marx, 2003). Third, Reiser, Krajcik, Moje, and Marx note that learning progressions distinguish various intermediate steps between the two anchors or learning endpoints. These are evidenced by students’ level of understanding and competency performance. Fourth, learning progressions, guided by targeted instruction and curriculum, are not inherently developmentally inevitable nor linear (Duncan, 2009). The progressions that were developed at the time were used within the Framework (NRC, 2012) to provide context for the NGSS (NGSS Lead States, 2013). However, to make the connections beyond formal educational settings, this requires a look at the necessity for non-traditional educational establishments to meet children’s developmental, social, and cultural needs.

A Framework for K-12 Science Education

Although Alaska has not adopted the NGSS, The Next Generation Science Standards (NGSS) reflect the most current research in a cognitive and scientific progression from childhood to adulthood (NRC, 2012). They are “intended to increase coherence in K-12 science education... [and are] built on the notion of learning as a developmental progression” (NRC, 2012, p. 1-3). The NGSS, developed based on the Framework are composed of three main dimensions: Disciplinary Core Ideas, Science and Engineering Practices, and Crosscutting
Concepts. These components were used to guide the process of developing updated F.I.E.L.D school benchmarks.

The NGSS require the understanding that there are critical ideas within the science disciplines that, when taught with a developmentally appropriate curriculum progression, increase in depth of content knowledge (NGSS Lead States, 2013). These ideas remain within student’s abilities based on executive function, referred to as the Disciplinary Core Ideas (DCIs) (NGSS Lead States, 2013, Appendix E). This content component was developed due to the inherent complexity of ‘good science teaching’ which “requires extensive teacher knowledge, excellent curriculum, effective systems of support and assessment, and much more time and devotion than are currently devoted to it” (NRC, 2008, p.57). The Disciplinary Core Ideas (DCIs) are identified as Earth and Space Science, Life Science, and Physical Science (NGSS Lead States, 2013, Appendix E).

To expand, each DCI divides into cognitively appropriate grade level progressions. As Ready, Set, Science: Putting Research to Work in K-8 Science Classrooms (NRC, 2008) states, “If mastery of a core concept in science is the ultimate educational destination, learning progressions are the routes that can be taken to reach that destination” (p. 63). Before the development of the NGSS, students were continually introduced to new concepts without building conceptual understanding in a meaningful way (NRC, 2008). The progression of the DCIs have replaced scattered un-connected content with developmentally sequenced ideas that are built over time.

Alongside core ideas, the NRC identified eight essential science and engineering practices. The NGSS notes that they are “key to the vision expressed in the Framework is for students to learn these disciplinary core ideas in the context of science and engineering practices”
The eight science and engineering practices (SEPs) defined in Appendix F are:

1. Asking questions and defining problems
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations and designing solutions
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information.

There are seven crosscutting concepts (CCC) identified within the *Framework* (2012) that are intended to unify the study of DCIs and SEPs. “Their purpose is to help students deepen their understanding of the disciplinary core ideas and develop a coherent and scientifically-based view of the world” (NRC, 2012). The seven crosscutting concepts are:

1. Patterns
2. Cause and effect: Mechanism and explanation
3. Scale, proportion, and quantity
4. Systems and system models
5. Energy and matter
6. Structure and function
7. Stability and change

CCCs are intended to be repeated in many different contexts to build familiarity and grow in complexity and sophistication as the depth of student understandings grow as well (NGSS Lead States, 2013, Appendix G, p.2).

The implementation of the *Framework’s* (2012) 3-dimensions can be visually explained through Houseal’s *Model of the Three Dimensions of Science Learning: A visual representation of three-dimensional learning* (Houseal, 2015). This model (Figure 1) is a visual tool that can be used for evaluating a curriculum to see if it is 3-dimensional or where it is lacking. This model is a 3-dimensional Venn-diagram which illustrates that if curricula incorporates DCIs and CCCs,
then it integrates content and big ideas, but lacks process. If it has CCCs and SEPs, then it integrates big ideas and process while lacking content. Finally, if it includes DCIs and SEPs, then it integrates content and process, but it is void of big ideas. Ideally, based on information from the *Framework* (2012), curricula should involve all 3-dimensions and would teach content, big ideas and processes (NRC, 2012).

![Figure 1. Houseal’s Model of the Three Dimensions of Science Learning](image)

Chapter 12 of the *Framework* (NRC, 2012) has thirteen recommendations for standards developers. Because the F.I.E.L.D program has multiple courses that vary in duration and the
number of meetings per week, the development of these standards specifically focus on recommendations 3, 4, 7, and 12, described in greater detail below.

- **Recommendation 3**: Standards should be limited in number.
- **Recommendation 4**: Standards should emphasize all three dimensions articulated in the framework—not only the crosscutting concepts and disciplinary core ideas but also scientific and engineering practices.
- **Recommendation 7**: Standards should be organized as sequences that support students’ learning over multiple grades. They should consider how students’ command of the practices, concepts, and core ideas becomes more sophisticated over time with appropriate instructional experiences.
- **Recommendation 12**: The standards for the sciences and engineering should align coherently with those for other K-12 subjects. Alignment with the Common Core Standards in mathematics and English/language arts is especially important.

**Alaska State Science Standards**

The Alaska State Science Standards are comprised of two separate documents that were developed to fulfill the No Child Left Behind Act of 2001 requirements. They have not yet been updated to reflect the *Framework* (2012) or the NGSS. The first document is the standards themselves, and the second document is the grade-level expectations for performance.

Similar to the NGSS, the Alaska State Science Standards are described in a short, two-page document that is broken into seven broad categories. These ideas are *Science as Inquiry and Process*, *Concepts of Physical Science*, *Concepts of Life Science*, *Concepts of Earth Science*, *Science and Technology*, *Cultural, Social, Personal Perspectives and Science*, and *History and Nature of Science*. It could easily be argued that this foundation, though dated, is forward-
thinking, as it incorporates concepts of cultural relevance, science as an inquiry process that is
cyclical and ongoing and does reflect several of the SEPs and CCCs found within the NGSS and
the Framework (2012).

The second document associated with Alaska’s Science Standards is a set of Grade Level
Expectations developed for grades 3-11. It was generated using the NRC’s 1996 National
Science Education Standards (NRC, 1996) alongside the Benchmarks for Science Literacy
(Project 2061, 1993). This document was most recently updated in 2003 to align with the
National Science Education Standards (ASBOE, 2019).

Themes in the Literature

During the exploration of the literature review, two themes continually surfaced. The
first was the importance of teacher knowledge in students’ success in science (Murphy, 2012;
NRC, 2007). The second was the idea that when students took control of their learning, meaning
they took part in making decisions and reasoned using executive function, the concepts became
meaningful (Kuhn, Franklin, 2008; Green, 2012; Kuhn, 2015). These two conceptual
understandings are critical for anyone using this product, and thus, will be explored further
below.

Teacher knowledge, with respect to how it appeared in the literature, had two parts: (a)
competence and (b) confidence. Elementary educators that had limited knowledge or experience
typically avoided teaching science (Goodrum, Hackling, & Rennie, 2001; Lee & Houseal, 2003),
which significantly impacted students. On the other hand, educators who had explicit science
competency gained through STEM courses felt confident making arguments based on scientific
evidence (Murphy, 2012) and were more likely to engage in science teaching at various levels.
These educators recognized that covering the content standards alone would not make a student
successful science learner. Hence, the inclusion in the Framework (2012) of the concepts, practices, and big ideas – combined in three-dimensional learning.

In various learning contexts, the literature demonstrated that when constructivist pedagogies were combined with confident and competent science educators, learners developed leadership and inquiry skills that supported them as they evolved from students or participants into subject matter experts (Watson, 1913; Dewey, 1938; Vygotsky, 1978; Greunwald, 2003; Immordino-Yang & Damasio, 2007; Lee & Anderson, 2013; Kuhn, 2015; Gabel, 2018). Students in these contexts became empowered as they learned they can “initiate, manage, and execute” (Kuhn, Black, Keselman, Kaplan, 2000) their own acquisition of knowledge and impact society (Kuhn, Franklin, 2008; Green, 2012; Kuhn, 2015). For the most effective use of the product from this project, the standards groupings, the users must be willing to allow students to engage with the science in a way that develops critical thinking and inquiry. To use the standards to their fullest extent, students should be given opportunities “to design studies, collect information, analyze data, and construct evidence…then debate the conclusion that they derive from their evidence” (Kuhn, Black, Keselman, Kaplan, 2000).

These two big ideas were not the only themes apparent in the literature. However, it is essential to draw attention to these two precisely when considering the use of these standards. By themselves, standards are just guidelines for content. To implement the content in a way that facilitates the most effective science learning, there are pedagogical factors and nuances that must be understood.
Chapter 3  
Methods  

Introduction  
It is a strange notion that as a current, professional educator, I had to investigate a massive amount of literature before I could reputably discuss the concepts covered in this paper. Before I began the research phase, I had been through the necessary educational framework, theory, and methods courses that most undergraduate programs require, so I had a working knowledge of John Dewey and a few other vital educational theorists from the mid-1900s. In the next section, I discuss how the Alaska State Science Standards align to what we currently know in terms of developmentally appropriate teaching and learning, the process of ensuring standards align vertically and performance outcomes of each level, and the process of creating new standards. This chapter explores the process of creating the standards, recommendations on how they can be used, the lessons learned during this process and some of the limitations I experienced.  

Initially, I was unclear on exactly what my research process would entail, and the resources I collected were not as helpful as I would have preferred. Using the Scimago Journal and Country Rank website in coordination with Google Scholar, I found reputable sources that led me to key researchers, such as Kuhn (2008, 2015). Kuhn’s (2008) work supported my understanding of cognition and developmental capabilities, especially in relation to how they influence scientific problem-solving. Just as I reached a point where I felt that I was beginning to recognize appropriate cognitive performance expectations of different age levels, the book *HPL II* (NRC, 2018) released by The National Academies Press (NRC, 2018). I investigated several chapters of *How People Learn* (NRC, 2000), *How People Learn II* (NRC, 2018), and the
Framework (NRC, 2012), which led to a deeper understanding of best learning practices and the research that supports it.

**Background**

The previous standards used in the Kellogg F.I.E.L.D program’s curriculum for the younger grades showed a precise alignment to the needs of the native Athabascan community at a certain point in time. They had been meticulously developed to meet homeschool students’ needs; these particular students hailed from diverse educational backgrounds. As I analyzed the existing standards and compared them with alignment documents, it was evident that the program’s growth directly reflected the students involved. Because of this, they did not always have a clear scope and sequence. For example, students explored salmon, moose, green energy, and numerology one year, then in the next age band, they studied living landscapes, homestead, and wilderness first aid. The ideas were relevant to the mission of the school, to encourage students’ discovery through exploring nearby nature, but the content from one year to the next didn’t relate.

**The Process of Standard Creation**

As I created the set of standards for the Kellogg F.I.E.L.D program, there were several steps that I used to ensure that the process of standard creation led to standards that honored the Louise Farm School’s/ Kellogg F.I.E.L.D program’s original purpose. As a reminder, the purpose of this Plan B project was to answer the following questions:
1. How does *A Framework for K-12 Science Education and Learning* align with Alaska’s current state standards and Louise Farm School/ F.I.E.L.D program’s standards?

2. How can educational best practices and current research, such as culturally relevant pedagogy, PBE, and the FK12 be used to connect Alaska State Science Standards to the current Kellogg F.I.E.L.D program?

First, I familiarized myself with the Kellogg F.I.E.L.D program’s current mission and goals. Since the program had invested a lot of time and energy into finding out the community’s needs, I did not want to lose that work as I moved forward.

**Informed Standard Creation: The Standards and Pedagogies that Informed the Creation of these Standards**

In the beginning, I struggled to find direction. I had so many documents and so much research available to me that I was overwhelmed. In the upper left corner of Figure 2 are the factors that impacted the original F.I.E.L.D supplemental program’s standards. These are the aspects that were already instrumental to the F.I.E.L.D program. In the lower right corner are the additional factors that influenced the new standards bundles.

Figure 2. Influences that Informed the Updated F.I.E.L.D standards.
Informed Standard Creation: The Standards and Pedagogies that Informed the Creation of the Updated F.I.E.L.D Standards

Figure 2 illustrates influencing factors that impacted the creation of the updated standards. These factors became manageable once I figured out how each portion of information connected to and influenced another.

To understand the alignment of the standards, I initially created several tables of standards to explore the convergences and gaps. These showed that the standards met some of the criteria and left others unanswered. Then I realized that I needed to see where the current standards were lacking to be able to successfully move forward (see Table 1).

As the Alaska State Standards were the main set of standards that the F.I.E.L.D program intended to support, I examined the similarities using the second column of the table. As you see in Table 1, the F.I.E.L.D standards included aspects of the Alaska State Standards, but they lacked the continuity and growth found within the state standards. Throughout the process of developing the updated standards, Sophia May, the Program Coordinator of the Kellogg F.I.E.L.D School stressed the need for these standards to be directly supported by the standards. The homeschool community is bound by mandated state assessments and the state standards, just like formal public schools are.

For the final column of Table 1, I chose to include the NGSS. There is currently a push in the United States to have state standards align to the NGSS and to that end, the Alaska State Science Standards are in the process of being adjusted to reflect them. As the draft of the proposed K-12 science standards stated, “… the team decided to use the Next Generation Science Standards (NGSS) as a basis for Alaska Science Standards due to its three-dimensional design and focus on science for all students”(ASBOE, 4). Due to the fact that these standards are
meant to be used in the future, I needed to be sure that the standards I created reflect the
upcoming would align with what was already in place as I developed my product. The standards
addressed directly through the F.I.E.L.D school standards are shown in the table below with
corresponding numbered bulleted points. The NGSS and Alaska State Standards that are
indirectly supported are noted with standard bullet points.

As you can see in Table 1, Environmental Sensitivity was aligned with the Alaska State
Standards and the NGSS, but the relationships in other areas were less clear. Areas such as
*Nature Studies* and *Our Shared Alaskan Experience* could be aligned to the standards with small
adjustments to the original F.I.E.L.D program standards outcomes. *Outdoor Pursuits* and *Farms
and Foods* were areas that were not as clearly related to the standards, but these could be content
suggestions provided within my product. I provided the standards and some opportunities for
content that related to the original F.I.E.L.D program’s influences that were shown in Figure 2.
### Table 1. Alignment Table for Kellogg F.I.E.L.D program, Alaska State Science Standards, and NGSS.

<table>
<thead>
<tr>
<th>F.I.E.L.D program/ Louise Farm School</th>
<th>Alaska State Standard</th>
<th>Next Generation Science Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Environmental Sensitivity</strong></td>
<td>1. Concepts of Earth Science (SD2)</td>
<td>1. ESS3.A Natural Resources (Earth and Human Activity)</td>
</tr>
<tr>
<td></td>
<td>3. History and Nature of Science</td>
<td>3. (CCC) Patterns</td>
</tr>
<tr>
<td></td>
<td>2. Concepts of Life Science (SC2)</td>
<td>• LS2 Ecosystems: Interactions, Energy, and Dynamics</td>
</tr>
<tr>
<td></td>
<td>3. Concepts of Earth Sciences (SD3)</td>
<td>• ESS3.C Human Impacts on Earth Systems</td>
</tr>
<tr>
<td></td>
<td>4. Concepts of Life Science (SC1)</td>
<td>• LS1 Interdependent Relationships in Ecosystems: Animals, Plants, and their Environment</td>
</tr>
<tr>
<td><strong>Outdoor Pursuits/ Farms and Food</strong></td>
<td>1. Interdependent Relationships in Ecosystems</td>
<td>• LS2.A Interdependent Relationships in Ecosystems</td>
</tr>
<tr>
<td></td>
<td>2. Concepts of Life Science (SC1)</td>
<td>• ESS3.C Human Impacts on Earth Systems</td>
</tr>
<tr>
<td></td>
<td>3. Concepts of Life Science (SC2)</td>
<td>• (SEP) Constructing Explanations and Designing Solutions</td>
</tr>
<tr>
<td></td>
<td>4. Concepts of Earth Sciences (SD3)</td>
<td>• ETS1.A Defining and Delimiting Engineering Problems</td>
</tr>
<tr>
<td></td>
<td>5. Concepts of Life Science (SC1)</td>
<td>• (CCC) Influence of Science, Engineering, and Technology on Science and the Natural World</td>
</tr>
<tr>
<td><strong>Our Shared Alaskan Experience</strong></td>
<td>1. Increase awareness of humans and their societies.</td>
<td>• (CCC) Stability and Change</td>
</tr>
<tr>
<td></td>
<td>2. Appreciate the uniqueness of the community we call home.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Identify how the environment has influenced life in Alaska.</td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Alignment Table for Kellogg F.I.E.L.D program, Alaska State Science Standards, and NGSS.
After matching the correlating standards areas within the F.I.E.L.D program’s
curriculum, the NGSS, and the Alaska State Standards, I used information from the NGSS
storylines (NRC, 2019) and other progression matrices (NSTA CCC, 2013; NSTA DCI, 2013;
NSTA SEP, 2013; NSTA Topics, 2013; Storyline, 2019) to build a table to guide the 3-
dimensional progression of the standards. I used this information to start to build the standards
bundles. The areas that were aligned to all three sets of standards were the first to be introduced
to the new bundles. Then I used the 3-dimensional matrices developed by the National Science
Teachers Association (NSTA) (NSTA CCC, 2013; NSTA DCI, 2013; NSTA SEP, 2013; NSTA
Topics, 2013) alongside the current subjects being taught by the F.I.E.L.D school to develop the
bundles. I used these documents to ensure the standards followed a sequence that continued to
build in a 3-dimensional way and included the clarifying statements and assessment boundaries
in this process. Unfortunately, as I developed this document, it became an overwhelming
amount of information. I was aware that the standards’ users would be people who may not have
a lot of experience with the NGSS, and if the document provided too much information all at
once, it would not be useful.
The New Kellogg F.I.E.L.D Program Standards

The new standards expand on the positive elements of the F.I.E.L.D program while offering structure, stability, and continuity from year to year as the instructors fluctuate. Figure 3 illustrates the scope and sequence of a portion of the engineering standards as they build from one age group to the next. This figure illustrates how the complexity of what students are required to do increases with their age, but the content itself remains open to the creativity of the teacher and interests of the students.

<table>
<thead>
<tr>
<th>2nd/3rd</th>
<th>3rd/4th</th>
<th>5th/6th</th>
</tr>
</thead>
<tbody>
<tr>
<td>Define a problem, ask questions, make observations</td>
<td>Define a problem and several criteria for success/constraints. Develop a simple prototype</td>
<td>Develop prototype. Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints</td>
</tr>
</tbody>
</table>

Figure 3. Engineering to Solve Problems Through the Grade Levels

Even though I had separated the standards by grade level, the amount of information on one page was still too much. I used the NGSS app as a reference tool throughout this project and appreciated the way that the user could expand or collapse information at their whim. With that in mind, I learned how to use the outline function of Microsoft Word to modify the amount of information being shown at a given time. I made it so that the user could expand or collapse sections at will (Appendices A-E), which can be seen in Figure 4.
Figure 4. Collapsed Outline of The Third and Fourth Grade Standards Bundle Found In Appendix C. To collapse an expanded outline form, select all the text under the heading “Topic” and right click. On the menu, select “Expand/Collapse” then “Collapse Headings”.

Finally, to remind the user that all 3-dimensions of the NGSS are incorporated into these standards, I used the NGSS’s color-coding system to distinguish the dimensions. I also used bold text to denote the critical phrases within each standard to clarify the focus of each standard (see Figure 5). The finished product was a set of developmentally appropriate, concise, and spiraled benchmarks that would serve the F.I.E.L.D program from year to year as they develop their curriculum.
Age: 10-11 (Third/ Fourth Grade)

Topic: Environmental Sensitivity (AK Standards: Concepts of Life Science)

- 3 LS4-3 and 4-4 Information processing from fossils
  - Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.
- ESS2-1 Display data in graphical format for weather in a particular season
- 4 LS 1-1/2 Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago.

- Clarification statement: Examples of data could include type, size, and distributions of fossil organisms. Examples of fossils and environments could include marine fossils found on dry land, tropical plant fossils found in Arctic areas, and fossils of extinct organisms.
- Assessment Boundary: Does not include identification of specific fossils or present plants and animals. Assessment is limited to major fossil types and relative ages.
- 3 LS3-2. Use evidence to support the explanation that traits can be influenced by the environment.

Figure 5. Expanded DCI’s to show the clarifying statements, assessment boundaries, and other additional information that can be accessed by clicking the triangle to the left of the standard

New Standards: A User Guide

The purpose of this product is to support the various users in ensuring that they have developmentally appropriate expectations and are teaching their students in a way that builds on previously taught skills. Each of the appendices provided has unit suggestions listed at the bottom of the page that supports current teachings in the F.I.E.L.D program or suggests culturally relevant topics of study. Ideally, educators will open the appendix that applies to the age level they need and see the collapsed outline of DCIs, CCCs, and SEPs, as shown in Figure 3. From there, the user can click on the triangles to the left of the text, one at a time, to reveal more information about the DCI/SEP/CCC/Performance expectation, as exemplified in Figure 4. The ability to reveal this information step-by-step will allow the user to reveal information in lesser amounts while developing their curriculum.

In the younger grades, users will notice that they may see the same standard(s) for many weeks. It is essential to recognize that these standards are multifaceted. They are not just content, but also skills and concepts that are intended to be explored in depth. Although a bundle
may have a small number of standards, they can be explored from several perspectives and with
different purposes each time, using the information from the CCCs and SEPs. These standards
are also intended to be a foundation. However, if the user finds that their students or curriculum
would benefit from the addition of another DCI, SEP, or CCC, they may make those changes or
other additions.

In an ideal setting, these standards would be tested over several years in the Kellogg
F.I.E.L.D school and modified to meet the challenges that arise over time. It is my sincerest
hope that this set of standards is seen as a dynamic resource for the educators that use them,
rather than stagnant and unchanging. The original document can be saved as the template file
and then subsequent versions can use the save as function on Microsoft Word to save it as a new
file. I hope that these standards will be used as a carefully developed foundation to guide the
users as they continue to design bundles and use those to create a curriculum to challenge and
inspire their students. Over time, these standards will need to be continually refined and altered
as necessary.

Connections

Overall, we are living in an incredible time for education. Our understanding about how
people learn and educational theories have evolved a great deal since the early 1900s, allowing
us to analyze successes and failures to distinguish ‘best practices.’ In addition, we have
technology that can see the human brain while it forms new neural pathways and how it changes
over time. We live in a society that allows for a multitude of choice. We can choose whether we
prefer to educate our children in private, charter, public, or homeschool settings, and we often
have the opportunity for supplementary programs such as what the Kellogg F.I.E.L.D program
provides for their community.
Although the standards do not distinctly reference the curricula, lessons, or activities that will be used to teach them, the Alaska State Science Standards were designed to be culturally relevant. They have specified standards that reflect cultural relevancy. Standard category F of the Alaska State Science Standards expressly acknowledges that science perspectives should be explored through multiple lenses: cultural, social, and personal (ASBOE, 2003). The desired outcomes of this Alaska State Science Standard notes that students should develop an understanding of interrelationships among individuals, cultures, and societies, as well as the fact that other beliefs and methods of explaining phenomena exist. Through these standards, they also give the user opportunities to implement aspects of Place-Based Education in the stated value of the connection between individuals and communities (TSS, 2018).

**Future Research and Recommendations**

For anyone developing standards for a supplemental science program, the first step is to explore the extensive set literature and previously developed resources. Several organizations and universities have been working on building curriculum (e.g. NSTA, McGraw Hill), based on the NGSS, which are available to the public. As time passes, there will be more available. Although these curricula may not meet the specific needs of every program, the essential elements and alignment documents are instrumental as a starting place. It is important to understand the mission and vision of the educational institution for which the standards are being developed. The distinct nature of the F.I.E.L.D school connected me to specific frameworks and bound my literature review to a manageable set of resources. Without the boundaries set by the school’s mission, there would have been a lack of direction in my literature review, and eventually in my product.

My top three recommendations for questions to explore in future research are:
• What impact has the NGSS had on science content knowledge since its implementation?
• What can school communities do to make student experiences in science 3-dimensional and authentic?
• What impact did teacher-created science curricula have on science content competency during the 90s and early 2000s?

Conclusion

Through the process of this literature review and the creation of updated standards for the Kellogg F.I.E.L.D program, I answered my research questions and learned a lot about how people learn. This learning has empowered me in several ways.

The first way in which I feel empowered by this research is that now I feel capable of using the Framework (2012) and analyzing a program’s alignment to their states’ standards. My question asked how the Framework (2012) aligned with Alaska State Standards and the F.I.E.L.D program’s standards. I had the most success in answering this question when using a table. I started with the standards that were already in place before searching the other standards documents to analyze their alignment. This process could be easily replicated using the table provided in Appendix F.

The next empowering aspect of this process was the investigation into best practices, pedagogies, and frameworks that support learning. In the process of answering my second research question, it forced me to reconsider what I had been doing on my own. My second question asked how best practices and current research could be used to connect the Alaska State Science Standards with the current F.I.E.L.D program. To answer this, I had to review the literature on Place-Based Education, Culturally Relevant Pedagogy, and the Framework (2012) to understand how they could be used to make connections. I learned that these connections are
made through intentional decisions within the standards and curricula built around them. These practices and pedagogies are intentional. They do not just occur naturally in a classroom or school. To incorporate these into the standards as I created the standards, I made sure each 3-dimensional, grade-level set had content suggestions that were relevant to place principles. Many of the suggestions also gave opportunities for students to participate in community membership, through problem-solving real-life issues or investigating culturally relevant content. In this way, I was able to intentionally connect the Alaska State Science Standards to the updated F.I.E.L.D program’s standards.
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doi: 10.1017/S003181910005600X


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https://doi.org/10.17226/24783.


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Appendix A

Age: 5 (Kindergarten/First)

Topic: Nature Studies/Environmental Sensitivity

LS1.A Structure and Function of Organisms

All organisms have external parts that they use to perform daily functions.

LS1.B Growth and Development of Organisms

Parents and offspring often engage in behaviors that help the offspring survive (Appendix E, p. 4)

Patterns (CCC)

Patterns can be observed, used to describe phenomena, and used as evidence.

Asking questions and defining problems (SEP)

Ask questions based on observations to find more information about the natural and/or designed world.

Performance Expectations:

Make observations to construct an evidence-based account that young plants and animals are alike, but not exactly like their parents.

(Clarification statement: Examples of patterns could include features of plants or animals share. Examples of observations could include leaves from the same kind of plants are the same shape but can differ in size; and, a particular breed of dog looks like its parents but is not exactly the same.) (Achieve, 2013, pg. 13)

Students should also recognize that plants and animals have parts that they use daily to help them survive.

(Clarification statement: Examples of observations could include camouflage, different body size/shape, or shape or type of foot/hooves/paws helps an animal survive; for example, goat hooves help them to navigate rocky cliffsides to avoid predators and reach food sources.)

Content Suggestions:

Unit 1: Horticulture (Seed recognition, plant life cycle, and plant adaptations) and Basic Nutrition

Unit 2: Alaska’s Wildlife and Wilderness Safety Basics (Animal Adaptations to survive in different weather and how humans can prepare to survive in the wilderness in the same weather conditions)
Appendix B

Age: 6-7 (First Grade)
Topic: Farms and Food
LS1.B Growth and Development of Organisms (Plant perspective)
Parents and offspring often engage in behaviors that help the offspring survive
Animals obtain food they need from plants or other animals. Plants need water and light.
LS3.A Inheritance of Traits
Young organisms are very much, but not exactly, like their parents and also resemble organisms of the same kind.

Cause and effect CCC
Simple tests can be designed to gather evidence to support or refute student ideas about causes.
Structure and function CCC
The shape and stability of structures of natural and designed objects are related to their function(s).
Systems and models CCC
Objects and organisms can be described in terms of their parts

Asking questions and defining problems SEP
Ask and/or identify questions that can be answered in an investigation
Developing and using models SEP
Distinguish between a model and the actual object, process, and/or events the model represents.

Performance Expectations:
Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.
[Clarification Statement: Examples of human problems that can be solved by mimicking plant or animal solutions could include designing clothing or equipment to protect bicyclists by mimicking turtle shells, acorn shells, and animal scales; stabilizing structures by mimicking animal tails and roots on plants; keeping out intruders by mimicking thorns on branches and animal quills; and, detecting intruders by mimicking eyes and ears.]
Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive.
[Clarification Statement: Examples of patterns of behaviors could include the signals that offspring make (such as crying, cheeping, and other vocalizations) and the responses of the parents (such as feeding, comforting, and protecting the offspring).]
Content Suggestions:
Unit 1: Gardening 101: Investigating how plants survive (Integrate Outdoor Pursuits where available)
Unit 2: Be Like a Tree and Stand Tall: Solving human problems like plants
Appendix C

Age: 8-9 (Second/Third)

Topic: Engineering to Solve Problems (AK: Science and Technology)

K-2 ETS1.A Defining and Delimiting Engineering Problems

Define a situation that people want to change or create can be approached as a problem to be solved through engineering.

Asking questions, making observations, and gathering information are helpful in thinking about problems.

ETS1.B Developing Possible Solutions

ETS1-1: Define a simple design problem that can be solved the development of an object, tool, process, or system and include several criteria for success and constraints on materials, time, or cost.

PS2 Motion and Stability: Forces and Interactions

3-PS2-2 Make observations and/or measurements of an object’s motion to provide evidence that a pattern can be used to predict future motion.

Mechanism and Prediction CCC

Events have causes that generate observable patterns.

Simple tests can be designed to gather evidence to support or refute student ideas about causes.

*Note about development of critical thinking: Students must be taught how to acknowledge and respond to evidence and disagree with their own (Kuhn & Franklin, 2008).

Structure and function CCC

The shape and stability of structures of natural and designed objects are related to their function(s).

Asking questions and defining problems SEP

Ask questions about what would happen if a variable is changed.

Identify scientific (testable) and non-scientific (non-testable) questions.

Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.

Developing and using models SEP

Distinguish between a model and the actual object, process, and/or events the model represents.

Compare models to identify common features and differences.

Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s).

Constructing explanations and designing solutions SEP

Construct an explanation of observed relationships (e.g., the distribution of plants in the backyard).

Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem.
Use tools and/or materials to design and/or build a device that solves a specific problem or a solution to a specific problem.

Performance Expectations
Generate and/or compare multiple solutions to a problem.
Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.
Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.
Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

Content Suggestions:
Unit 1: Nutrition and Local Foods (Basic Nutrition, Living Landscape, and Potential Problems)
Unit 2: Problems and Solutions (Engineering solutions to farmer’s problems and Wilderness First Aide part 1)
Appendix D

Age: 10-11 (Third/ Fourth Grade)
Topic: Environmental Sensitivity (AK Standards: Concepts of Life Science)
3 LS4-3 and 4-4 Information processing from fossils
Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.
Clarification Statement: Examples of evidence could include needs and characteristics of the organisms and habitats involved. The organisms and their habitat make up a system in which the parts depend on each other.
ESS2-1 Display data in graphical format for weather in a particular season
4 LS 1-1/2 Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago.
Clarification statement: Examples of data could include type, size, and distributions of fossil organisms. Examples of fossils and environments could include marine fossils found on dry land, tropical plant fossils found in Arctic areas, and fossils of extinct organisms.
Assessment Boundary: Does not include identification of specific fossils or present plants and animals. Assessment is limited to major fossil types and relative ages.)
3-LS3-2. Use evidence to support the explanation that traits can be influenced by the environment.
Structure and function CCC
Different materials have different substructures, which can sometimes be observed.
Substructures have shapes and parts that serve functions
Patterns
Asking questions and defining problems SEP
Ask questions about what would happen if a variable is changed.
Identify scientific (testable) and non-scientific (non-testable) questions.
Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.
Use prior knowledge to describe problems that can be solved.
Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost.
Developing and using models SEP
Develop a diagram or simple physical prototype to convey a proposed object, tool, or process.
Use a model to test cause and effect relationships or interactions concerning the functioning of a natural or designed system.
Collaboratively develop and/or revise a model based on evidence that shows the relationships among variables for frequent and regular occurring events.
Develop a model using an analogy, example, or abstract representation to describe a scientific principle or design solution.
Develop and/or use models to describe and/or predict phenomena.
Constructing explanations and designing solutions SEP
Construct an explanation of observed relationships (e.g., the distribution of plants in the backyard).
Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem.
Identify the evidence that supports particular points in an explanation.
Apply scientific ideas to solve design problems.
Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution.

Performance Expectations
Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms.
(Clarification Statement: Patterns are the similarities and differences in traits shared between offspring and their parents, or among siblings. Emphasis is on organisms other than humans.)
(Assessment Boundary: Assessment does not include genetic mechanisms of inheritance and prediction of traits. Assessment is limited to non-human examples.)
(Clarification Statement: Examples of the environment affecting a trait could include normally tall plants grown with insufficient water are stunted; and, a pet dog that is given too much food and little exercise may become overweight.)

Content Suggestions:
    Unit 1: Field Learning (Wilderness First Aide, Weather Preparation, Life in Alaska— influenced by environment)
    Unit 2: Natural History of Alaska (Fossils, Alaskan communities/ migration, and Human Influence on animal habitats)
Appendix E

Age 12-13 (Fifth/ Sixth Grade)

Topic: Our Shared Alaskan Experience (AK: Cultural, Social, Personal Perspectives, and Science)

ESS3.A Natural Resources
Energy and fuels that humans use are derived from natural sources, and their use affects the environment in multiple ways. Some resources are renewable over time, and others are not. (4-ESS3-1)

ESS3.B Natural Hazards
A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts. (4-ESS3-2) (Note: This Disciplinary Core Idea can also be found in 3.WC.)

ESS3.C Human Impacts on Earth Systems
Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. But individuals and communities are doing things to help protect Earth’s resources and environments. (5-ESS3-1)

ESS2.C The Role of Water in Earth’s Surface Processes
Nearly all of Earth’s available water is in the ocean. Most fresh water is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere. (5-ESS2-2)

ETS1.B Developing Possible Solutions
Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2)
At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2)
Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. (3-5-ETS1-3)

LS2.C: Ecosystem Dynamics, Functioning, and Resilience
When the environment changes in ways that affect a place’s physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die.

Stability and change (CCC):
Change is measured in terms of differences over time and may occur at different rates. Some systems appear stable, but over extended periods of time will eventually change. Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales, including the atomic scale. Small changes in one part of a system might cause large changes in another part. Stability might be disturbed either by sudden events or gradual changes that accumulate over time.
Influence of Science, Engineering, and Technology on Science and the Natural World

Asking questions and defining problems
Ask questions that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information.
Ask questions to clarify and/or refine a model, an explanation, or an engineering problem.
Ask questions that require sufficient and appropriate empirical evidence to answer.
Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles.

Planning and carrying out investigations
Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.
Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.
Make predictions about what would happen if a variable changes.
Test two different models of the same proposed object, tool, or process to determine which better meets criteria for success.

Analyzing and interpreting data
Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation.
Analyze data to refine a problem statement or the design of a proposed object, tool, or process.
Use data to evaluate and refine design solutions.

Engaging in argument from evidence
Construct an explanation of observed relationships (e.g., the distribution of plants in the backyard).

Apply scientific ideas to solve design problems.
Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution.

Obtaining, evaluating, and communicating information
Combine information in written text with that contained in corresponding tables, diagrams, and/or charts to support the engagement in other scientific and/or engineering practices.
Compare and/or combine across complex texts and/or other reliable media to support the engagement in other scientific and/or engineering practices.
Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem.
Communicate scientific and/or technical information orally and/or in written formats, including various forms of media and may include tables, diagrams, and charts.

Performance Expectations
Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affects the environment.
[Clarification Statement: Examples of renewable energy resources could include wind energy, water behind dams, and sunlight; non-renewable energy resources are fossil fuels and fissile materials. Examples of environmental effects could include loss of habitat due to dams, loss of habitat due to surface mining, and air pollution from burning of fossil fuels.

Content Suggestions:

Unit 1: Humans in Alaska (Native Traditions, Natural Resources, Natural Hazards, Human Impact) *Potential case study on Salmon, Moose, or other Native Species whose ecosystem has been impacted by humans*

Unit 2: Interdependence (Influence of Science on the natural world ie. sustainable systems and green energy, Water’s Role in Change (geographical))
Appendix F: Alignment Table Template

<table>
<thead>
<tr>
<th>School’s Current Science Standards</th>
<th>State’s Standards that Align with Current Science Standards</th>
<th>National Standards</th>
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