SCIENTIFIC LITERACY: TEACHER CONCEPTUAL FRAMEWORK IN RELATION TO STUDENT ACHIEVEMENT AND ATTITUDES

by

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ABSTRACT

This study engaged teachers in professional development regarding science pedagogy to see if design and implementation of scientific literacy units increased student performance and classroom instruction. These professional development activities focused on scientific and engineering practices as defined by the National Research Council, scientific literacy skills and practices, and unit development. Teachers in this study taught explicit skills and practices during the fall semester and planned a scientific literacy unit that they implemented in their classrooms in the spring semester. The project measured conceptual change and attitudes in teachers in comparison to student achievement and attitudes about science. The study found that teacher conceptual change and attitudes affected student attitudes and achievement.

INTRODUCTION AND BACKGROUND

That public schools are constantly subjected to standardized testing has been thoroughly scrutinized. These standardized tests heavily stress math and reading. Intermediate teachers consistently claim their instructional time for science and social studies is minimized both in quantity and value, due to pressure to prepare students in math and reading.

Livingston, Montana is no exception to standardized testing. East Side Intermediate School houses grades three through five. Third grade is the initial standardized testing grade of students in Montana in English language arts and math. Fourth grade is tested in language arts, math, and science. Fifth grade is tested in language arts and math. East Side Intermediate is one of two schools tested in each grade level population in the Livingston School District. Students arrive to the school with no previous experience in standardized testing, and the performance-based tests take place online. East Side Intermediate School consists of 296 students. Forty-six percent of students receive free and reduced lunches; eleven percent of the school is from a minority group (Principal Stevenson, personal communication, April 6, 2016). The first round of Smarter Balanced Achievement Consortium administered at East Side in 2015 resulted in such dissonance from classroom experiences that scores were not sent home to families. Teachers and students reported the tests were too advanced (The Regents of the University of California, 2015). Teachers felt the testing concepts and questions were not achievable by students. These tests were aligned with new Common Core standards adopted by the state.

Adopted in 2014, Common Core Standards specifically prescribe teaching literacy within science, social studies, and technical areas. The *Montana Common Core Standards in Literacy in History/Social Studies*, *Science, & Technical Subjects* are explicitly listed for grades kindergarten through high school (Office of Public Instruction, 2015). Montana Common Core Standards are state-testable standards in language arts in which the application of scientific literacy is required. Since this development, East Side Intermediate School has experienced a decrease in reading achievement on standardized tests.

Common Core English Language Arts Standards have resulted in the adoption of several language arts programs in Livingston, Montana, that are nationally stamped with Common Core approval. Yet purchased programs fall short of the state test expectations. The programs, or textbooks, are compliant with separate *Informational Text* standards for reading or English teachers not related to *Science*, *Social Studies*, or *Technical Texts*. Nationally, Common Core Standards have a separate *Informational Text* standards as a set of requirements in addition to *Standards in Literacy in History/Social Studies, Science, & Technical Subjects*.

Montana blended these two sets of standards into one document. All states have these standards, but separate documents in other states mean that these standards can be omitted or partially omitted by textbooks and still be stamped with Common Core. In Livingston's Park High School, science teachers are responsible for student mastery of scientific literacy. In elementary, teachers are responsible for all Common Core

Standards, and many teachers follow the purchased program with fidelity without knowing the gap of expectations between the program and state standards exists.

Montana Common Core Standards in Literacy in History/Social Studies, Science, & Technical Subjects demand skills in which critical thinking and assessment of data is crucial. The state standardized tests, Smarter Balanced Assessments, assess these skills (The Regents of the University of California, 2015). For example, Smarter Balanced Assessments require a fifth grader to read two sources and watch a video about a science topic. The student is required to ferret out data, cite evidence by directly quoting articles and/or the video, and write a comprehensive paragraph comparing and contrasting the sources. Fourth grade students are required to compare and contrast three separate written sources on the same topic in a table by placing checkmarks in all categories that apply to each source. Each source requires multiple checkmarks for completion. Additionally, fourth graders construct explanations that include specific details from sources and select the best source for certain information. Third graders contrast three separate written sources on the same topic in a table by placing checkmarks in the corresponding sources. Each source requires one checkmark for completion. Third graders also construct explanations about details of the varying sources.

None of the purchased English Language Arts programs lead students through this process explicitly or in complete complexity. Without explicit teaching of science literacy standards, a gap in state assessment achievement will continue to be evident. Standards are written as student performance expectations. Programs are written as prescribed pedagogy. They don’t always meet in perfect synchrony, and standards vary among states. A committee may analyze gaps between programs and standards during the program vetting process, but it is rarely part of teachers' standard practice. There are cases in which teachers rely on the prescribed program in order to meet standards without a clear understanding of the standards and their aim. Without a comprehensive understanding of the standards, a master teacher could teach the entire purchased language arts programs with fidelity and total student comprehension and fall short of the state standards and subsequent assessments.

Science literacy standards are left out even when elementary teachers crave more time for science. Some Livingston elementary teachers report little or no time for science, citing their push to master core subjects as the cause. Subjects of application, science and social studies, are forgone while the standards that tie them to core subjects sit stagnant. The missing element is teacher education. Training, or professional development, in pedagogy that ties standards together could bring science standards and pedagogy to life through rich, multidisciplinary classroom experiences. According to the National Academies of Sciences, Engineering and Medicine, teachers need prolonged professional development to teach new standards. As pedagogy changes and "understanding of how best to learn and teach science evolves and curricula are redesigned, many teachers are left without the experience needed to enhance the science and engineering courses they teach" (The National Academies of Sciences, Engineering, and Medicine, 2016, para. 1).

The purpose of this study was to integrate science with core subjects in the classroom through professional development. Science practices were utilized as the hook for student research and communication in literacy for deep reading of informational text. This united the wishes of teachers and administration at local, state, and national levels by streamlining standards to attain achievement on standardized tests (Figure 1).

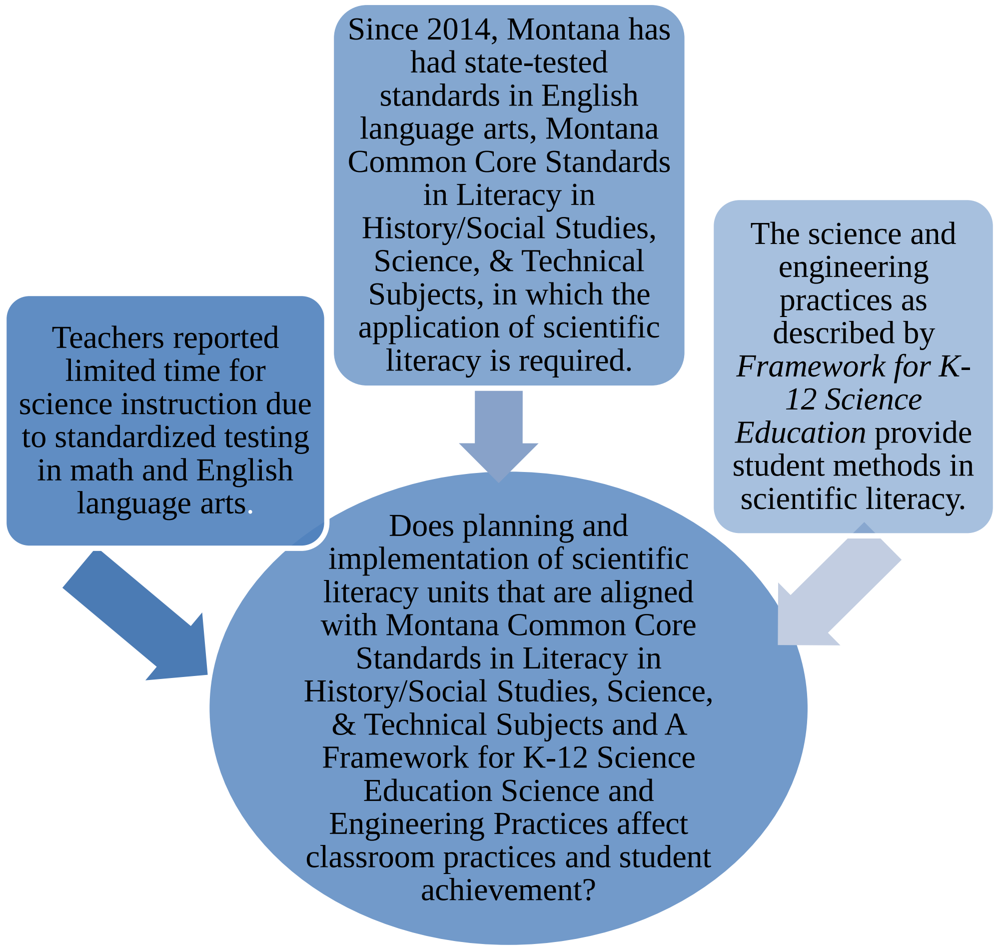

Figure 1. Project Rationale.

Beyond the scope or purpose of state testing, students were engrossed in meaningful study of engaging topics through application of science and engineering practices and literacy. Applying critical thinking practices of scientific literacy is pragmatic in a lifelong-learner world of information. From this study, a set of data was gleaned to determine if sustained teacher professional development had an effect on teacher pedagogical conceptual framework, closed student standardized achievement gaps, increased science instructional time in the classroom, and provided rich science experiences in classrooms.

CONCEPTUAL FRAMEWORK

This framework reviews literature and research in two related, yet separate fields.

Measuring Conceptual Change

Conceptual change theory is learning that requires the change of an existing conception (Davis, 2001). This theory of learning, particularly focused on science learning, has had less than 100 years of history. Early influences were formed by Piaget and Kuhn and conceptual change has continued to be a central topic in science education research for the last 25 years (Hovardas & Korfiatis, 2006; Moore, 1980; Simatwa, 2010).

Kuhn's contribution to the theory's development is regarded as nothing less than revolutionary. He theorized that learning science is not merely a process in which one gathers a set of facts or knowledge. Instead, he proposed the process of conceptual change required a shift in paradigm or a revolution within one's prior thinking (Conceptual Change, 2011). Piaget, known for his work in child development, referred to learning as a result of processes that included assimilation and accommodation (Simatwa, 2010). This is comparable to Kuhn's theory because in order to assimilate a new concept, the learner's current concept is required to accommodate, or change.

It was in the early 1980's that the conceptual change theory was published by a group of science education researchers at Cornell University (Posner, Strike, Hewson, &

Gerzog, 1982). In the research, a glimmer of Piaget's influence is evident with the use of the term *accommodation*. Accommodation is the change that takes place in the learner regarding a concept, and the researcher termed this *conceptual change*.

In the revisionist model of conceptual change, the whole learner is recognized, and the theory is not merely rational and logical (Davis, 2001). Instead, a holistic view of the process that includes the learner's motivations, curiosity, and experiences are included in the process of knowledge accommodation. Revisionists criticize other conceptual change models for not considering the whole person, including each person's unique set of needs. Critics have termed these other theories *cold conceptual change* (Pintrich, Marx, & Boyle, 1993).

Constructivist models of conceptual change rely on discussions and interactions between the student, instructor, and environment. The instructor is enabled to construct the environment and lesson as well as cultivate interactions in order to enhance the participation of the learner. These factors, along with the fundamental, constructivist model of a cooperative learning environment, impact the accommodation of new concepts and enliven the learner as an active participant (Davis, 2001).

The most widely researched measurement method of conceptual change is the concept map. Concept maps were developed by Novak, a professor at Cornell University, for the purpose of understanding student conceptual knowledge in science (Novak & Musonda, 1991). Appropriately named, concept maps have been used to measure conceptual change. Concept maps are diagrams of relationships within a concept. These are recorded through a series of boxes and connecting lines (Davis, 2001). Concept maps can be considered graphic models of a person's knowledge structure that include a hierarchical structure of cross-links and relationships (Novak & Canas, 2008).

Quantitative and qualitative data can be collected from the use of concept maps. Quantitative data can be collected from three tested methods. First, the number of non-repeated nodes, or concept boxes, are counted as representation of the learner's breadth of a concept. Secondly, the connections between the concepts, or cross-links, are counted as a representation of the learner's complexity of the concept. Thirdly, the number of hierarchies from the center, or starting node, represents the learner's depth of the concept (Novak & Gowin, 1985).

A pre- and post-concept maps built around a central question can provide insight into how a learner's concept has grown or changed in breadth, depth, and complexity over time. A central question is key as many criticisms around conceptual change theory are based upon the disagreements about what exactly a concept is and a definitive definition of the term (Dillion, 2008).

Qualitative data were collected by comparing and contrasting concept map vernacular to those of an expert in the subject. The quality of vocabulary used distinguishes novice learners from those of expert status. These ratings are subjective and are, therefore, qualitative data (Miller, Koury, Fitzgerald, Hollingsead, Mitchem, Tsai & Park, 2009).

Concept maps were used in a study by Miller, which measured conceptual change among teachers. Before the treatment, participating teachers were given a workshop on concept map construction that included both instruction and practice. After this workshop, concept map instruction was discontinued. The pre- and post-concept maps were measured quantitatively through Novak and Gowin's (1985) recommendations. Data was collected on 251 subjects against a rubric to ensure consistency. Subjects were asked to compare their pre- and post-concept maps, and write a reflective narrative.

The purpose of the Miller study was to describe and test concept maps as a method for measuring conceptual change. Researchers found both quantitative and qualitative measurements valid as long as a clear and controlled protocol was adopted. Researchers also emphasized the careful development of a qualitative rubric for data collection to ensure any similar study's validity. The researchers found concept maps to be, "a credible and effective research tool to differentiate learners and assess conceptual change in learners using pre- and post-instructional concept maps" (Miller et. al., 2009, p. 12).

A study by Hernandez, Buzzo, and Rivera (2008) used interviews as a method for conceptual change measurement. The research team used pre- and post-interviews and traditional content tests as measurement tools for teachers regarding professional development in science content. Although the interviews provided useful insight into teachers' preconceptions, only qualitative observations were made from the collected interview data that were not conclusive in measuring conceptual change (Hernandez, et al., 2008).

One particular research project in Israel by Avargil and Herscovitz considered the difficulties of conceptual change on teachers. These researchers focused on the conceptual change of teachers as they faced the challenges of teaching and assessing context-based chemistry. Eight teachers were evaluated by interviews, observations, and submissions of assignment design. Teachers were charged with teaching and assessing thinking skills that would produce scientifically literate citizens. The authors cited teachers as one of the biggest factors in education reform success. Teachers moved through a model of conceptual change that ranked their knowledge progression of teaching the concept. The model cited that teachers with only content knowledge were at the beginning of conceptual change, and teachers who were able to relate assessment knowledge of the content were at the furthest stage of professional growth (Avargil & Herscovitz, 2012).

Research supports using concept maps to quantitatively and qualitatively measure conceptual change. Extensive methodology has been developed and tested for this method. Interviews have also provided supporting qualitative data in previous research projects.

Teaching and Assessing Scientific Literacy

Literacy is the ability to complete language-based acts such as reading, writing, speaking, and listening for a deepened understanding of content. The integration of science and literacy is advocated by both reading and science teachers as well as by major research publications such as *A Framework for K-12 Science Education* (Washburn & Cavagnetto, 2014). The scientific practices as described by *Framework for*

K-12 Science Education provide tools to reach the goal of scientific literacy (National Research Council, 2012).

Additionally, recently adopted Common Core English Language Arts Standards focus on critical thinking, problem solving, and skills used in college and adult life. These standards include requirements for reading "complex texts that provide facts and background knowledge in areas such as science and social studies" (NGA Center/CCSSO, 2010).

Researchers that advocate the Next Generation Science Standards (NGSS) cite poor American competition in content areas against other countries as a signal for change (National Center for Education Statistics, 2010). The NGSS website's page regarding the need for standards includes, "Americans are being forced to increasingly make decisions—including on health care and retirement planning—where literacy in science and mathematics is a real advantage" (NGSS Lead States, 2013). In 2012, The National Center for Education Statistics ranked American students 23rd in science and 20th in reading worldwide (National Center for Education Statistics, 2010). Couple this with the data that less than 33% of graduate students can read a table or graph regarding their health, and the need for literacy in society is clear (National Assessment of Adult Literacy, 2003).

Teaching strategies for scientific literacy are recently emerging in research. Washburn and Cavagnetto (2014) presented an implementation strategy they call the PONG cycle. PONG is an acronym that describes how to explore a problem and make meaning from the observations. . This is an argument-to-learn cycle of strategies in which the teacher engages students in a problem. Students observe phenomena related to the problem, make reasoned claims based on evidence, critique and share claims, and finally, revise claims. Washburn and Cavagnetto followed a fifth grade teacher who guided her class through the PONG cycles in order to learn about sound. The students argued, critiqued, presented, negotiated, and dissected in order to build the ultimate can and string phone. This article concluded that science literacy and Common Core are a natural fit that can teach literacy within context on science content. It recommends the PONG cycles as a teaching pedagogy as well as for a framework for unit planning (Washburn & Cavagnetto, 2014).

Spektor-Levy et al. (2009) led a research team that tested specific teaching and assessment strategies for scientific communication. In this method, teachers focused on explicit instruction of scientific communication clusters, deemed skills for scientific literacy, within their science content. Instruction was followed by a performance-based assessment. The researchers mapped science communication skills in clusters (Figure 2). The clusters consist of six categories with each category subdivided into three to four subcategory skills. Clusters were taught explicitly through structured instructional models. These models included activities applicable to any science content for skill mastery of scientific literacy skills.

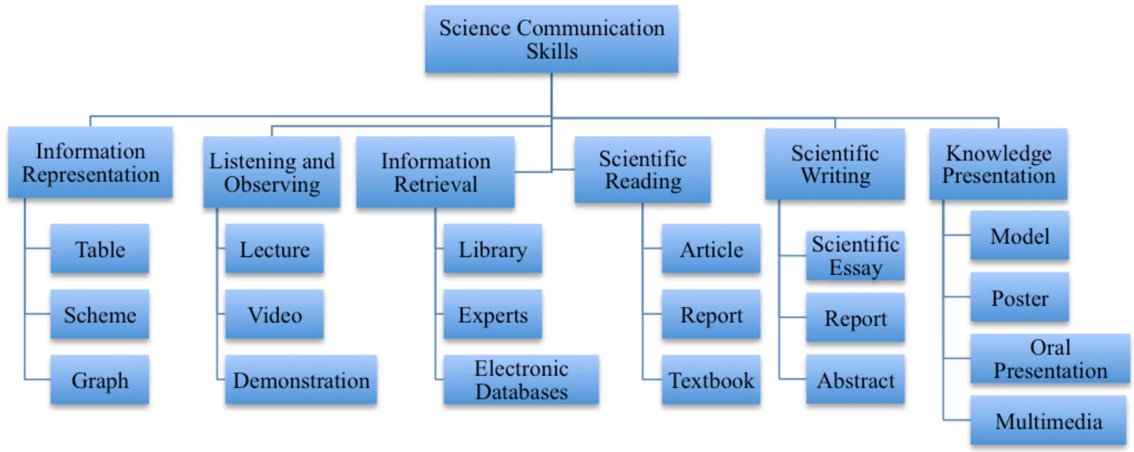

Figure 2. Adapted from Spektor-Levy et al., (2009). Scientific Communication Skills Clusters.

Students who received only explicit instruction on one cluster achieved higher than students who received none of the treatment. Low and average achieving students who received components of the treatment improved in achievement significantly. The study concluded that students would not acquire scientific communication skills on their own, and that skills for scientific literacy need to be explicitly taught. This research stressed performance assessments as a valid means of literacy assessment. In these assessments or tasks, students were asked to perform skills from several different clusters in order to create a final product. Each task was based upon science content for context and real world application. The researchers referred to this method as *assessment for learning* and deemed it an effective method of assessment (Spektor-Levy, et al., 2009).

The recently developed Smarter Balanced Assessments also focus on performance assessments, or performance tasks. The Common Core-aligned assessments have been developed in cooperation with universities and professionals. Like the Spektor-Levy study tasks, each task is based around a central theme that connects to the real world.

The assessment's website states, "These activities are meant to measure capacities such as depth of understanding, writing and research skills, and complex analysis, which cannot be adequately assessed with traditional assessment questions" (The Regents of the University of California, 2015).

Alternate assessments of literacy are also evident in research. Taylor (1994) from Ottawa University examined literacy portfolios as an alternative assessment to the common instrument of standardized testing. Portfolios are collections of student work over time. Taylor cites portfolios as being diverse, learner-centered collections that are tailored to personality. When properly planned, portfolios gain strength over shallow grades with focus upon the improvement of specific student skills. This planning is identified in four distinct stages that include the comparison of portfolio assessment to the instructor's pedagogy and beliefs, planning the assessment, implementation of the assessment, and the evaluation of the assessment's success and failure for revision. The planning of the portfolio was stressed as a means for a valid assessment of instructor goals. Through the use of portfolios, change is evident both in quantitative and qualitative measures.

Both performance assessments and portfolios are cited as valid assessment methodologies for collecting qualitative and quantitative data regarding scientific literacy. Explicit instruction for specific scientific literacy skills, or clusters, is recommended. PONG cycles are recommended for designing units of study.

METHODOLOGY

The purpose of this study was to determine whether planning and implementation of scientific literacy units aligned in two content areas, *Montana Common Core Standards in Literacy in History/Social Studies, Science, & Technical Subjects* and *A Framework for K-12 Science Education* Science and Engineering Practices, had effects in intermediate elementary classrooms. Measured effects included student attitudes toward learning through informational text, student achievement in scientific literacy, teacher attitudes toward teaching through informational text, teacher conceptual understanding of science pedagogy, and reported instructional time spent in science per week. The subjects of this study were five intermediate elementary teachers and their third and fourth grade students.

The intermediate school included teachers of third, fourth, and fifth grades. Third and fourth grade teachers participated in the research. Fifth grade teachers did not participate because I was the professional development trainer, the instructional coach, and the researcher as well as a team member of the fifth grade teachers. I considered this to be a conflict of interest and did not focus my research on the fifth grade teacher team members though members were present and participating in treatment. Classrooms in which the prescribed order of data collection was compromised were omitted from data.

The research methodology for this project received an exemption by Montana State University's Institutional Review Board and compliance for working with human subjects was maintained (Appendix A). For data collection, teachers were assigned a letter at random for identification. Students were assigned numbers according to the alphabetical last names in each class. Students were identified by a combination of their teacher's letter and their student number for comparison of individual pre and post data. Normalized gains were used as an analytical tool for multiple data collection instruments according to the research of Hake (1999) in order to provide an analogous number for comparison between data sets.

Teacher and Student Informational Text Attitude Survey items were assigned Likert-type five rank scales (Likert, 1932). Items responded to with *Strongly Disagree* were assigned a score of 1, *Disagree* a score of 2, *Neutral* a score of 3, *Agree* a score of 4, and *Strongly Agree* a score of 5. This system aligns negative responses with lesser values and positive responses with greater values. A neutral score is 3, the median of possible responses. The item *Learning from informational text overwhelms me* was omitted from the data set. In this particular item, the reversely worded statement and attached emoticon skewed mean student values. In addition, the item's responses did not match the attitudes displayed by students in responses submitted throughout the rest of the survey. Since the validity of the item was questionable, it was excluded from both teacher and student data sets to maintain integrity of the data.

Before treatment began, all students completed the Student Informational Text Attitude Survey to assess pretreatment attitudes toward learning from informational text (Appendix B). The survey included a Likert response scale of five items in which students could range from *strongly disagree* to *strongly agree*. All items were linked with an emoticon to connect each response to student feelings. Teachers read the statements aloud, and students circled their correlating response for the item. These results were analyzed for mode, mean, and median values. Responses were also analyzed for frequency by positive, negative, and neutral responses pre and post treatment. Although unconventional, a normalized gain was included for each response for comparison of normalized gains between instruments. These scores were compared to Teacher Informational Text Attitude Survey results. Open response questions were included on the surveys and were evaluated for themes.

Teachers completed the Teacher Informational Text Attitude Survey to assess pretreatment attitudes toward informational text instruction (Appendix C). Each survey question directly corresponded to a question on the Student Informational Text Attitude Survey. Students were provided with statements about learning through informational text. Teachers were provided with statements about teaching through informational text. The survey included a Likert response scale of five items in which teachers could range from *strongly disagree* to *strongly agree.*

Teacher survey results were analyzed for mode, mean, and median values. Responses were also analyzed for frequency by positive, negative, and neutral responses pre and post treatment. Although unconventional, a normalized gain was included for each response for comparison of normalized gains between instruments. These scores were compared to Student Informational Text Attitude Survey results. Open response questions were included on the surveys and were evaluated for themes.

Teacher open response questions correlated with student open response statements. The teacher and student surveys were analyzed for themes within grade levels and the study as a whole. These themes were compared to student themes.

Teachers reported their estimated instructional minutes spent in science per week before treatment in order to provide a comparison for the post treatment.

Teachers completed a pre treatment Concept Map, also known as a word web, with informational text in the center to record teacher conceptual understanding of this fragment of scientific literacy (Appendix D). Originally, scientific literacy was the center of the Concept Map. Some teachers pushed back on this because they perceived a lack of a “concrete concept” from which they could write. Therefore, the map was altered to have a concrete concept, informational text, from which all teachers had experience. Informational Text is frequently used in *Montana Common Core English Language Arts Standards*. Teachers received explicit instruction in concept mapping in order to normalize results based on concept mapping experience.

Concept Maps were assessed according to the research of Miller et al. (2009) by unique ideas, depth, and connections. Responses were tallied in the appropriate section according to a rubric (Appendix E). Duplicate answers were not tallied. The quality of answers was not considered. Specifically, points were not assigned for the type of answers provided. Individual teacher scores were recorded for each category as well as a sum of categories. Results were analyzed for sums in categories and as a whole.

Students were then administered the *Smarter Balanced Consortium English Language Arts Performance Assessment* (SBAC) released item from Montana’s Office of Public Instruction. The third grade assessment focused on informational text sources regarding astronauts (Appendix F). The fourth grade assessment focused on informational text sources regarding animals (Appendix G). This state test evaluated student pretreatment achievement in *Montana Common Core Standards in Literacy in History/Social Studies, Science, & Technical Subjects* (Appendix H). This performance assessment requires students to analyze varying sources of informational text and present viable evidence for a claim. The student must master science practices and literacy skills rather than content to master the assessment.

The assessment was purposefully given last in pretreatment data collection in order to prevent skewed results on the attitude survey for teachers and students because the test itself was an experience upon which the student or teacher could have reflected. Teachers gave the test with only the explanation of what a pretest was and a discussion of how the test would help in setting goals for the remainder of the year. Students read and completed the assessment independently as required for state testing. The researcher scored the test, and a point was given for each task completed. Points were not based on quality of the response. A point was only given if the student completed the direction. These scores were converted into percentages in order for the scores to be correlated as a whole. The third and fourth grade tests varied in level of difficulty by number of responses required. Scores were analyzed according to box and whisker five number summaries, individual student growth, and for normalized gains within grade levels and as a whole study.

If a classroom took the pre treatment data collection out of the prescribed order or varied treatment procedures, that specific classroom was not included in the data pool for this study due to the possibility of skewed pre treatment data. This process resulted in data collection from three third grade classes and two fourth grade classes in the building out of eight possible classrooms.

The treatment involved professional development under Montana Partnership in Region for Excellence in STEM (MPRES). This professional development was a blend of an online course, Professional Learning Communities (PLC), and face-to-face workshops that focused on *A Framework for K-12 Science Education* Science and Engineering Practices (Appendix I). The professional development took place over eight weeks in the first semester of the school year. A two-day workshop was the kick off of the professional development. The first day, teachers were rigorously engaged in Science and Engineering Practices by unpacking, examining, and applying them. Teachers also compared Science and Engineering Practices to those of Common Core English Language Arts and Math. MPRES trainers shared classroom examples and research-based applications that could be applied throughout varying grade levels. Notebooking in grade progressions was explored through student samples, pedagogy, literature connections, and assessments.

The second day of the kick off workshop engaged teachers in the PONG cycle. The PONG cycle is a unit design referenced in the Conceptual Framework and enlists students in engaging in a proposed problem, observing the problem, and negotiating toward an end goal. Trainers implemented a unit in which teachers experienced practices as students over a half-day. Teachers were put into varying groups to complete a PONG cycle that required scientific literacy skills to research, design, build, and redesign an engineering solution to the problem of dirty water at a cabin location. Throughout the designed unit, teachers were deeply engaged in the following practices: Developing and Using Models, Obtaining, Evaluating, and Communicating Information, Engaging in Argument; Asking Questions and Defining Problems; Planning and Carrying Out Investigations; Constructing Explanations; and Designing Solutions. The session represented the experience students would go through in a PONG cycle unit of several weeks, which wove Science and Engineering Practices together with scientific literacy.

The second half of the day, teachers looked at science phenomena lessons from a teacher, or pedagogy, perspective. Lessons reviewed focused on students to building a teacher-directed model of popular science topics, specifically volcanoes and water cycles. Teacher deepened the lessons to include student-directed Science and Engineering Practices and scientific literacy skills for classroom use. This required teachers to collaborate in creating a lesson that enlisted scientific practice and literacy rather than rote cut-and-paste modeling in traditional pedagogy. The focus practices were Engaging in Argument (from evidence to connect to Common Core) and Developing and Using Models. The teachers then had both unit and phenomena design perspectives of implementing a portion of scientific literacy with Science and Engineering Practices.

The online course followed, in which teachers were presented with additional examples of implementation in classrooms as well as deeper background knowledge about each science and engineering practice. Teachers worked with their professional learning communities to plan and implement a practice each week in their classrooms. Student work samples, specifically student notebook entries, were posted online as part of the online discussion in the course. Teachers engaged in pedagogical discussions throughout the progression of their team with student work samples as the catalyst.

Two more workshops that focused on specific practices were woven throughout the professional development curriculum. One day focused on Mathematical and Computational Thinking and the other focused on Analyzing and Interpreting Data. Teachers were engaged in scientific literacy as well as Science and Engineering Practices from student and teacher perspectives in each workshop. These workshops connected Science and Engineering Practices to *Common Core* math standards and were not as relevant to the study. The first two workshops explicitly connected to *Common Core English Language Arts* standards. Although mathematics are an important and indispensible part of scientific literacy, effects in classrooms regarding mathematical portions of scientific literacy and Science and Engineering Practices were not included as a data set for the study.

The final workshop pinpointed Planning and Carrying Out Investigations. Throughout the day, teachers engaged in research, argumentation, and design of paper planes. Planes were flown at the close of the project to determine winners based on data sets created by the participants. This project embedded focal science practices with language arts and mathematics. Finally, teachers presented the pedagogical change in their classrooms to each other. This served as a capstone of the professional development experience and solidified their journey with conversation and celebration.

Throughout the professional development, teachers met with the MPRES instructional coach for unit design. Each grade level created a PONG cycle unit which combined *Montana Common Core Standards in Literacy in History/Social Studies, Science, & Technical Subjects* and *A Framework for K-12 Science Education* Science and Engineering Practices. The coaching sessions outlined science and English language arts standards, skills, assessments, and topics for the unit containing a unifying theme. Third grade teachers created a unit around the theme of bees (Appendix J). Fourth grade teachers two intertwined units on land and resources (Appendix K). Each grade level unit was built around a PONG cycle and encompassed explicit scientific literacy skills, or clusters, identified by Washburn in the Conceptual Framework.

Teachers fine-tuned units to include specific Science and Engineering Practices throughout their online course and implemented the unit during the spring semester. By design, teachers streamlined student Science and Engineering Practices by incorporating each practice intentionally throughout the curriculum in the fall semester as background knowledge for the project-based unit in the spring. Teachers also explicitly taught scientific literacy skills throughout the fall including detailed and focused reading of various sources of informational text. Teachers assessed student progress with a rubric designed by the researcher that was based on informational text standards (Appendix L). This prepped students for the unit's implementation in the spring semester in which the PONG cycle was fully implemented in the teachers' unit design.

Post treatment, students completed the Informational Text Attitude Survey (Appendix B). This survey was delivered the same way as the pretreatment survey in which teachers read the statements aloud, and the students circled their correlating response. Results were evaluated in the same manner as pre treatment scores and analyzed for gains or losses to determine if the treatment had an effect on attitudes toward informational text. Teachers completed their Informational Text Attitude Survey (Appendix C). These were evaluated in the same manner as pre treatment scores and analyzed for gains or losses to determine if the treatment had an effect on attitudes toward informational text. Finally, student and teacher pre and post data was compared for gains or losses in each response item and as a whole. Teachers reported their estimated instructional time spent in science per week for comparison to pre treatment. Pre and post treatment science instructional time was analyzed for percentage increases/decreases.

Teacher and (*n*=5) Student (*n*=90) Informational Text Attitude Surveys from the study were analyzed for mean, median, and mode values. Normalized gain and means as an analytical tool for Likert surveys are controversial because the numeric value between scaled response choices is not absolute (Allen & Seaman, 2007). Though controversial, mean and normalized gains for each item and as a whole survey were included in order to analogously compare gains/losses between data collection instruments. The survey questions are designed to target a package attitude regarding informational text.

Teachers completed a post treatment Concept Map that centered on informational text (Appendix M). Maps were assessed according to the rubric used in pretreatment data collection for consistency and reliability (Appendix E). Scores were compared to pretreatment data and analyzed in percentage increases/decreases of each rubric category and as a sum to find evidence of conceptual change in teacher pedagogy/knowledge. Percentages were compared to all other data points in student/teacher data for trends.

All teachers were emailed the Teacher Interview Questions (Appendix N) with a request for an optional reply. A randomized list of students was also interviewed according to Student Interview Questions (Appendix O). Teachers and students were permitted to pass on any questions. Teacher and student responses were analyzed separately for themes. Teacher and student themes were analyzed for comparison in grade level and as a whole study.

As a final data collection method, students were then administered the *Smarter Balanced Consortium English Language Arts Performance Assessment* (SBAC) released item for each grade level from Montana's Office of Public Instruction in order to evaluate student post treatment achievement in *Montana Common Core Standards in Literacy in History/Social Studies, Science, & Technical Subject*s (Appendices J & K). All post treatment data collection was completed before state testing. This was purposefully delivered last in data collection again as it was in pretreatment collection to prevent the test from causing bias in other data collection instruments. Teachers gave the test with only the explanation of what a posttest was and a discussion of how the test would help reflecting upon progress for the year. Students read and completed the assessment independently as they would be required to do for state testing.

The researcher scored the test, and a point was given for each task completed. Points were not based on quality of the response. A point was only given if the student completed the direction. These scores were converted into percentages in order for the scores to be correlated as a whole. The third and fourth grade tests varied in level of difficulty by number of responses required. Scores were analyzed for mean, normalized gains, mode, and medians. Individual scores were also graphed to show individual growth/loss. Classroom normalized gains were figured and reported to individual classroom teachers but not published in the study as part of the privacy agreement.

Individual student data within qualifying classrooms was terminated if students did not complete all of the pre and post treatment data collection instruments. If a student was absent during any treatment, the student's data points were terminated from the data sample. Scores listed, including zeros, are scores earned by a student. This ensured comparable data from separate collection instruments was used in the analysis. From this process, 50 students from three third grade classrooms (n=50) were included in the data set; 40 students from two fourth grade classrooms were included in the data set (n=40). The total number of students included in this study was 90 (n=90) from five classrooms. The number of teachers included was five (n=5). The total number of participants from which data was collected was 95 (N=95).

Focus questions relied on multiple sources for data triangulation (Table 1). Student and teacher attitude data was collected via Student and Teacher Informational Text Attitude Surveys (Appendices B and C). Student achievement data was collected through Smarter Balanced Consortium English Language Arts Performance Assessment Released Items for third and fourth grades (Appendices F and F). Teacher conceptual framework was collected by examining Teacher Pre and Post Informational Text Concept Maps (Appendices D and M). Data collection instruments were supported by Teacher and Student Interview Questions (Appendices N and O).

Table 1
Data Triangulation Matrix

Question Will treatment affect…	Data Source #1	Data Source #2	Data Source #3	Data Source #4
…student achievement?	Smarter Balanced Consortium English Language Arts Performance Assessment Released Item (Pre/Post)	Student Interviews	Teacher Interviews	
… student attitudes of informational text?	Student Informational Text Attitude Survey (Pre/Post)	Student Interviews	Teacher Interviews	
…teacher attitudes of informational text?	Teacher Informational Text Attitude Survey (Pre/Post)	Teacher Concept Map (Pre/Post)	Teacher Interviews	
…teacher conceptual understanding in science pedagogy?	Reported Science Instructional Time (Pre/Post)	Student Interviews	Teacher Interviews	Teacher Concept Map (Pre/Post)

DATA AND ANALYSIS

Pre and Post Informational Text Attitude Survey results reported correlations in value change or stability between teacher (n=5) and student (n=90) attitudes. Student pre and post survey results are not due to chance and are significantly different (**t**-test; $p < 0.05$). Mean, median, and mode scores from teachers and students were compared from pre and post surveys (Table 2).

Table 2

Student (n=90) and Teacher (n=5) Informational Text Attitude Survey Responses

Survey Item Responses for 3rd Grade	Mode Pre	Post	Median Pre	Post	Mean Pre	Post	Normal-ized Gain
Student Item: I enjoy learning from informational text.	3	4	3	4	3.42	3.57	9.5%
Teacher Item: I enjoy teaching with informational text.	4	5	4	5	4	4.6	60%
Student Item: I have the tools to learn from informational text.	4	4	4	4	3.61	3.89	20.1%
Teacher Item: I have the tools to teach with informational text.	4	4	4	4	3.5	4.2	46.7%
Student Item: I know how I will be graded on informational text.	3	3	3	3.5	3.36	3.46	6.1%
Teacher Item: I have clear assessments for informational texts.	2	4	2	4	2.6	3.4	33.3%
Student Item: I take meaningful assessments for informational texts.	3	3	3	4	3.54	3.67	8.9%
Teacher Item: I have meaningful assessments for informational text.	2	3 & 4	2	3.5	2.6	3.2	25%
Student Item: I know what my teacher expects when reading informational texts.	4	5	4	5	3.72	4.27	43.1%
Teacher Item: I know the Common Core State Standards for informational texts in my grade level.	2	4	2	4	2.6	3.8	50%
Student Item: I use informational texts to learn about exciting topics	5	5	4	4	3.51	3.86	23.5%
Teacher Item: I use informational texts to teach about exciting topics.	4	4	4	4	3.6	4	28.6%
Student Item: Informational texts help me learn about important events.	4	5	4	4	3.63	4.03	29.2%
Teacher Item: Informational texts help me learn about important events.	4	4	4	4	4	4.4	40%
Student Item: When I read informational texts, I have a picture in my brain of how the information is connected.	5	5	4	3	3.58	3.59	0.7%
Teacher Item: When I read informational texts, I have a picture in my brain of how the information is connected.	4	4	4	4	3.4	4.2	50%
Student Summative Normalized Gain: Teacher Summative Normalized Gain:	18% 42%						

Mean, median, and mode calculations for teachers (*n*=5) and students *(n*=90) showed various correlations. Overall reported data produced a 58% correlation rate showing gains in both student and teacher data. Analyzing only instances in which teachers' data points increased in value, students' data points correlated with an increase in value 93% of the time. Calculations that reported correlations in stability of values between students and teachers occurred in 25% of the overall reported data points. When teacher median and modes remained stable, student data also remained stable in 75% of occurrences. Teacher and student data values correlated in value gains and stability for 83% of the possible data points. There was not a case in which both data points showed a value decrease.

Without exception, each post survey response calculated mean showed a gain in positively rated responses regarding by both teachers and students. Every post survey item mode response remained stable or increased in value for teachers and students (Table 2). Students and teacher data points did not correlate in gains, stability, or losses for 17% of the total calculations. In 4% of the total calculations, students decreased in value when teachers remained stable. Student data increased in value when teacher data remained stable 4% of the time as well. Finally, teachers increased in data value when students remained stable for 8% of the calculations.

There was not a case in which teacher and student mean, median, or mode values went in opposite directions. When a score did not correlate, one set remained static in value and the other experienced an increase or decrease in value. There was not a case in which the teachers' mean, median, or mode response value decreased, and the students' response value remained stable.

The outlier item, "When I read informational text, I have a picture in my brain of how the information is connected," displayed a decrease in median value by students and remained static for teachers. This was the only case in which a decrease in value by students was recorded for mean, median, or mode. Mode values remained stable in the item for both teachers and students.

Student survey responses were analyzed by item for pre and post results (*n*=90). Pre treatment results response frequency reports a marginal majority of positively rated attitudes. Positively rated responses of *5-strongly agree* and *4-agree* comprised 51% of pre treatment data. Negatively rated responses of *2-strongly disagree* and *1-disagree* made up 15% of all responses, and 34% of responses were *3-neutral*. Pre treatment response frequency for each item demonstrates distribution of a slightly positively rated attitude with a little more than a third of neutral responses toward informational text learning (Figure 3).

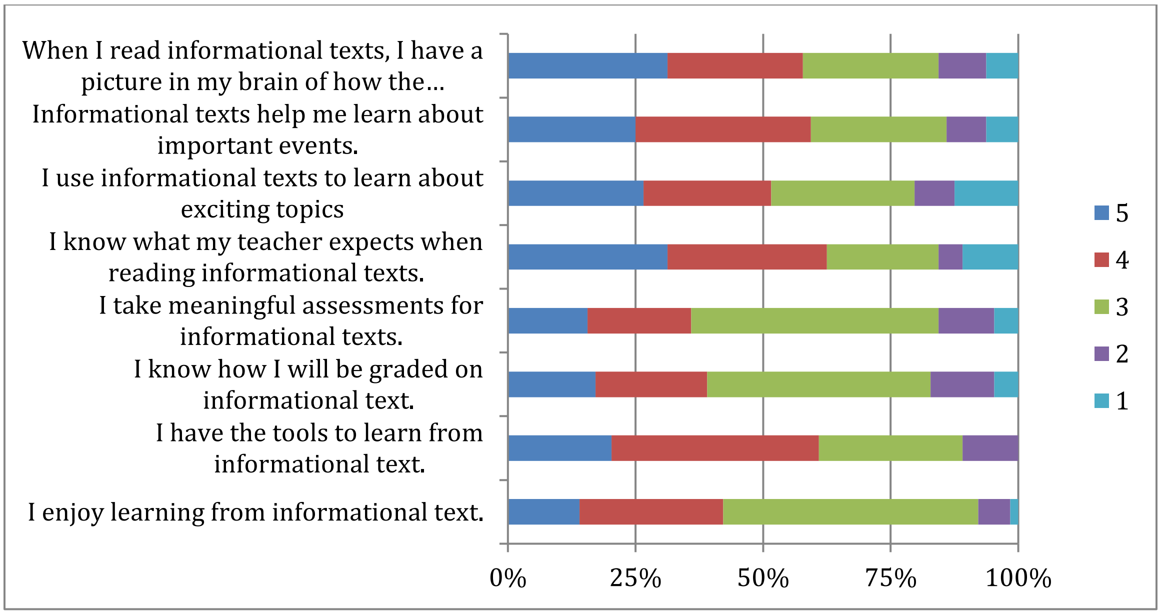

Figure 3. Pre Treatment Informational Text Attitude Survey Student results, (*n*=90). Key: 1=Strongly Disagree; 2=Disagree; 3=Neutral; 4=Agree; 5=Strongly Agree.

Student post treatment results report an increase in positively rated attitudes response frequency toward informational text. Positively rated responses, *5-strongly* *agree* and *4-agree*, comprised 64% of post treatment data. Post treatment data had an increase of 13% in positively rated responses from pre treatment data. Negatively rated responses, *2-strongly disagree* and *1-disagree*, made up 8% of all responses. This is a 7% decrease in negatively rated responses from pre treatment data. Post treatment data reported 25% of responses as *3-neutral*. This is a 9% decrease of neutral responses. The greatest pre and post change for student attitude results occurred in the positively rated response category. Post treatment response frequency for each item shows distribution of a more positively rated attitude toward informational text learning; a fourth of student responses reported neutral attitudes (Figure 4).

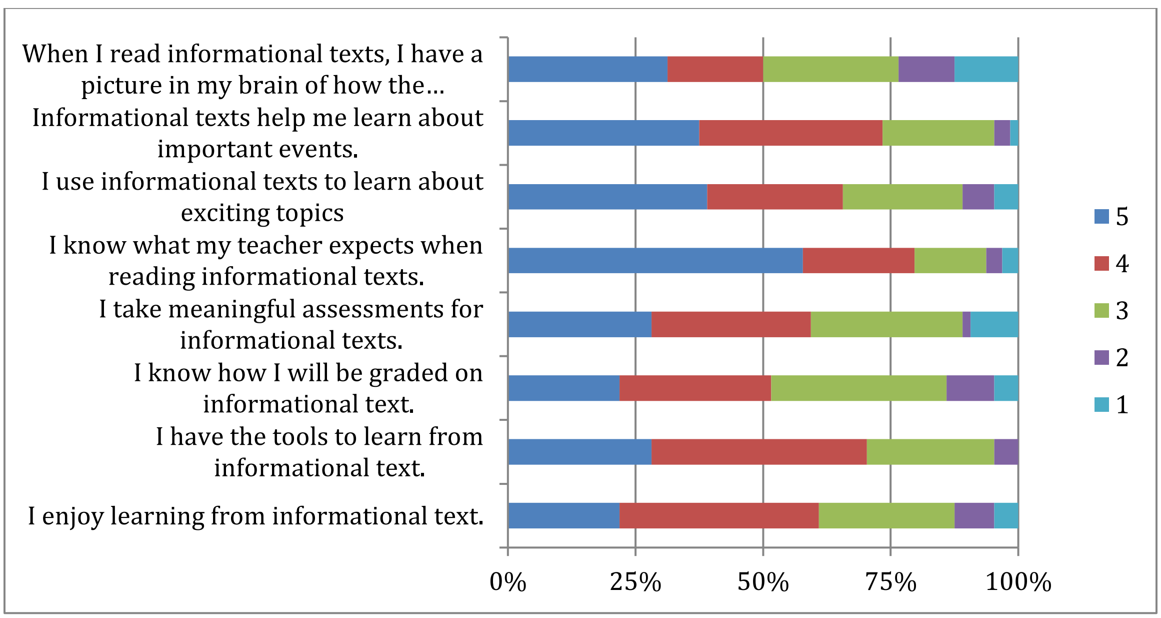

Figure 4. Post Treatment Informational Text Attitude Survey Student results, (*n*=90). Key: 1=Strongly Disagree; 2=Disagree; 3=Neutral; 4=Agree; 5=Strongly Agree.

Teacher survey responses were analyzed by item for pre and post results (n=5). Pre treatment results response frequency reports a marginal majority of positively rated teacher attitudes toward informational text. Positively rated responses, *5-strongly agree* and *4-agree*, comprised 52.5% of pre treatment data. Negatively rated responses, *1-strongly disagree* and *2-disagree*, made up 27.5% of all responses, and 20% of responses were *neutral*. Pre treatment response frequency for each item demonstrates a little more than half of the distribution as positively rated attitudes with a little more than a fourth of negative responses toward informational text teaching (Figure 5).

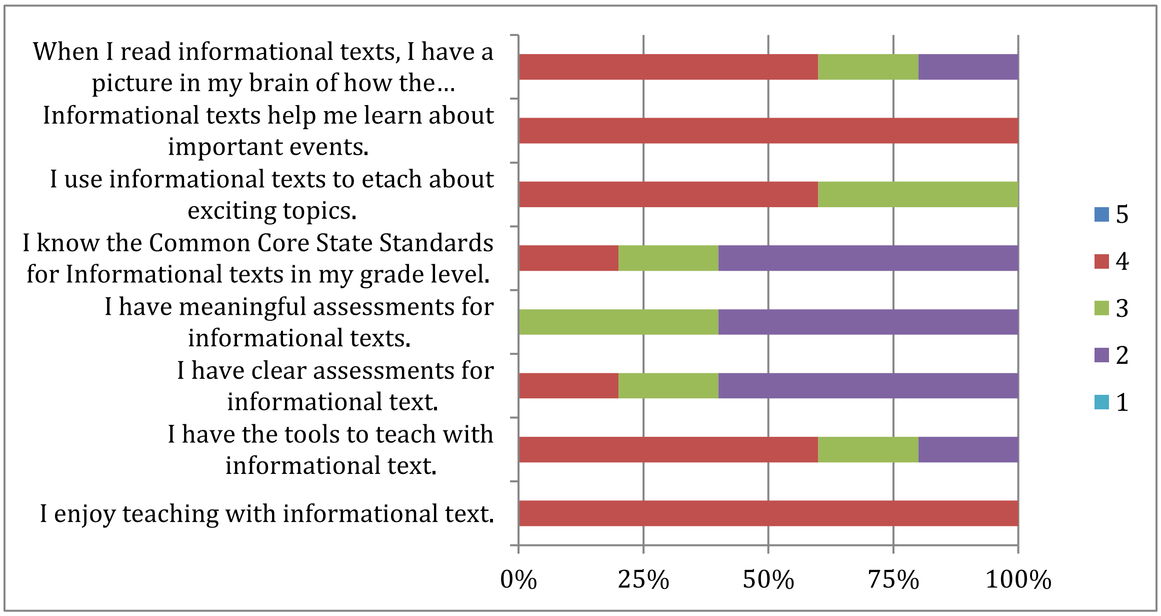

Figure 5. Pre Treatment Informational Text Attitude Survey Teacher results, (*n*=5). Key: 1=Strongly Disagree; 2=Disagree; 3=Neutral; 4=Agree; 5=Strongly Agree.

Teacher survey post treatment results response frequency reports growth in positively rated attitudes toward informational text. Positive responses, *5-strongly agree* and *4-agree* comprised 85% of post treatment data. This calculated to a growth of 32% in positively rated response frequency from pre treatment results. Negative responses of *1-strongly disagree* and *2-disagree*, made up 5% of all responses. This is a decrease in negatively rated responses by 22.5% from pre treatment results. Post treatment results recorded 10% of responses as *3-neutral*. Post treatment response frequency for each item demonstrates a difference in distribution from pre treatment results. Positively rated responses increased and negatively or neutral responses decreased in frequency (Figure 6).

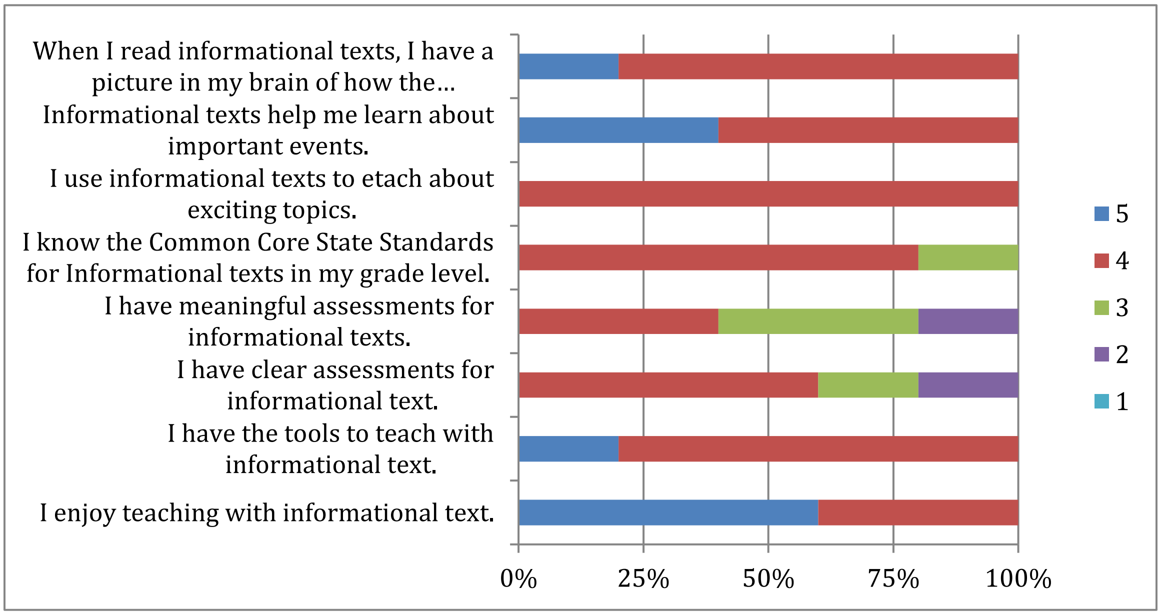

Figure 6. Post Treatment Informational Text Attitude Survey Teacher results (*n*=5). Key: 1=Strongly Disagree; 2=Disagree; 3=Neutral; 4=Agree; 5=Strongly Agree.

Teacher and student frequencies in positive, negative, or neutral categories were compared pre and post survey (Table 3). When teachers gained in a response category, students gained in the response category. When teacher categories reported loss, student categories reported loss. Teacher and student response relationships reported a 100% correlation and were uninterrupted in the categorical data. Teacher frequency gain or loss was consistently more substantial in value than student frequency gain or loss for each and every category.

Table 3
Teacher (n=5) and Student (n=90) Survey Response Frequencies by Category

	Positive		Neutral		Negative	
	Students	Teachers	Students	Teachers	Students	Teachers
Pre	51.2%	52.5%	34.2%	20%	14.6%	27.5%
Post	63.8%	85%	25.2%	10%	7.7%	5%
Total Gain/Loss	+12.6%	+32.5%	-9%	-10%	-6.9%	-22.5%

Student survey open responses supported scaled survey item attitudes and categories of neutral, positive, and negative. All open response items are quoted exactly in punctuation, capitalization, and spelling. Pre and post treatment negative category responses included statements about boredom. Many students wrote the exact words, “It is boring,” while other wrote indications. One student replied, “I do not have a lot of intrest in informationl text it is boring to me you just read information.” Another student wrote, “I cold be reading some thig else,” while a classmate responded, “booooooored.” One student declared it was “not that fun at all.” Other negative responses indicated nervousness about informational text. One student wrote, “ono,” and another student replied informational text gave him/her, “bad toughts.”

Students also responded pre and post treatment in the positive category that indicated they could learn something from informational text or were excited about it. One student wrote, “it is good for learnig and I want to be a reptil biologhst so I read infomastinal text a lot.” Another student replied, “I like lurning.” Several responses read, “cool.”

Neutral responses were peppered through pre and post treatment results. Neutral responses were unique in that they were not found as a consistent theme in an individual student’s responses. Neutral open responses were in multiple student responses and item dependent. Pre treatment responses that indicated a neutral category contained students who were confused about what informational text is. One student described it as a "Crazy Big Word." Another student said, "What do you mean." And another student thought that informational text was, "diary of the wipy kid," referring to a popular graphic novel among elementary students. One student confessed to, "not nowing what it means." Another said, " I dont no." Post treatment responses that indicated a neutral category were not definitive in nature. One student wrote, "Its kinda exiting." These types of responses indicated a slight change in attitude for the student without a full commitment to a positive or negative category. Other post neutral responses reported factual claims about informational text such as, "It will be true." These responses did not indicated attitudes but rather an understanding of what informational text is in the classroom. Pre and post treatment neutral responses were very different in nature. Post treatment neutral responses indicated an understanding of informational text whereas pre treatment neutral responses indicated confusion. Therefore, the neutral category of pre and post treatment survey results indicates very different themes of understanding versus attitudes.

Pre treatment teacher open responses included traditional examples of informational text such as "Journey's Reading Curriculum" or "textbook-nonfiction." Most teacher open responses for pre treatment were short lists as these examples also demonstrate. One teacher declared neutrality by responding, "neutral-I enjoy pieces of it, but sometimes I enjoy fiction!"

Post treatment teacher responses about informational text increased in length and depth. One teacher wrote, "I (heart) it personally and am learning to really enjoy it professionally." Teachers also listed more specific informational texts that were being used in the classroom such as, "Exploration history of Spain/England Articles-Science textbook-ecosystems Compared 2 articles of marine archeology 1 magazine & 1 in reading text." Expanded and varied lists are also demonstrated in this response, "Migration- The Journey: Stories of Migration. Lots on honeybees!" All teacher pre and post data is consistent with attitude and does not represent understanding of informational text.

Teacher and student response relationships were more evident in the post survey open responses. The teacher who mentioned migration and honeybee sources of informational text had students list migration and honeybees ten times on the same response item as the teacher. This trend continued throughout classrooms to the extent that when one teacher responded as "this morning" being the last informational text read in the classroom, five students also responded similarly stating that they had read informational text that morning rather than listing the text read. One teacher who mentioned a study on mountains had nine students list mountain texts as informational texts they had read last. This teacher/student response relationship was not present in the pre survey responses.

Survey open response items and category frequency by teachers report growth in attitudes toward teaching with informational text. Open responses showed growth in examples of informational text used in the classroom, depth of informational text use in the classroom, and cross-connections of when or where informational text is used in the classroom. This data was supported by teacher concept map results and increased teacher-reported science instructional minutes in the classroom.

Pre-concept maps listed types of informational text and features of informational text. Places to access informational texts were also included in the pre-concept maps. Pedagogy included on the maps related solely to language arts. Depth did not reach beyond two levels and consisted of additional descriptors of informational text. Concept map cross-connections concerned how types of informational texts were related rather than to pedagogy or classroom use (Figure 7).

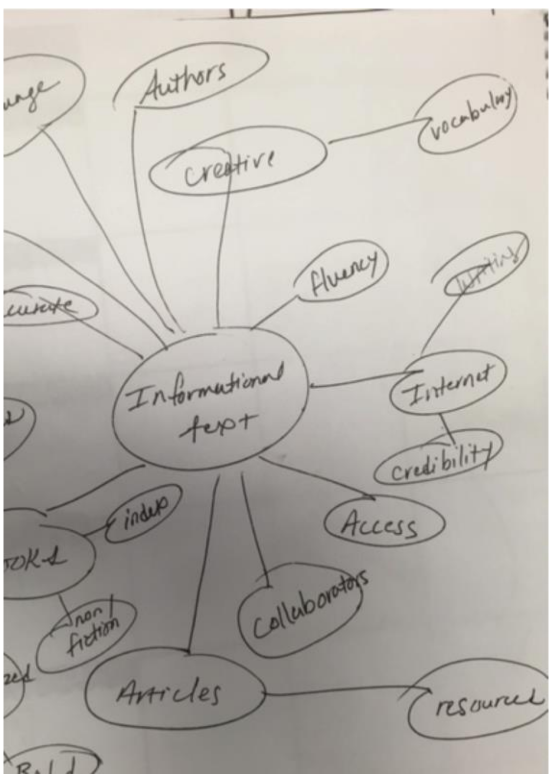

Figure 7. Pre treatment teacher concept map.

Post treatment concept maps also included lists of types of informational texts and language arts pedagogy. In addition, the post treatment maps included pedagogy that weaved science and engineering practices into language arts performance expectations. Depth ranged between two and three levels on each map. Cross-connections were focused on student performance expectations and pedagogy while still maintaining connections between types and features of informational texts. Pedagogy was also included for science as well as for the core subjects of math and language arts. Teachers included parts of scientific literacy that were also embedded in core subject through student practices and methods of communication (Figure 8).

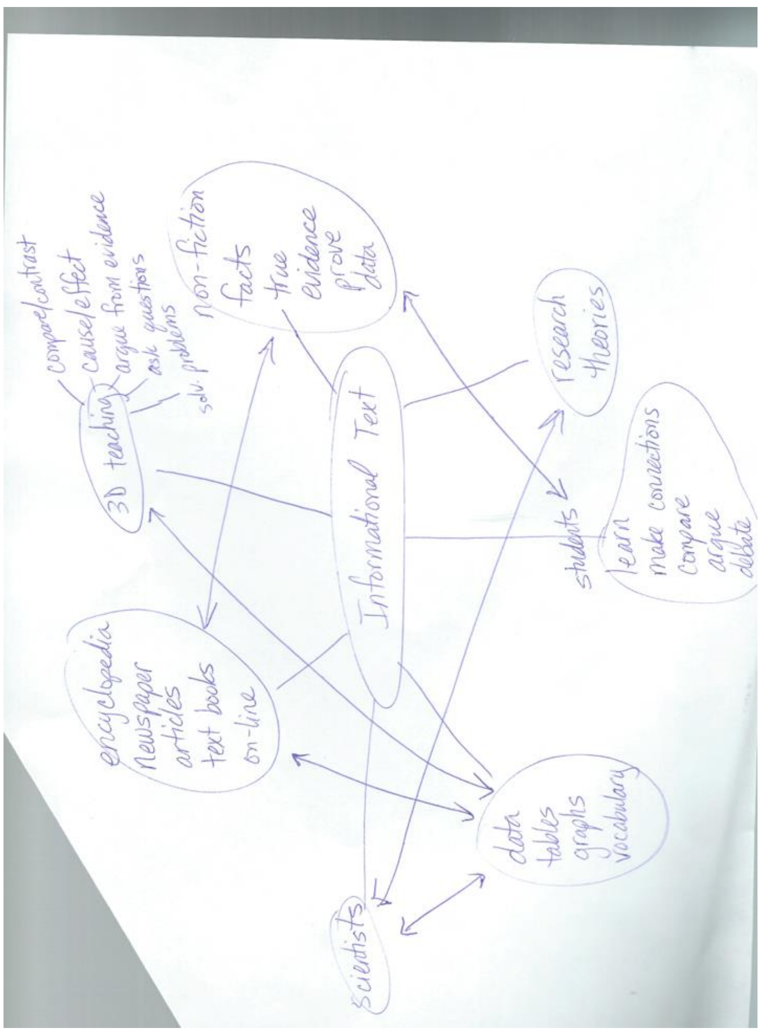

Figure 8. Post-treatment teacher concept map.

Concept maps were analyzed for percentage increase/decrease in categories of unique ideas, depth, and cross-connections, and as a sum (Table 4). All categories experienced gain.

Table 4
Teacher Pre and Post Treatment Informational Text Concept Map Results

	Unique Ideas		Depth		Cross-Connections		Sum	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Totals	93	121	10	12	32	55	135	188
Gain/Loss		30.1%		20%		71.9%		39.26%

The lowest category gain, 20%, was in the depth category. Although teachers expanded unique ideas by 30%, depth remained at two or three levels per teacher. The quality of depth was not defined or measured; only the quantity is reflected. The largest gain, 72%, was in cross-connections. This is reflected by teacher open responses in which connections between subjects and content areas were used as examples. An increase in cross-connections was included in teachers' unit designs as well in which teachers were engaging students in science practices such as Engaging in Argument from Evidence, Constructing Explanations, and Obtaining, Evaluating, and Communicating Information during slotted English language arts sections. Teachers engaged students in additional science and engineering practices such as Developing and Using Models and Designing Solutions during slotted-science sections.

By cross-connecting, or crosscutting, content areas, most teachers increased reported science instructional minutes per week. One teacher remained static in science instruction time. No teacher decreased in science time throughout the treatment. Reports were converted to minutes. If a teacher reported a range of minutes for a week, the average of the range was used for the data point (Figure 9).

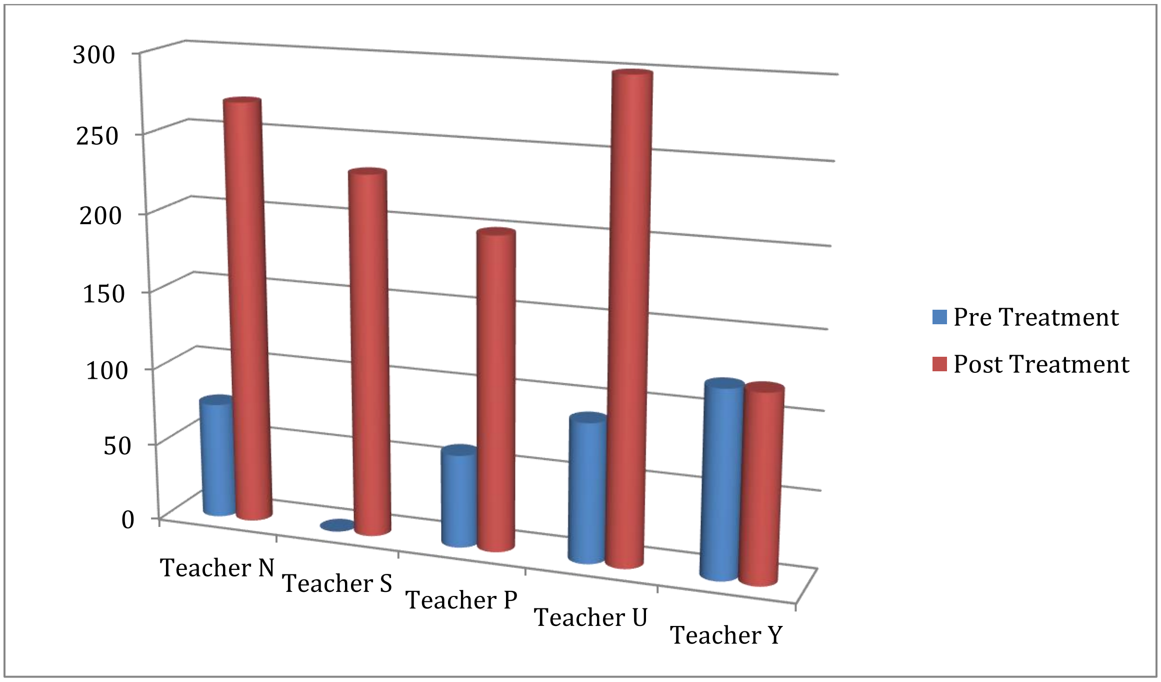

Figure 9. Teacher reported science instructional minutes per week, (*n*=5).

Teacher reported science instructional minutes per week (*n*=5) were calculated for percentage increase/loss. Teacher Y did not increase science instructional minutes throughout the treatment. Teachers P and U increased by 233% while Teacher N increased by 260%. Teacher S began with zero minutes per week and increased to 231 minutes. Since a zero cannot be calculated in as a base for a percentage increase, it was calculated as a value of one. This percentage increase, calculated at a start of one minute per week, equated to an increase of 23,000%. The total minutes of instruction gained per week was 776. The total teacher reported science instructional minutes increased by 225% (Table 5).

Table 5
Percentage Gain/Loss of Teacher Reported Science Instructional Minutes

	Pre	Post	Minutes Gained Per Week	% Gain/Loss
Teacher N	75	270	195	+260%
Teacher S	0 (calculated as 1)	231	231	+23000%
Teacher P	60	200	140	+233%
Teacher U	90	300	210	+233%
Teacher Y	120	120	0	+0%
Total	345	1,121	776	+225%

Smarter Balanced Consortium English Language Arts Performance Assessment results were tracked for individual student progress (*n*=90). Scores are scattered throughout the plot based on percentage of achievement and student number (Figure 10).

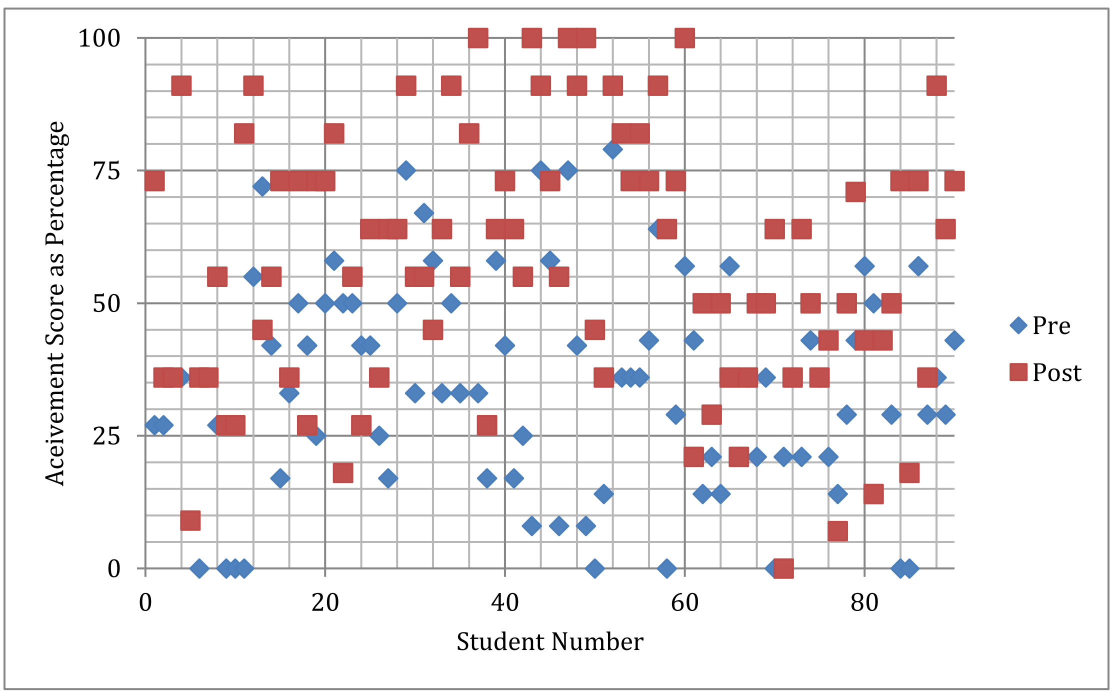

Figure 10. Smarter Balanced Consortium English Language Arts Performance Assessment Released Item individual student results (*n*=90).

Cases did exist in which a student experienced a decrease in score. This is attributed to dependent variables for the student such as missing meal, lack of sleep, or personal conflict. These cases were included in the data set. They represent real complexities and variables of student achievement results. Zeros indicate scores of earned scores of zero.

The pre and post results for Smarter Balanced Consortium English Language Arts Performance Assessment Released Item reported gains in achievement (*n*=90). The data sets are not likely to be a result of chance, and there was a significant difference in achievement scores between pre and post treatment (**t**-test; $p < 0.05$). The results revealed a moderate normalized gain of 30% (Table 6). Maximum, mean, median, mode, and quartile values all increased in value. The minimum value remained static at zero.

Table 6
Smarter Balanced Consortium English Language Arts Performance Assessment Released Item Results (*n*=90)

	Pre	Post	Gain/Loss	Normalized Gain
Mean	32.35%	52.675%	+20.3	30%
Minimum	0%	0%	0	
Q1	21%	36%	+15	
Median	36%	50%	+14	
Q3	50%	73%	+23	
Mode	36%	73%	+37	
Maximum	82%	100%	+18	

Quartile ranges have common values between pre and post treatment data. The median for pre treatment data, 36%, is equal to the first quartile marker for post treatment data, 36%. Additionally, the median for post treatment data, 50%, is equivalent to third quartile marker of pre treatment data, 50%. While the normalized gain supports a gain of data mean, this comparison of pre and post treatment quartiles and medians marks a gain in specific quartiles and supports a conclusion of gains for the span of the sample. These results are graphed on a box and whisker plot to visually organize quartile ranges (Figure 11).

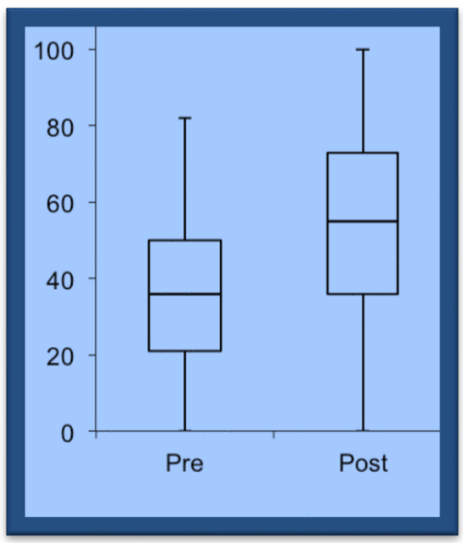

Figure 11. Smarter Balanced Consortium English Language Arts Performance Assessment Released Item box plot, (*n*=90).

Teacher and student interviews supported data collection instruments as a whole. Student interviews reflected attitudes about informational text and added attitudes regarding science to the data set. One student said, “I love science! It’s my favorite subject. We do a lot of science.” Another student exclaimed, “Science is when we do stuff!” Student interviews championed positive science attitudes. No negative or neutral science attitudes were reported.

Teacher interviews contained reflection closely aligned with data collection instruments. Specifically, teacher interviews encased the spectrum of other data collection instruments. One teacher wrote about student notebooks, "I feel their notebooks show more depth of understanding than I have seen in my classroom previously. When we connect another subject to our previous learning, they seem to remember it better (and make connections more easily). From observation they seem more engaged and excited about science." This statement shows evidence of depth and cross-connections in teaching pedagogy as well as evidence in deeper student understanding and positive category attitudes. When asked how pedagogy was affected, a teacher responded,

> "I'm more excited about it and am working on finding ways to be more project and research-based in my room. It will take time to get there though…I honestly hadn't thought much about it [science] before. It was just another thing I had to do… Now I see so many possibilities to teach science through other disciplines and teach the skills they need in Language Arts and Math through science! I think we are finding a way to simplify what we do while giving kids more challenging and interesting learning tasks. This is still a work in progress, but I hope we can develop more cross-cutting units of study!"

This interview response supports other data instrument findings of increased science instructional minutes, teacher concept growth particularly in cross-connections, teacher positive attitude shift, and student positive attitude shifts. This statement also shows evidence of pedagogy development taking time. The teacher refers to the shift in pedagogy as a "work in progress" states it will "take time to get there though."

The theme most evident in teacher interviews was the difference in individual and team pedagogy shifts and implementation. The previous interview excerpts show significant gains in teaching pedagogy and practices. This was not the case across the spectrum of teachers. One teacher said about the effects on the teaching team, "I think it overwhelmed them and discouraged them because they were not able to fit it into what we already do." The difference of pedagogical shifts and unit implementation were so vast in the interview responses, normalized gains for classrooms were reexamined. Individual classroom scores and normalized gains are not published in this study due to the privacy agreement. The data that can be used to explore the range of unit implementation is the range of normalized gains of Smarter Balanced Consortium English Language Arts Performance Assessment Released Item results in classrooms. The mean normalized gain for the whole sample was a gain of 30%. The range of normalized gains in classrooms was 37%. This could point to varying scales of implementation of scientific literacy practices due to time restraints or other variables.

INTERPRETATION AND CONCLUSION

This study found that teacher attitudes and pedagogical framework affect student achievement and attitudes. Student attitudes were correlated to teacher attitudes in open responses and in rated survey data. When rated survey items were categorized by positive, neutral, and negative responses, teacher and student responses showed a close relationship and correlated 100% of the time. Each time the teacher responses increased or decreased in percentage of frequency, student responses followed suit. This was true for neutral, positive, and negative response frequencies.

Teacher attitudes seemed to have strong influences on student attitudes. There was not one case in which individual survey item values in mean, median, and mode calculations went in opposite directions for teacher and students results. Student attitude results experienced less significant gains or losses in value than teacher gains or losses. This suggested that student attitudes are dependent on teacher attitudes. Student and teacher response relationships were also strongly correlated in the open response section of the post surveys. From attitude survey results, it's concluded that a teacher's attitude has a significant effect on student attitudes in regards to learning through informational text. Whether this effect is from the teacher's attitude toward content in the classroom, or if the effect is from more time spent in the content area, is an unknown variable.

A teacher's attitude or comfort level toward science pedagogy correlated with conceptual framework growth and an increase in teacher reported instructional time. Conceptual framework growth may have even been directly related to the teacher attitudes. Teacher attitudes exhibited a normalized gain of 42%; teacher concept maps exhibited gains of 39% suggesting that attitudes were closely related to conceptual change in pedagogical framework.

Teacher concept maps reported significant growth in cross-connections regarding informational text pedagogy and science application. As teachers became more comfortable with pedagogy and implementation of science practices, science instructional minutes increased exponentially. This is especially true for teachers who implemented science practices in other subject areas. The total minutes of instruction gained per week was 776. That calculated to 37,160 minutes, or roughly 619 hours, of science instructional time gained for the year in the five classrooms. This is powerful data that supported that teacher conceptual framework influenced classroom experiences. The gain in teacher reported science instructional minutes concluded that professional development regarding specific pedagogy directly affects classroom instruction. Without professional development and time dedicated to pedagogical growth, classroom instruction in the undeveloped content suffers or remains undeveloped.

As attitudes in students and teachers present more positively and more time is spent on content areas in the classroom, achievement in student skills increases. The triangulation of the data collection instruments showed relationships in gains between teacher conceptual framework in pedagogy, teacher and student attitudes, and student achievement. The increase in student achievement reported a normalized gain of 30%. The mean normalized gain (teachers and students) for the whole attitude survey results computed to 29.7%. Although unconventional, a normalized gain for a package attitude regarding informational texts provides an analogous statistic to compare to other data instruments. Though more research is required, the range between normalized gains of achievement and attitudes at 0.3% suggested a very strong correlation between the two variables. Teacher attitudes increased by a normalized gain 41.7%. The conceptual framework of teachers concept map increased by 42.3%. Though the teacher concept maps report an increase of 42.3%, this is not normalized since the possibility of responses does not have a ceiling. The range between teacher attitude and conceptual framework increases was 0.6%, suggesting a strong correlation between teacher attitudes and teacher conceptual framework in pedagogy.

The correlation of teacher to student data was evident in multiple data collection instruments and data points. It is possible that the data expresses a trickle-down effect of importance. Further research could explore whether more conceptual framework in pedagogy is needed to affect attitudes of teachers to affect attitudes of students to affect learning and achievement. The strength of data correlations between students and teachers in this study was evident throughout. This study concludes that the treatment did positively affect teacher conceptual framework of pedagogy, teacher attitudes, student attitudes, science instructional time, and student achievement. Furthermore, the study provided data that supported conceptual framework of pedagogy, teacher and student attitudes, and student achievement was closely correlated in a classroom setting.

VALUE

The importance of extended professional development and the integration of reflective practices for educators have never been so evident to me. In this study, teachers were engaging students in science and engineering practices. The science and engineering practices were published in *A Science Framework for k-12 Education* by the National Research Council. The purpose of the practices was to provide student performance expectations that would give students tools to solve unique and complex problems as scientists and engineers do on the job. Who else practices at work, or reflects upon the practice of one's professions? Doctors practice medicine. Attorneys practice law. They participate in continuous, reflective practices throughout their careers. In this study, teachers were engaging in a practice of their own profession through extended, team-based professional development. And the results astounded me. The teachers changed. The students changed. And they changed in relation to one another.

Reflection as a teacher and elongated professional time to build one's practice is essential. Its effect ripples through our own attitudes, the attitudes of our students, time allotted to content in classrooms, and student achievement. Engaging students in practices as scientists, historians, researchers, and mathematicians builds problem-solvers with more positive attitudes. Engaging in professional practices may be the only way to truly build conceptual framework for teachers. The basis of conceptual change is rooted in attitude-based decisions. If teachers are going to grow in pedagogical framework, time has to be spent to be able to move through roadblocks and change mindsets. According to existing conceptual change models, attitude and reflective steps are necessary to complete lasting change (Graves, 2015). These steps not in linear form, but as continuous cycles of feedback loops (Figure 12). Regardless of how they are presented in theory, time and reflection is necessary for teachers to work through changing their pedagogical framework.

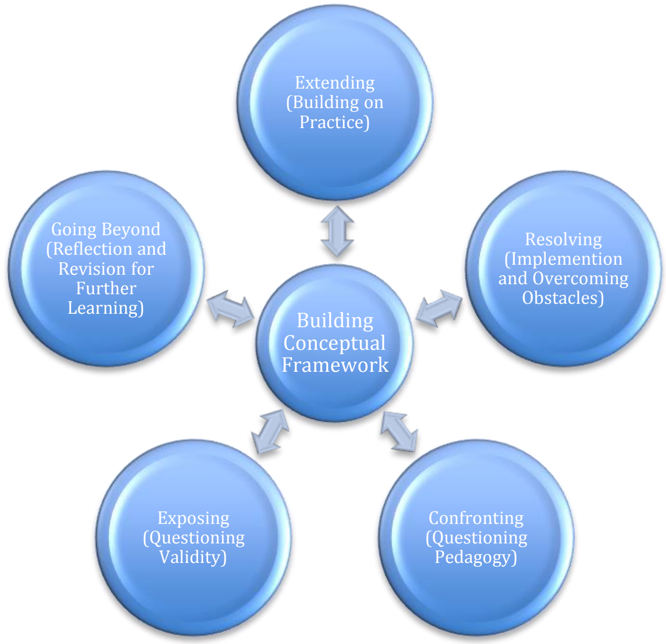

Figure 12. Adapted from Graves Conceptual Change Model.

This study has greatly influenced my approach to professional development. As an MPRES trainer and instructional coach, focusing on teacher attitudes toward pedagogy had not really been a priority before crunching this data. I wanted to lessen the juggling orbs for elementary and intermediate teachers in order to streamline their daily teaching requirements. I believed if we blended multiple subject areas, student attitudes could improve via more applicable projects and learning. I had hoped that this could change attitudes toward teaching science, but I had not factored in how pronounced the correlation of teacher attitudes are to student attitudes and achievement.

I was working through teachers to improve student attitudes without any mindfulness of the teacher attitudes themselves and their effect on the classroom environment. This study suggested a trickle-down hierarchy with teacher attitudes and conceptual framework reigning as the strongest influence. The professional development here provided the opportunity to work long-term with teachers and develop units that were interesting to the team for implementation. Appealing to that interest is paramount.

Previously, I had designed my professional development sessions with the student results in mind. Throughout my career, planning backward from the end goal, known as backward design, has been a focus (Wiggins & McTighe, 1998). I was working upstream and for results rather than true change. In order to go with the flow of influence, we must also design experiences for teachers in which teacher attitudes and conceptual framework is built as a means to student results. Teacher professional development largely has an end goal of improving student achievement results. The end result requires complex interactions of student and teacher attitudes, time, and an exchange/exploration of information. Backward design can begin the planning process, but ultimately, the trickle-down effect of attitude, pedagogy, and achievement relationships need to factor into the equation. Teachers must be active and reflective participants in prolonged professional development where they make attitude-based decisions in order to experience actual change. This requires extended periods of professional development rather than one-time shots. This is true for building my own framework as an intermediate teacher as well as for building professional development for others that will have lasting change.

This study fueled my own reflection as a practitioner in my intermediate classroom. As a teacher, I’ve been acutely aware of my attitude in my classroom. I had been told pre-career by professors, and later, in the midst of my career by colleagues, that our attitudes affect students. This study provided evidence outside of anecdote to solidify the practice of mindfulness regarding my attitudes while influencing young minds. I found it astounding that students were able to answer open response items with such closeness to their teacher's responses. This wasn't evident in the pre treatment, so it developed over time spent with the teacher. So much of what we do permeates our students in our daily relationship with the class.

The study revealed that student gain regarding creating pictures in their mind about informational text was statistically lower than the gains in other items. Does this mean that the developed pedagogy does not aid students in developing this skill? Is this a hole in my classroom as well? From this outcome, I have decided to add the option to draw pictures as summaries to the Informational Text Rubric (Appendix L). Students will have options of writing and sketching ideas that summarize the text based on the content. There will be a minimum requirement of one of each. Additionally, adding student concept maps to interpret informational text at the conclusion of a reading session will connect ideas and provide a conceptual framework summarizing what was read. This may begin to fill the data hole regarding students visualizing informational text.

This study also raised many questions for further study. Questions regarding my own professional practice and for the teaching profession as a whole have surfaced as points to ponder. I blend many subjects throughout the day in project-based learning to provide applicable learning experiences for students. How do they feel about this? When I give them options to choose their own reading material through pointed research, does their enjoyment of informational text increase? Do they find the projects as applicable as I do, or this my own attitude being reflected back at me?

For the profession of teaching, my questions are directed at unintended consequences concerning intermediate classrooms. Teachers in this realm of teaching are faced with multiple content areas of increasing complexity. How do changing content standards in three disciplines (English language arts, math, and science) in quick succession, unintentionally affect teacher pedagogy, professional practices, and student outcomes? Does this adversely affect classroom attitudes and time spent on instruction in these disciplines? Does this affect student attitudes and achievement? Have we adequately trained teachers or spent time developing complex pedagogical framework with implementation of changes? Are our resources being well-spent in short-term professional development settings?

My research connects attitudes, teacher conceptual framework, and achievement. These are areas of education that are difficult to quantify in an analogous manner. How could these three areas be triangulated to support or further what has been found in this study? Is the use of normalized gains (although controversial for surveys) for all three data sets viable as a means of comparison? Would a repeat of the study find also close correlations of student and teacher attitudes, student attitudes and student achievement, and teacher attitudes and pedagogical conceptual framework? If attitudes had improved by a larger number, would achievement have followed in proportion to the attitude gain? Could a larger study encompass attitude surveys about both content areas, science and informational text, that were being connected? Could a study find the same result while blending mathematical portions of scientific literacy and science practices? Will achievement scores from state tests at the close of this school year reveal a statistically significant difference between treatment and control classrooms in the school or state? These questions led me to the conclusion that more research is needed in this field to support teacher professional development needs and budgets in an ever-changing pedagogical atmosphere. The study was successful in beginning this quest.

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APPENDICES

APPENDIX A

MONTANA STATE UNIVERSITY STUDY EXEMPTION

INSTITUTIONAL REVIEW BOARD

For the Protection of Human Subjects
FWA 00000165

MONTANA STATE UNIVERSITY

960 Technology Blvd. Room 127
c/o Immunology & Infectious Diseases
Montana State University
Bozeman, MT 59718
Telephone: 406-994-6783
FAX: 406-994-4303
E-mail: cherylj@montana.edu

Chair: Mark Quinn
406-994-5721
mquinn@montana.edu
Administrator:
Cheryl Johnson
406-994-6783
cherylj@montana.edu

MEMORANDUM

TO: Christina Lynn Gillespie and John Graves

FROM: Mark Quinn *Mark Quinn CJ*

DATE: June 4, 2015

RE: *"Pedagogy in Scientific Literacy and Student Achievement" [CG060415-EX]*

The above research, described in your submission of **June 4, 2015**, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101. The specific paragraph which applies to your research is:

_X_ (b) (1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

_X_ (b) (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

____ (b) (3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

____ (b) (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that the subjects cannot be identified, directly or through identifiers linked to the subjects.

____ (b) (5) Research and demonstration projects, which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.

____ (b) (6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA, or approved by the EPA, or the Food Safety and Inspection Service of the USDA.

Although review by the Institutional Review Board is not required for the above research, the Committee will be glad to review it. If you wish a review and committee approval, please submit 3 copies of the usual application form and it will be processed by expedited review.

SUBJECT CONSENT FORM FOR PARTICIPATION IN HUMAN RESEARCH AT MONTANA STATE UNIVERSITY

Project Title: Pedagogy in Scientific Literacy and Student Acheivement

You are being asked to participate in a research study of professional development and student achievement.

Rationale of research: This research may help lighten the load of teachers by blending two sets of standards while at the same time increasing student achievement.

Why/how subject was identified as a possible subject: You were identified as a possible subject from your interest in scientific literacy professional development and student achievement.

Participation is voluntary. If you agree to participate you will be asked to participate in professional development workshops, complete short reflections, take a pre and post survey, and administer two pre and post instruments, an attitude survey and a SBAC released items, to your students. Finally, you will be asked to develop a unit that blends science and Common Core ELA standards and use it in your classroom before SBACs are administered in your school.

Project Timeline:

This project will begin in the fall of 2016 and finish in the spring of 2017.

A pre and post attitude survey will be administered to teachers and students at the beginning of the project and at the close of the project.

Teachers and students will construct a concept map of scientific literacy in September and in May.

Teachers will write one reflective paragraph up to four times throughout the project.

Teachers will be asked to administer one English Language Arts performance task from Smarter Balanced Assessment released items at the start of the project and after the unit has been completed in the classroom. These items will be provided by the researcher. Any student who is not receiving instruction from the unit is not required to complete the assessment items.

Teachers will receive explicit instruction on concept mapping and grading in August.

Teachers will attend professional development that address scientific literacy once a month September thru December.

Teachers will schedule a session with researcher to develop a blended unit of Common Core ELA and science standards in March. Sessions may include all grade level teachers in the study and will focus on one grade level only.

APPROVED
MSU IRB
06/04/2015
Date approved

Teachers will implement the unit in the classroom in March or April.

Risks: There are no foreseen risks in research participation.

Benefits: Benefit to the participant includes an applicable, standards-based unit in which to add to your classroom curriculum.

Financial Compensation: Teachers will receive financial compensation in the form of curriculum rate pay during the unit building session.

Alternatives Available: Teachers may seek out other professional development in this area.

Source of funding of project: NA

Cost to subject: None

IF YOU HAVE ANY QUESTIONS, PLEASE EMAIL CHRISTINA GILLESPIE AT christina.gillespie@livingston.k12.mt.us

If you have additional questions about the rights of human subjects, please contact the Chair of the Institutional Review Board, Mark Quinn, (406) 994-4707 [mquinn@montana.edu]..

Confidentiality of Records: Teachers will receive a letter to be used as his/her identification for all assessments, reflections, and pre/post tests. Students will use the teacher letter followed by a number for all assessments and pre/post tests. This will allow the researcher to connect the teacher to the student and release information to the administration **without** using identifying factors such as the teacher's name or grade level. During face-to-face professional development, teachers will not be assessed in any way.

AUTHORIZATION: I have read the above and understand the discomforts, inconvenience and risk of this study. I, ____________________________ *(name of subject)*, agree to participate in this research. I understand that I may later refuse to participate, and that I may withdraw from the study at any time. I have received a copy of this consent form for my own records.

Signed: ____

Investigator: _______________________________________

Date: ____

APPROVED
MSU IRB
06/04/2015
Date approved

MONTANA STATE UNIVERSITY
Request for Designation of Research as Exempt
MSSE Research Projects Only
(10/14/11)

****

THIS AREA IS FOR INSTITUTIONAL REVIEW BOARD USE ONLY. DO NOT WRITE IN THIS AREA.
Confirmation Date: 6/4/15
Application Number:

****

DATE of SUBMISSION: June 5, 2015

- ok as exempt
- MSSE Classroom project
- Little/no risk
- Principal approved
- No concerns
MG
6/4/15

Address each section – do not leave any section blank.

I. INVESTIGATOR:

Name: **Christina Lynn Gillespie**
Home or School Mailing Address: **105 South 8th Street Livingston, MT 59047**
Telephone Number: **406-224-0009**
E-Mail Address: **christina.gillespie@livingston.k12.mt.us**
DATE TRAINING COMPLETED: **03/09/15**
Investigator Signature ______________________

Name of Project Advisor: **Dr. John Graves**
E-Mail Address of Project Advisor: **graves@msu.edu**

II. TITLE OF RESEARCH PROJECT: **Pedagogy in Scientific Literacy and Student Achievement**

III. BRIEF DESCRIPTION OF RESEARCH METHODS (If using a survey/questionnaire, provide a copy).

1. **Likert Survey: Separate student and teacher surveys analyzed for themes amongst responses**
2. **Concept Maps: Open-Ended teacher and student-designed maps will be ttilized as a pre and post measure and analyzed for depth, breadth, and complexity in accordance to the verified protocol resulting from the research of Kevin Miller, et al. in 2009**
3. **Smarter Balanced Assessment ELA Perfomance Task released items for relevant grade level with be used as a pre and post test instrument analyzed for normalized gains**
4. **Teachers will be asked to submit open-ended reflections of their growth as professionals and student growth in acheivement/skills every two months. These will be analyzed for themes and will not exceed two paragraphs.**

IV. RISKS AND INCONVENIENCES TO SUBJECTS (do not answer "None"):
Inconveniences to teacher subjects include research methodology completion and time in professional development.

Inconveniences to student subjects include research methodology completion.

V. SUBJECTS:

A. Expected numbers of subjects: **+/-100**

B. Will research involve minors (age <18 years)? **Yes If teachers sign up for the study, students of varying ages under 18 will be involved and remain private.**

C. Will research involve prisoners? **No**

D. Will research involve any specific ethnic, racial, religious, etc. groups of people? (If 'Yes', please specify and justify.) **No**

VI. FOR RESEARCH INVOLVING SURVEYS OR QUESTIONNAIRES:
(Be sure to indicate on each instrument, survey or questionnaire that participation is voluntary.)

A. Is information being collected about:
Sexual behavior? **No**
Criminal behavior? **No**
Alcohol or substance abuse? **No**
Matters affecting employment? **No**
Matters relating to civil litigation? **No**

B. Will the information obtained be completely anonymous, with no identifying information linked to the responding subjects? **No**

C. If identifying information will be linked to the responding subjects, how will the subjects be identified? (Please circle or bold your answers)
By name **No**
By code **Yes**
By other identifying information **No**

D. Does this survey utilize a standardized and/or validated survey tool/questionnaire? **(If yes, see IRB website for <u>required wording</u> on surveys and questionnaires.)** No

VII. FOR RESEARCH BEING CONDUCTED IN A CLASSROOM SETTING INVOLVING NORMAL EDUCATIONAL PRACTICES:

A. This research project must be approved by your Principal or School Administrator, unless there are circumstances or policies that do not make this possible. **Provide a copy of the principal's signed approval.** If such approval is not possible, please explain.

Copy is attached.

B. **Participation of your students in research must be voluntary** and can never affect their rights. Please make this issue clear on all of your research surveys (use introductory text, see below) and/or interviews (use introductory verbal statement, see below). The following wording or something similar can be used for the introductory text or statement: **Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.**

C. Extra credit should not be used to encourage participation. If you absolutely need to use extra credit, then an alternative activity involving the same amount of time and effort must be provided for those who choose not to participate. This must be clearly described in your IRB application.

Extra credit will not be offered.

E. Depending on your school policies, **consent forms may or may not be required for your research.** Please indicate whether you will be using consent forms or not. If you are not using consent forms, please justify (e.g., school policy, etc.). **If you do use consent forms, you must include signature lines for parental consent AND student assent.** (Please use accepted format from our website and provide a stand-alone copy. Do not include form here.)

Consent forms will not be used. Students will remain anonymous and will not include any personal information. Only regular classroom work may be commented on by the teacher through the process with the addition of research methodology remaining anonymous.

I, Robert Stevenson, Principal of East Side Elementary, verify that the classroom research conducted by Christina Gillespie is in accordance with established or commonly accepted educational settings involving normal educational practices. To maintain the established culture of our school and not cause disruption to our school climate, I have granted an exemption to Christina Gillespie regarding informed consent.

(Signed Name)

Robert J. Stevenson Principal

East Side Intermediate

Livingston, MT

(Printed Name)

6/4/15

(Date)

APPENDIX B

STUDENT INFORMATIONAL TEXT ATTITUDE SURVEY

HOW DO YOU FEEL ABOUT INFORMATIONAL TEXT? (Students)

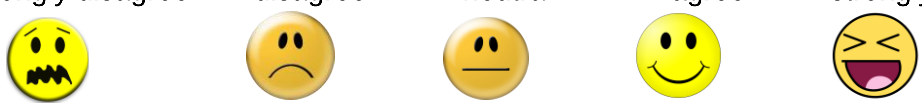
Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

I enjoy learning from informational text.

strongly disagree | disagree | neutral | agree | strongly agree

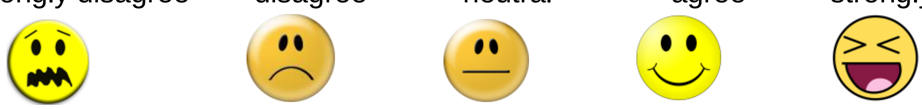
I have the tools to learn from informational text.

strongly disagree | disagree | neutral | agree | strongly agree



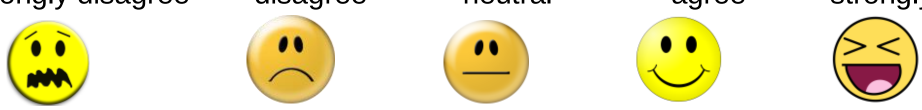
I know how I will be graded on informational texts.

strongly disagree | disagree | neutral | agree | strongly agree



I take meaningful assessments for informational text.

strongly disagree | disagree | neutral | agree | strongly agree

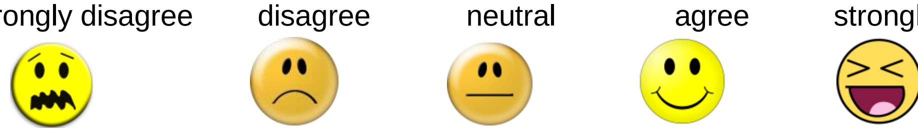


Learning from informational text overwhelms me.

strongly disagree | disagree | neutral | agree | strongly agree

I know what my teacher expects when reading informational texts.

strongly disagree | disagree | neutral | agree | strongly agree



I use informational texts to learn about exciting topics.

strongly disagree | disagree | neutral | agree | strongly agree

Informational texts help me learn about important events.

strongly disagree disagree neutral agree strongly agree

When I read informational texts, I have a picture in my brain of how the information is connected.

strongly disagree disagree neutral agree strongly agree

The last informational text I read

When I hear "informational text," I think…

This is what I think about informational text…

APPENDIX C

TEACHER INFORMATIONAL TEXT ATTITUDE SURVEY

HOW DO YOU FEEL ABOUT INFORMATIONAL TEXT? (Teachers)

Participation in this research is voluntary and participation or non-participation will not affect a teacher's professional standing in any way. You can choose to not answer any questions you do not want to answer and/or you can stop at anytime.

I enjoy teaching with informational text.
strongly disagree disagree neutral agree strongly agree

I have the tools to teach with informational text.
strongly disagree disagree neutral agree strongly agree

I have clear assessments for informational text.
strongly disagree disagree neutral agree strongly agree

I have meaningful assessments for informational text.
strongly disagree disagree neutral agree strongly agree

Teaching information text overwhelms me.
strongly disagree disagree neutral agree strongly agree

I know the Common Core State Standards for Informational texts in my grade level.
strongly disagree disagree neutral agree strongly agree

I use informational texts to teach about exciting topics.
strongly disagree disagree neutral agree strongly agree
Informational texts help me learn about important events.
strongly disagree disagree neutral agree strongly agree

When I read informational texts, I have a picture in my brain of how the information is connected.
strongly disagree disagree neutral agree strongly agree

The last informational text I used in class for instruction was…

When I hear "informational text," I think…

This is what I think about informational text…

APPENDIX D

PRE TREATMENT CONCEPT MAP EXAMPLE


Language
Authors
creative
vocabulary
validity
accurate
fluency
Informational text
Internet
credibility
genres
index
Books
Access
collaborators
non fiction
italicized
Articles
resources
Bold

APPENDIX E

MILLER CONCEPT MAP RUBRIC

1. Concept node = 1 point each
2. Hierarchy levels = 1 point times the number of levels
3. Branches = 2 points times the number of branches at the horizontal level of the map at which the number of branches is the greatest
4. Cross-links = 4 points times the number of cross-links

SCORE

Scored Category	Raw Points Received	Multiplier (Multipliers were not used in this study in order to compare categories.)	Category Score
Concept Node			
Hierarchy		1	
Branches		2	
Cross-links		4	

Participant Score Total: ________

APPENDIX F

THIRD GRADE SMARTER BALANCED ASSESSMENT CONSORTIUM

RELEASED ITEM

Student Directions

Astronauts Informational Performance Task

Task:

Your class has been learning about different types of jobs to prepare for your school's job week. Your teacher has asked each person to learn about a different job. You think being an astronaut must be an interesting job so you decide to learn about what it is like to be an astronaut. You have found two sources about being an astronaut.

After you have reviewed these sources, you will answer some questions about them. Briefly scan the sources and the three questions that follow. Then, go back and read the sources carefully so you will have the information you will need to answer the questions and complete your research. You may click on the Global Notes button to take notes on the information you find in the sources as you read. You may also use scratch paper to take notes.

In Part 2, you will write an informational article using information you have read.

Directions for Beginning:
You will now review two sources. You can review either of the sources as often as you like.

Research Questions:

After reviewing the research sources, use the rest of the time in Part 1 to answer three questions about them. Your answers to these questions will be scored. Also, your answers will help you think about the information you have read and viewed, which should help you write your informational article.

You may click on the Global Notes button or refer back to your scratch paper to review your notes when you think it would be helpful. Answer the questions in the spaces below the items.

Both the Global Notes on the computer and your written notes on scratch paper will be available to you in Part 1 and Part 2 of the performance task.

Part 1

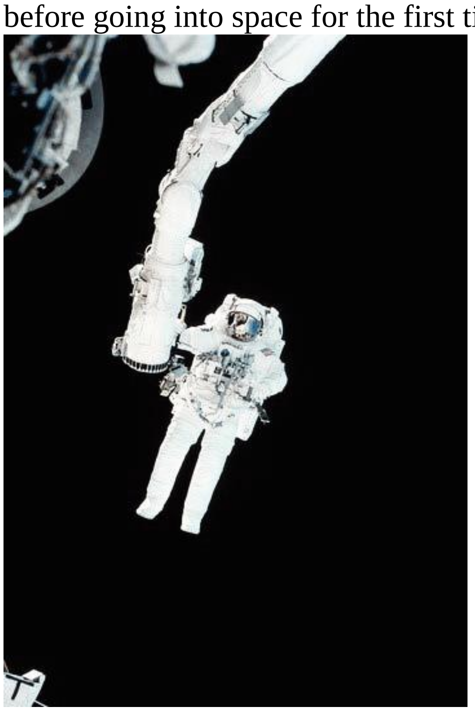
Sources for Performance Task:

Source #1
You have found a source describing the type of training that astronauts receive in order to do their job.

What is an Astronaut?
by Talia Yee

Have you ever thought about what it is like in space? Astronauts are people who go out into space. Being an astronaut is an exciting job. Astronauts who see Earth from space say that it is round, like a ball. While in space, astronauts can look down and see clouds, land, and water. Some can even see the moon up close. Astronauts get the chance to see more stars than you or I have ever seen.

Being an astronaut may be exciting, but it is not an easy job. A person who wants to be an astronaut has to study for years. There are many things an astronaut must learn to do before going into space for the first time.



A weightless astronaut in space

Astronauts train for hundreds of hours. During their training, they learn about space. This type of training might include studying the stars and Earth. It is important that astronauts study space so that they understand what they will work with while in space. The astronauts also learn medical skills like basic first aid during their training. This training allows them to treat simple medical problems so that they can keep each other healthy and safe in space.

In their training, astronauts also learn what life is like on the International Space Station (ISS). The ISS is a large spacecraft that orbits the earth. The ISS is a place where astronauts do science experiments while in space. Astronauts also learn to eat, exercise, and do experiments while floating in the air. They also practice riding in special vehicles that are just for space. These vehicles bring supplies like food and fuel to the ISS. The vehicles are about the size of a pick-up truck with 12 wheels. Astronauts even take classes in scuba diving! When they're walking underwater in their scuba suits, astronauts feel the same as they would feel walking in space. Lastly, astronauts must also learn how to work together as a team. This is important because as many as eight astronauts may be in one spacecraft. These astronauts have to learn how to live and work together in a space.

Each astronaut has a special job to do as part of the team. Some astronauts learn how to put things together so they become good at fixing things. This is important because if something on a space ship breaks, the astronauts must be able to fix it themselves. Some astronauts are pilots who know how to fly airplanes. These astronauts have to study how to fly and steer a spaceship. They train for many hours to learn how to turn it, how to make it go faster and slower, and how to guide it through space. Some astronauts are leaders and are in charge of all of the people on the ship. They make sure that everybody is doing the right job. Other astronauts learn mostly about science. Their job is to learn how living things change when they are in space.

Although each astronaut has a special job on the team, each of them has to learn how to work where there is no gravity. When they are in a spaceship that is moving around Earth, they can feel as though they do not weigh anything. They are able to float. Many astronauts say that it is fun to float around the inside of a spaceship. Objects in the spaceship can also float, so astronauts can lift and move heavy things easily.

Feeling weightless is fun, but being in space is work for astronauts. Astronauts must be healthy and eat right. They have to exercise and be in good shape. Astronauts have many adventures, but they work hard, too.

scuba diving: swimming under water with a special suit, air tank, and fins

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Photograph of weightless astronaut (Image Number *4128R-4871*), copyright by Superstock. Used by permission.

Source #2
This article describes what happens to astronauts' bodies when they go into space.

Life in Space

by Aaron Higgins

Many people say they want to be an astronaut, but do they know what it's really like? When astronauts are in space, they feel weightless. They can float. This sounds like fun, but it is not that simple. The human body is used to being on Earth, but some people stay out in space for months. A lot of strange things happen to the body when it floats for that long.

Astronauts sometimes feel sick in space. It takes a few days for them to get used to feeling weightless and being able to float.

Being in space also changes how blood flows in the body. In space, more blood flows to the astronauts' heads so their faces get puffy and their necks get bigger. At the same time, less blood flows to their legs, making them skinny. They call this condition "bird legs."

The heart is a muscle that pumps blood around the body. The heart does not have to work as hard to pump blood in space. A muscle that does not work hard gets weaker and smaller. Astronauts' other muscles and their bones can also get weaker. This is because they do not have to work as hard to move the astronaut's body.

To help keep their muscles strong, astronauts have to do exercises when they are in space. They use big rubber bands attached to the walls of the space ship and hook them over their shoulders. Then they bend their knees and press against the rubber bands to make their legs stronger.

Even with regular exercise in space, astronauts come back feeling weak. It takes time for them to get back their Earth legs and learn how to live with gravity again.

Sources Used

Discovery News (2009, May 13). Astronaut [Video file]. Retrieved from http://news.discovery.com/videos/cool-jobs-astronaut.html

NASA (2009). When space makes you dizzy. Retrieved from http://www.nasa.gov/audience/forstudents/5-8/features/F_When_Space_Makes_You_Dizzy.html

Checkmark the boxes to match each source with the idea or ideas that it supports. Some ideas may have more than one source selected.

	Source #1: "What is an astronaut?"	Source #2: "Life in Space"
Astronauts feel weak when they come back from space.		
Since objects are also able to float in space, astronauts are able to lift heavy objects they would not be able to lift on Earth.		
Astronauts have a special view of Earth from space.		

Which source **most likely** has the most useful information about the kinds of work that astronauts do while they are in space? Explain why this source **most likely** has the most useful information about the kinds of work that astronauts do while they are in space. Support your explanation with **two** details from the source.

Explain why it is hard to be an astronaut. Give **two** reasons, one from Source #1 and one from Source #2. For each reason, include the source title or number.

APPENDIX G

FOURTH GRADE SMARTER BALANCED ASSESSMENT CONSORTIUM

RELEASED ITEM

Student Directions

Animals and Their Surroundings Informational Performance Task

Task:
Your school's science fair is taking place soon. Your class has decided to focus on doing science projects about animals. You become interested in learning more about where animals live. You have found three sources about this topic in the school library.

After you have reviewed these sources, you will answer some questions about them. Briefly scan the sources and the three questions that follow. Then, go back and read the sources carefully so you will have the information you will need to answer the questions and complete your research. You may click on the Global Notes button to take notes on the information you find in the sources as you read. You may also use scratch paper to take notes.

In Part 2, you will write an informational article using information you have read.

Directions for Beginning:
You will now review several sources. You can review any of the sources as often as you like.

Research Questions:
After reviewing the research sources, use the rest of the time in Part 1 to answer three questions about them. Your answers to these questions will be scored. Also, your answers will help you think about the information you have read, which should help you write your informational article.

You may click on the Global Notes button or refer back to your scratch paper to review your notes when you think it would be helpful. Answer the questions in the spaces below the items.

Both the Global Notes on the computer and your written notes on scratch paper will be available to you in Part 1 and Part 2 of the performance task.

Part 1

Sources for Performance Task

Source #1
You have found an article that describes how animals survive in different environments, the places where plants and animals live.

It's a Cold (Hot, Dry, Dark) Cruel World!

by Dawn Baertlein

Living creatures survive in all types of environments. Each environment creates different challenges for animals that live there. Some living creatures survive at the bottom of the sea where it is dark as night and very cold. Other plants and animals live in dry, hot environments. People can use tools like flashlights or fans to help them survive. Animals and plants, however, must rely on nature to help them survive.

Near the South Pole, in Antarctica, it is very cold. It is usually about minus 57 degrees Fahrenheit. Water freezes at 32 degrees Fahrenheit, so Antarctica is much colder than ice. Scientists live at the South Pole, but they live in buildings with thick walls and heating. What do animals do?

Some animals have bodies that help them live in the cold. The icefish lives in water so cold that even in summer, chunks of ice continue to float in the water. How do icefish keep from freezing? The only way icefish can survive in this extreme environment is because they have a special substance in their blood that keeps ice crystals from forming inside their bodies.

Penguins have thick layers of fat or blubber to help them stay warm, but sometimes even that is not enough! Often penguins must rely on each other for survival. They cuddle up together as close as they can to share their body heat.

Another area that can be hard to live in is the dry, hot desert. People who live in the desert often wear special clothes to protect them from the heat. When they build homes they have air conditioners to keep them cool and to find water they dig wells that provide water from deep in the ground. How do animals survive in the hot, dry conditions?

Many desert animals come out only at night, when it's cool. Snakes, lizards, mice, and squirrels live in burrows. During the day, they stay under the ground and out of the sun.

In the hot Sonoran Desert of Arizona, an owl lives in a nest that sits on a tall cactus. The cactus stems store water. Rain doesn't fall often in the Sonoran Desert, but when it does, it falls quickly and heavily. Then the water quickly flows away. The cactus has roots that spread out only inches below the surface of the soil. The roots are like a big sponge, soaking up rainwater fast. Now the cactus can store water for months and the owl has a nice home high up in the cactus.

An owl nests on a cactus in the desert

The ocean has very different challenges from those of the desert. The deepest parts of the ocean are very dark and cold because the sun's rays are unable to shine through all of the layers of water. Some of the very deepest parts of the ocean have thermal vents on the ocean floor that are like little volcanoes under the sea. The water coming out of the vents is very hot. Crabs survive at the bottom of the sea by scurrying around the vents looking for food.

Arctic chill, desert sun, and cold, pitch-dark ocean—these are difficult conditions that would be hard for people to survive. But nature gives plants and animals the ability to live almost anywhere.

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Photo of owl on cactus (Image *1598R-10034017*), copyright by SuperStock. Used by permission.

Source #2
You have found an article from *Appleseeds* magazine that describes how some animals build their homes.

Animal Architects

by Donna Henes

Everybody Needs a Home
Homes protect us from weather and keep us safe and comfortable. Animals are no exception.

Humans live in a wide variety of structures. Around the world, people have designed and built their homes to suit their particular needs and ways of life. Animals do the same.

In addition to making living places, people and animals both build other structures: bridges, dams, traps, and storage areas. These structures help people and animals survive.

People and animals both use different materials and methods for their constructions. They build with wood, weave with fibers and vines, dig into the earth, and mold out of mud.

From sky-high nests to elaborate [or fancy] tunnels, the amazing works of animal architects [or building designers] rival those of the greatest human engineers. Let's take a look at some.

Beavers build lodges along the banks of lakes and ponds. Using branches they chewed apart themselves, beavers begin by building a cone-shaped frame. Then they fill in the gaps with mud and leaves. The entrance to the lodge is always at the bottom, underwater, so beavers can come and go without being seen by predators.

In addition to their lodges, beavers build dams. Water builds up behind the dams, creating flooded areas that are ideal places for beavers to find food. The flooded areas also provide pools for other wildlife.

Termites build 20-foot-high mounds out of dirt and their own saliva. These giant structures are like small apartment buildings. Besides living areas, these towers have food storage areas, nurseries for "baby" termites, a special chamber for the king and queen, and even gardens. (A chamber is like a room.) . . .

An inside view of a termite mound

Wombats dig huge underground burrows that can be 100 feet long. Wombat tunnels are elaborate, with many entrances, side tunnels, and resting chambers. Inside the burrow, sleeping nests are built on raised "platforms" to keep them dry in case of flooding. Often, several burrows are connected, creating structures so huge they can actually be seen from space! . . .

A wombat coming out of its burrow

Bald eagles build massive nests, 4 to 5 feet across and 3 to 6 feet deep, high in tall trees. They use their beaks and amazingly strong talons [or claws] to break branches and twigs for nest material. Like beavers, eagles begin by building a stick frame. Then they weave in smaller branches and twigs for added strength and protection. Finally, eagles line their nests with grasses and other soft material to make them comfy. . . .

Take a look around you. [You may] find other examples of amazing animal architecture.

Sources Used

Henes, D. (2009). Animal architects. *Appleseeds*, *11*(7), 16-18.

Photograph of termite mound (Image *4268R-11707*), copyright by Superstock. Used by permission.

Photograph of wombat in burrow (Image *1889R-38764*), copyright by SuperStock. Used by permission.

Source #3

You have found an article that discusses plants and animals that live in the same place. The article describes how these plants and animals depend on each other to stay alive.

Don't Step in that Ecosystem![1]

by Courtney Duke

The next time you go out, take a careful look around. Maybe you see a small pond. Plants might be growing in the pond, birds might take baths in it and, if you're lucky, the pond might even be a home to tadpoles.

Any place where plants and animals live and interact [work together] with nonliving things (like air, water, and soil) is called an ecosystem. The plants and animals in an ecosystem need each other to survive. It is important that there is a balance among all things in an ecosystem. A small change in any part of an ecosystem can have a big effect. For example, if the food that an animal eats can no longer be found, then that animal will either die or have to leave that ecosystem. When that animal is no longer a part of the ecosystem, then the rest of the living and nonliving parts of the ecosystem are affected because all parts of the ecosystem depend on each other.

All parts of an ecosystem are connected to each other. Think about an oak tree in the forest. It is a home to the bugs and birds that live in its bark and branches, and to the squirrels who make their nests in its trunk. The oak tree also provides food to other animals in the ecosystem. When its acorns are ripe, they fall to the forest floor. These rich nuts are good food for the mice and deer that eat them to fatten up for the winter. Mice save the acorns so that they have food in the winter months, and in the spring, hawks swoop down looking for a mouse meal. In a way, the oak tree helps the hawk find its food. This is an example of how the plants and animals in an ecosystem work together in order to survive.

Now think of the ocean. Imagine diving into the deep blue water. Near the surface, you see a rocky ridge of coral called a coral reef. The reef is home to many plants and animals. For example, sea plants move back and forth in the current, and fish come to feed or to hide from other living things that can harm them. Coral reefs, in fact, are home to about one-quarter of all the fish in the sea. Reefs also attract birds, whales, turtles, and seals. The number and many different types of animals that depend upon coral reefs make them one of the most important ecosystems in the world.

There are many different kinds of ecosystems, and they can be very small like a pond or very big like a coral reef ecosystem. Ecosystems are everywhere.

[1]ecosystem: an area where plants, animals, and other nonliving things live and depend on each other for survival

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Pala, C. (2008, September). Our imperiled oceans: victory at sea. Retrieved from: http://www.smithsonianmag.com/science-nature/our-imperiled-oceans-victory-at-sea-7468851/?no-ist

Source #1 discusses what some animals do to survive in their environment. Explain how the information in Source #2 adds to the reader's understanding of what some animals do to survive in their environment. Give **two** details from Source #2 to support your explanation.

Which source would **most likely** be the most helpful in understanding how plants and animals work and live together to allow the place where they live to continue to grow? Explain why this source is **most likely** the most helpful. Use **two** details from the source to support your explanation.

Checkmark the boxes to match each source with the idea or ideas that it supports. Some ideas may have more than one source selected.

APPENDIX H

RELATED MONTANA COMMON CORE STANDARDS

Grade 3 students:	**Grade 4 students:**	**Grade 5 students:**
	Key Ideas and Details	
1. Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers.	**1.** Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.	**1.** Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text.
2. Determine the main idea of a text; recount the key details and explain how they support the main idea.	**2.** Determine the main idea of a text and explain how it is supported by key details; summarize the text.	**2.** Determine two or more main ideas of a text and explain how they are supported by key details; summarize the text.
3. Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect. Include texts by and about American Indians.	**3.** Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text. Include texts by and about Montana American Indians.	**3.** Explain the relationships or interactions between two or more individuals, events, ideas, or concepts in a historical, scientific, or technical text based on specific information in the text. Include texts by and about Montana American Indians.
	Craft and Structure	
4. Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a *grade 3 topic or subject area*.	**4.** Determine the meaning of general academic and domain-specific words or phrases in a text relevant to a *grade 4 topic or subject area*.	**4.** Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a *grade 5 topic or subject area*.
5. Use text features and search tools (e.g., key words, sidebars, hyperlinks) to locate information relevant to a given topic efficiently.	**5.** Describe the overall structure (e.g., chronology, comparison, cause/effect, problem/solution) of events, ideas, concepts, or information in a text or part of a text.	**5.** Compareandcontrasttheoverallstructure(e.g.,chronology, comparison, cause/effect, problem/solution) of events, ideas, concepts, or information in two or more texts.
6.Distinguishtheirownpointofviewfromthatoftheauthorofa text.	**6.** Compare and contrast a firsthand and secondhand account of the same event or topic including those of American Indians; describe the differences in focus and the information provided.	**6.** Analyze multiple accounts of the same event or topic, including those of historical and contemporary American Indian events and topics, noting important similarities and differences in the point of view they represent.
	Integration of Knowledge and Ideas	
7. Use information gained from illustrations (e.g., maps, photographs) and the words in a text to demonstrate understanding of the text (e.g., where, when, why, and how key events occur).	**7.** Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, time lines, animations, or interactive elements on Web pages) and explain how the information contributes to an understanding of the text in which it appears.	**7.** Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently.
8. Describe the logical connection between particular sentences and paragraphs in a text (e.g., comparison, cause/effect, first/second/third in a sequence).	**8.** Explain how an author uses reasons and evidence to support particular points in a text.	**8.** Explain how an author uses reasons and evidence to support particular points in a text, identifying which reasons and evidence support which point(s).
9. Compare and contrast the most important points and key details presented in two texts on the same topic.	**9.** Integrate information from two texts on the same topic in order to write or speak about the subject knowledgeably.	**9.** Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably.
	Range of Reading and Level of Text Complexity	
10. By the end of the year, read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the grades 2–3 text complexity band independently and proficiently.	**10.** By the end of year, read and comprehend informational texts, including history/social studies, science, and technical texts, in the grades 4–5 text complexity band proficiently, with scaffolding as needed at the high end of the range.	**10.** Bytheendoftheyear,readandcomprehendinformationaltexts, including history/social studies, science, and technical texts, at the high end of the grades 4–5 text complexity band independently and proficiently.

APPENDIX I

FRAMEWORK FOR K-12 SCIENCE EDUCATION SCIENCE AND ENGINEERING PRACTICES

SCIENCE AND ENGINEERING PRACTICES

1. Asking questions (for science) and defining problems (for engineering)

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 (for science) and designing solutions (for engineering)

7. Engaging in argument from evidence

8. Obtaining, evaluating, and communicating information

APPENDIX J

THIRD GRADE UNIT OUTLINE

Unit	Topic/Interdisciplinary Subject/Standards	Skills/Activities	Activity/Scientific Practices	Assessment
Life Cycles 2 weeks	How long does a bee live? **3-LS1-1 From Molecules to Organisms: Structures and Processes.** Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.	**Drawing Models (Bee, ant, butterfly, apple tree, lilac)** Students will be able to complete (scaffolded to ability) and label a model to make sense of life cycles.	**Activities:** -What is a Honeybee Brainstorming Sheet -Research by reading various provided resources. -Construct a model and label (drawing or 3D clay model) **PRACTICE: Developing and Using Models**	Model (Rubric) Notebook entries
Hive system/social structure 6 Weeks	People vs. Bees Social Studies Perspective: Do we need each other? Math: Honeycomb Shapes/Fraction of Bee Roles in a Hive/Area of a Hive Used for Varying Roles **Montana Common Core Writing**	**System models Arguments through evidence:** Student will be able to argue that a honey bee would not be able to survive without a social structure.	**Activities:** -Explore the structure of a hive as teacher sees fit -Hive Jive: Bee Jobs and Hive Family Structure **(Obtaining, Evaluating, and Communicating Information)** -Show unlabeled photos of regular bee eggs and to-be queen bee cells. Students construct an explanation of	Notebook entries Opinion Paragraph with supporting details

	Standards (W.3.) Text Types and Purposes W.3.1 1. Write opinion pieces on topics or texts, supporting a point of view with reasons. **W.3.1a a.** Introduce the topic or text they are writing about, state an opinion, and create an organizational structure that lists reasons. **W.3.1b b.** Provide reasons that support the opinion. **W.3.1c c.** Use linking words and phrases (e.g., because , therefore , since , for example) to connect opinion and reasons. W.3.1d d. Provide a concluding statement or section **3-LS2-1. Ecosystems: Interactions, Energy, and Dynamics.**	Student will be able to list supporting details based on scientific observation and reading.	which set of eggs may end up being the queen and identify characteristics to support their thinking. **(Constructing Explanations and Designing Solutions)** -Honey Bee Bop: Adapted Scholastic Resource Communicating in a Hive **(Obtaining, Evaluating, and Communicating Information)** -Construct a model of a hive with components of structure and function **(Developing and Using Models)** -Students will construct an argument with supporting details that declares whether or not bees would be able to survive without a hive. **(Engaging in Argument from Evidence)**	

	Construct an argument that some animals form groups that help members survive. **3-LS3-1 Heredity: Inheritance and Variation of Traits.** 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. (Queen, hive only) **3-LS4-2 Biological Evolution: Unity and Diversity.** Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding			

	mates, and reproducing.			
Government 2 Weeks	Bee Laws **Montana Common Core Reading Standards for Informational Text Key Ideas and Details** **1.** Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. **2.** Determine the main idea of a text; recount the key details and explain how they support the main idea. **3.** Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect.	**Reading Informational Text** From multiple sources, student will be able to highlight evidence of "Bee Laws" in informational text and discuss them in class.	-Read from multiple sources (vocabulary word = sources) and find evidence based on guiding questions. **(Obtain, Evaluate, and Communicate Information/Constructing Explanations)** Who's in charge? What rules balance a hive? -Place finding on class board of teacher's choice.	Informational Reading (student posts on board/note book)

	Include texts by and about American Indians. **Craft and Structure** **4.** Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 3 topic or subject area. **5.** Use text features and search tools (e.g., key words, sidebars, hyperlinks) to locate information relevant to a given topic efficiently. **6.** Distinguish their own point of view from that of the author of a text. Integration of Knowledge and Ideas **7.** Use information gained from illustrations (e.g., maps, photographs) and the words in a text to demonstrate understanding of the text (e.g.,			

	where, when, why, and how key events occur). **8.** Describe the logical connection between particular sentences and paragraphs in a text (e.g., comparison, cause/effect, first/second/third in a sequence). **9.** Compare and contrast the most important points and key details presented in two texts on the same topic. Range of Reading and Level of Text Complexity **10.** By the end of the year, read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the grades 2–3 text complexity band independently and proficiently. Describe the relationship between a series of historical			

	events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect. Include texts by and about American Indians.			
Heredity 1 Week	Compare traits of wasps, hornet, yellow jackets, bumble bee **Montana Common Core Writing Standards (W.3.) Research to Build and Present Knowledge** **W.3.7 7.** Conduct short research projects that build knowledge about a topic. Include sources by and about American Indians. **W.3.8 8.** Recall information from experiences or gather information from print and digital	**Compare/Contrast** Students will be able to distinguish between honey bees and wasps, hornets, yellow jackets, and bumble bees.	-"What's the Buzz on the Playground?" Research Series **(Obtain, Evaluate, and Communicate Information)**	Notebook Entry Venn Diagram

	sources; take brief notes on sources and sort evidence into provided categories. Include sources by and about American Indians. **3-LS3-1 Heredity: Inheritance and Variation of Traits.** 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. (similar organisms)			
Climate Regions 2 Weeks	Social Studies Connection (Climate Region Mapping of United States) Math: Graphing and Data Tables "Follow a bee hive"	**Climate Graphing Reading and Mapping** Student will be able to determine whether bees can survive in varying climate regions	-Social Studies series maps and regions **(Obtain, Evaluate, and Communicate Information)** -Create tables and graphs to communicate climatic regions and their characteristics **(Analyzing and**	Graph (math) Information al Reading Map

	3-LS3-2 Heredity: Inheritance and Variation of Traits. Use evidence to support the explanation that traits can be influenced by the environment. **3-LS4-1 Biological Evolution: Unity and Diversity.** Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago. (Optional Connection) **3-LS4-3 Biological Evolution: Unity and Diversity.** Construct an argument with evidence that in particular habitat some organisms can survive well, some less well, and some cannot survive well.	throughout the United States.	**Interpreting Data)** -Rosedale's Field Trip -Graph Rosedale's flower colors **(Analyzing and Interpreting Data)** -"Follow a Beehive" Where does a Livingston beehive go in the winter? Read newspaper article and reach out to local beekeepers	

	3-ESS2-1 Earth's Systems. Represent Data in tables and graphical displays to describe typical weather conditions expected during a particular season. **3-ESS2-2 Earth's Systems.** Obtain and combine information to describe climates in different regions of the world.			
Ecosystems 3 Weeks	Life cycles = (lilac, apple trees) Dandelions **3-LS4-4 Biological Evolution: Unity and Diversity.** Make a claim about the merit of a solution to a problem caused when the environment change and the types of plants and animals that live there may change. (Spraying for dandelions and moving bees	**Cause and Effect Notebooking** Students will be able to identify the importance of bees as pollinators in a system. Student will evaluate the efficacy of honey bees in comparison to other pollinators. Students will be able to communicate		Diagram/Model Flow Chart (science) Honey Bee 1st person narrative Notebook/graph

	to California for winter) **3-ESS2-1 Earth's Systems.** Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard. (build a model of a hive with wind protection OR draw a model of a design that would attract more bees to their own yard) **3-5-ETS-1 Engineering Design.** Defina a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. **3-5-ETS-2 Engineering Design.** Generate and compare multiple solutions to a problem based on how well each is likely to meet	the importance of pollinators to local crops and humans.		

	the criteria and constraints of the problem. Gardening Activity			

APPENDIX K

FOURTH GRADE UNIT OUTLINE

Topic	Skill/Learning Outcome	Standard	Activities/ Practices	Assessment	Notes

Climate (Temperature and Rainfall) "Amazing Places" Reading Unit is concurrent with this unit. See below. Timeline: 4 Weeks	Students will be able to create/use a table that organizes climate characteristics of regions including information from provided temperature and rainfall maps. Students will draw characteristics of a landscape when given the conditions of temperature and rainfall.	Earth's Systems ESS2-2. Analyze and interpret data from maps to describe patterns of Earth's systems.	**Analyze and Interpret Data/Obtaining, Evaluating, and Communicating Information** Provide a temperature map of North America. Provide a map of precipitation of North America. Create a table in science notebook of temperature and rainfall of North America identify commonalities. Have students create two maps (one rainfall	Layered Maps (2)* Completion of table or graph Compare/Contrast Identify patterns on map in writing (Informational) Students will digitally communicate an understanding of why climate zones happen. (Differentiation: Word document, PowerPoint with captions, Excel table)	Focus on Western Hemisphere **Cross Cutting Concepts** Patterns Cause and Effect Materials: Maps Tracing Paper/Transparencies Fossil Evidence Plate Tectonics Erosion/Weathering

		and one temperature). Layer maps: transparency, vellum on a blackline map. Differentiation: Teacher can copy provided map and layer them on a blackline of North America. Compare and contrast temperature and rainfall in biomes across North America. Discuss as a class. Draw in notebooks with evidence from informational texts (Amazing Places) and biome maps.	

Amazing Places	Reading Unit 3: "Amazing Places:" Students will identify evidence of places with varying characteristics of temperature and rainfall. Examples will be collected in a notebook.	ELA RI 4.7 Interpret information presented visually orally or quantitatively and explain how information contributes to an understanding of the text in which it appears. w. 4.8 Recall relevant information from experiences or gather relevant information from print and digital resources. Take notes, categrorize information and	Read for Evidence: Mark up text to identify characteristics climate regions in North America. (Photcopy pieces of book to allow for student markup) Compare three articles and create graphic organizer of information. Scientific LIteracy: Students work in small groups assigned by climate region, to collaboratively construct an explanatio	Rubric of Mark up text that shows multiple sources. Source is cited. Class presentation rubric (3 sources, clear explanations, etc.) Informational essay on specific climate region that cites 3 sources. NG: P.209 "Write Like a Researcher"

		provide a list of sources. 9. Integrate information from two texts on the same topic in order to write or speak about the subject knowledgeably.	n that communicates the climatic characteristics of a climate region by aggregating data from the table, readings, and maps.		
Local Landform Project (2 weeks)	Students will evaluate a local landform to determine its formation and future.	Technology / Media W4.8 ELA 4-ESS2-1.Earth's Systems: Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice wind, and	**Devloping and Using Models** -Topographical Maps (additional layer on past unit's map) -Toilet Paper Timeline (geological timeline) -Mud Mountain (water, wind and ice erosion) -Plate Tectonics/	Power Point (Rubric) Informational Text (Rubric)	Geological Features – (Scale / Map) – Clay or Topographical representations (painted) – create key for map Modeling Tectonics – graham crackers with icing "Squeezebox" Before Daily Lake

	vegetation.	Volanos (graham cracker activity or squeezebox) -Local Landform Project

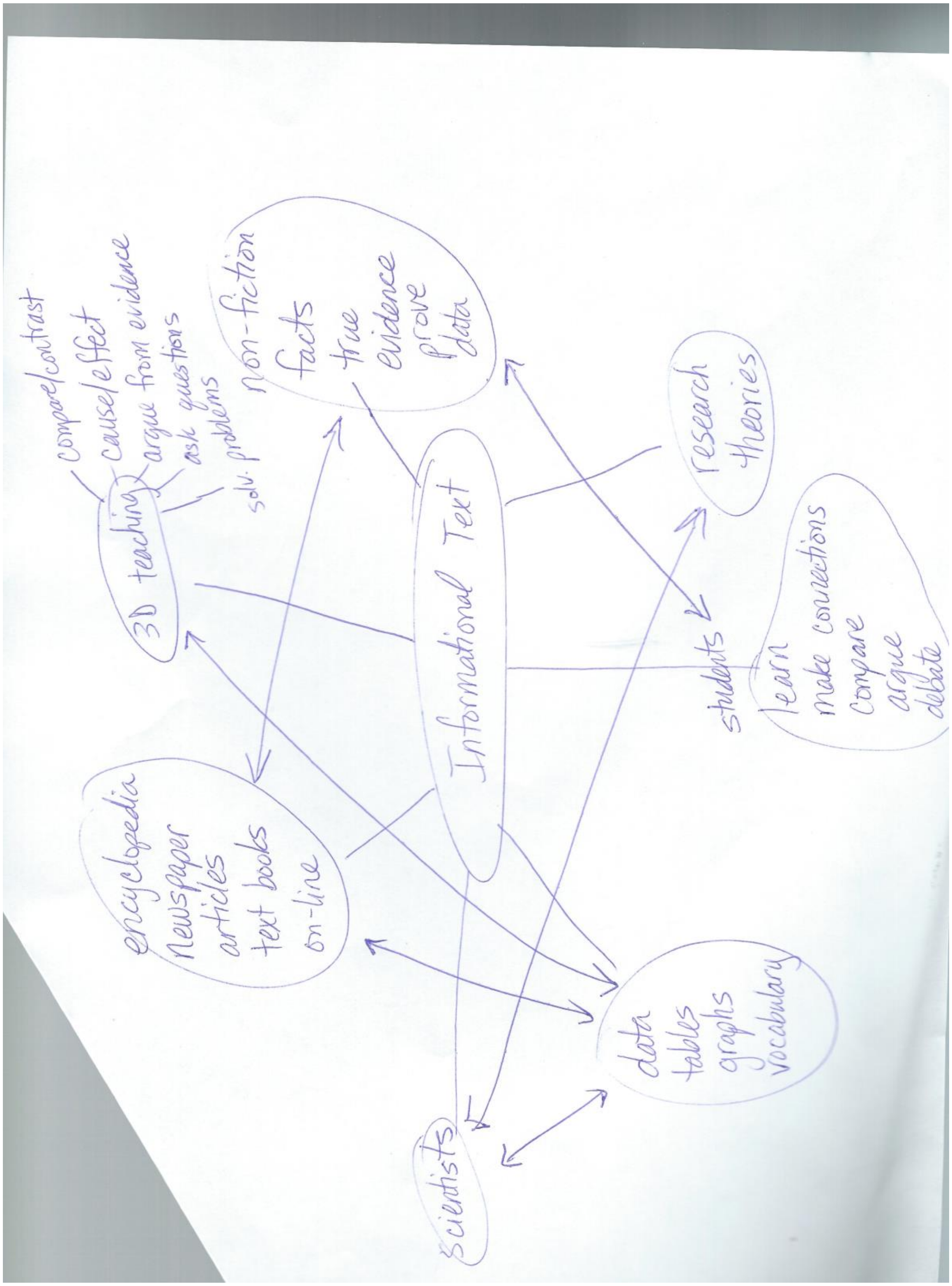
APPENDIX L

INFORMATIONAL TEXT RUBRIC

	1	2	3	4	5
Highlighting	All or none of the text is highlighted.	Very little or most of the text is highlighted without a connection to margin notes, questions, or evidence.	Various portions of the text are highlighted with few connections to margin notes, questions, or evidence.	Selected portions of the text are highlighted with moderate connections to margin notes, questions, or evidence.	Selected portions of the text are highlighted with obvious connections to margin notes, questions, or evidence.
Margin Thoughts	No margin thoughts are present.	Few margin thoughts are present or thoughts do not remain on topic.	Some margin thoughts are present and contain inferences or personal opinions.	Some margin thoughts are present and contain inferences as well as personal opinions.	Margin thoughts are present and contain inferences as well as personal opinions. Margin thoughts serve as a conversation between the text and student.
Questions	No questions are present.	Few questions are present or questions do not remain on topic.	Some questions are present and connect to the topic.	Questions are present and connect to the text and/or previous experience.	Questions are present and connect to the text and/or previous experience. Some questions extend the topic further than the text.
Context Clues	Student does not question context or use word replacement for vocabulary.	Student marks unknown vocabulary.	Student asks about meaning of vocabulary but does not dig any deeper.	Context clues are used for questions regarding vocabulary. Other resources may have been used.	Context clues are used for questions regarding vocabulary. Word replacement is used as a strategy for comprehension. Other resources may have been used.
Summaries	No summaries of text are included.	One summary of the text is included.	Student summaries include at least half of text content.	Student summaries are throughout text and include most main ideas.	Student summarizes text regularly and includes main ideas of text.
Evidence (Purpose identified in class.)	No evidence is identified.	One piece of evidence is highlighted or underlined only.	One piece of evidence is highlighted/underlined with notes in margin.	Two pieces of evidence are highlighted/underlined with notes in margin.	At least three pieces of evidence are highlighted/underlined with notes in margin.

APPENDIX M

POST TREATMENT CONCEPT MAP EXAMPLE


Informational Text
3D teaching
compare/contrast
cause/effect
argue from evidence
ask questions
solv. problems
non-fiction
facts
true
evidence
prove
data
research
theories
students
learn
make connections
compare
argue
debate
encyclopedia
newspaper
articles
text books
on-line
data
tables
graphs
vocabulary
Scientists

APPENDIX N

TEACHER INTERVIEW QUESTIONS

TEACHER INTERVIEW QUESTIONS

Experience was defined as the professional development in science and engineering practices, unit design, and unit implementation.

1. Did this experience affect student achievement in science? (If yes, what qualitative or quantitative evidence do you have of that?)
2. Did this experience affect student achievement in reading informational text? (If yes, what qualitative or quantitative evidence do you have of that?)
3. Did this experience affect student attitudes toward informational text? (If yes, what qualitative or quantitative evidence do you have of that?)
4. Did this experience affect student attitudes toward science? (If yes, what qualitative or quantitative evidence do you have of that?)
5. Did this experience affect your attitude toward informational text? (If yes, what qualitative or quantitative evidence do you have of that?)
6. Did this experience affect your attitude toward science? (If yes, what qualitative or quantitative evidence do you have of that?)
7. Did this experience affect your pedagogy in teaching informational text? (If yes, what qualitative or quantitative evidence do you have of that?)
8. Did this experience affect your pedagogy in teaching science? (If yes, what qualitative or quantitative evidence do you have of that?)
9. Did this experience affect your team in any way? (If yes, what qualitative or quantitative evidence do you have of that?)
10. How would you describe scientific literacy?

APPENDIX O

STUDENT INTERVIEW QUESTIONS

STUDENT INTERVIEW QUESTIONS

1. Have you grown in science this year? (If so, how?)
2. Have you grown in reading informational text this year? (If so, how?)
3. How have your feelings changed about science this year?
4. How have your feelings changed about informational text this year?
5. Was this year's science experience different than other years? (If so, how?)
6. Was this year's reading in informational text different than other years? (If so, how?)
7. How do you think your teacher feels about science?