

INCORPORATING LANGUAGE ARTS STRATEGIES IN THE SCIENCE
CLASSROOM TO IMPROVE STUDENT WRITING

by

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July 2014

DEDICATION

This great tome is dedicated to my parents. Thank you for all the support and patience, especially patience, you've given me as I made my way along my own personal Kamilche cutoff. I couldn't have attempted even half of what I've done without knowing that you were there behind me.

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ABSTRACT

The focus of my action research-based classroom project involved incorporating language arts writing strategies to help scaffold student writing in science with the goal of making writing easier for students in a variety of situations. Progress was tracked using practice tests for the Science Measurement of Student Progress (MSP), which utilized writing scenarios on a variety of topics. These tests had two main writing components, a conclusion and creating a procedure. Students completed a pretest and posttest using the same Powerful Classroom Assessment (PCA). In between these, students also completed another Powerful Classroom Assessment and a 2012 MSP Released Item. My 8th grade class was broken up into six subgroups by either special needs or scores on the 7th grade Writing MSP. In language arts class, students learned the PEEL process for paragraph writing that stands for Point, Evidence, Explanation, and Link. Students then employed this scaffold in classes across the curriculum, including science, throughout the year. Results showed improvement in student scores on the conclusion questions, especially for using data to support a claim. Student scores did improve to same extent with the procedure questions. The conclusion from the data is that using the PEEL paragraph writing process in multiple classes throughout the year improved students' ability to use evidence to explain a claim.

INTRODUCTION AND BACKGROUND

During the past six years I have taught eighth grade science at Tukes Valley Middle School (TVMS) in Battle Ground, Washington. Currently, TVMS serves approximately 500 students in grades five through eight. In 2013, almost 36% of our students qualified for free or reduce price lunches. Demographically, 85% of our students are identified as White, while 15% of students are identified in a minority category (OSPI, 2013). Our school also serves two groups that are not identified in traditional demographic categories. First, a portion of our students are from Russian and Ukrainian immigrant families, many of which speak their native language at home. Several of these students currently receive English language services or have progressed to a monitored status. The second group belong to the Apostolic Lutheran faith and make up a large portion of our school population. These families are generally traditional single income households with many children. Most of these families do not participate in organized school activities, such as sports and music. They also have little or no exposure to popular culture activities like television and movies. While not identified in standard demographics, both of these groups contribute to our school culture.

Currently, I teach 108 students in five 48 minute science class periods. Eight students are served for Special Education in various combinations of reading, written language, math and/or study skills. Four students have been identified as highly capable learners. Six students are identified as English Language learners; four of these students receive services while the other two have progressed to a monitored status. Home languages include Russian, Ukrainian, and Spanish. At TVMS, science is taught as an integrated program, covering physical, life, and Earth/space science every year.

Washington students are tested in the spring of each year, third through eighth grades, on various subjects using the Measurement of Student Progress (MSP). Science is tested only in fifth and eighth grades, writing in fourth and seventh grades, while math and reading are tested yearly. The eighth grade Science MSP assesses content taught in sixth through eighth grades. The MSP format includes a combination of multiple choice and short answer questions. In order to best prepare my students for the assessment, I have been searching for strategies to improve their test taking skills as well as improving their general scholastic abilities.

Scientific inquiry has increasingly been used in science classrooms to model the way science is conducted in the professional world. Due to the open-ended format of scientific inquiry, students practice their explanation and reasoning skills when describing inquiry results. The Science MSP utilizes this type of writing in short answer assessment questions. Good informational writing skills require the author to make a claim and support that claim with evidence. The new Common Core State Standards (CCSS) for English Language Arts (ELA) require that students in the eighth grade can write both argument and expository texts, complete with a position or topic, evidence, and reasoning. New ELA standards for reading informational text require that students identify evidence from text and make inferences from text as well. These new ELA standards are also very similar to the CCSS for writing and reading in science and technology. Students in the eighth grade should be able to write informative text and arguments based on science specific content, as well as identifying evidence in their reading. Continuity of writing styles across the curriculum should enable students to become adept with writing and reading informational material.

The focus of my action research-based classroom project involved incorporating writing strategies currently used in the ELA classroom to help scaffold student writing with the goal of making writing easier for students in a variety of situations. Progress was tracked using practice assessments for the Science MSP, which utilized writing scenarios on a variety of topics.

CONCEPTUAL FRAMEWORK

Scientific literacy helps people use science and technology in their everyday lives and create connections between science and other fields, as well as the connection between the history of science and scientific thought. Scientifically literate people are familiar with natural phenomena and understand how to question, test and communicate results, while using evidence to support their explanations. Promoting science literacy benefits students both in and outside of the classroom and also supports life-long science learning (Hand, Lawrence & Yore, 1999).

With the adoption of the Common Core State Standards (CCSS), the focus for English Language Arts has shifted to include more complex reading and writing within content areas to prepare students for either college or career after high school. According to the CCSS website (2014) the intention is to expose students to the types of reading and writing they will encounter in the working world. This shift will also help students in their discipline content classes as the skills of reading, writing and language become tools to understand the world around them (Cervetti & Pearson, 2012). The change also supports students as the language of courses becomes specialized.

The CCSS group vocabulary into three tiers. Tier one includes common, everyday words that are used in general conversation. Tier two vocabulary are high-

frequency words that are used across the curriculum. Tier three contains specialized, low-frequency words specific to a content area, like meiosis, phenotype, and heterozygous in genetics (Tyson, 2014).

High-level literacy skills are not necessarily taught in secondary classes where students encounter more complex texts, which may also be abstract or vague, expecting the reader to understand discipline related knowledge. Shanahan and Shanahan (2008) found that the basic literacy skills taught in early grades help with decoding and phonics, but as students advance to higher grades, the complexity and specialization of text also advances and this is not always being addressed in upper level content classes. Progress with early literacy skills cannot predict how students will develop the more complex and specialized skills needed for reading and writing in upper level science, math, history, and literature classes (Shanahan & Shanahan, 2008).

In the science classroom, literacy instruction can be used as a tool to enhance science, while science content can give meaning to student literacy (Cervetti & Pearson, 2012; Thier 2010). The 2012 Framework for K-12 Science Education identifies constructing explanations, designing solutions, and engaging in argument from evidence as practices for writing in science (Reiser, Berland & Kenyon, 2012). This has become the current format of claim, evidence, and reasoning used in science writing (McNeill & Krajcik, 2009). The claim answers the content question and hooks the reader with a preview of the reasoning (Grymonpre, Cohn & Solomon, 2012). Evidence supports the claim with related data, while reasoning explains how the data supports the claim and the pertinent scientific principles (McNeill & Krajcik, 2009). In this explanation students tie together cause and effect with reasoning and evidence to explain a phenomenon.

Students should also be able to question possible gaps or flaws in claims and arguments and, once these are identified, reevaluate and adjust their position (Reiser et al., 2012).

Unfortunately, students often have problems formulating claims and supporting them with evidence. They may also find it difficult to limit their evidence to data and observation, instead using generalization and inference to support claims (Grymonpre et al., 2012). Practice with creating explanations and arguments in the classroom increases students' ability to complete the process on their own and improves their reasoning skills (McNeill & Krajcik, 2009). Students also need strategies to help them identify applicable evidence and adequately explain how it supports a given claim. Additionally, students need to learn how to write in the formal science paper voice and develop skills for understanding quality research (Grymonpre et al., 2012; Wheatley, Dobbs, Willis, Magnan & Moeller, 2010). Teachers need to identify strategies that help students express more complex ideas about the content they are learning (Hohenshell & Hand, 2006).

Students can struggle with writing for a variety of reasons. Writing is complex and it can be difficult for students to focus on specific topics and effectively communicate details to an audience. Students may find it hard to express all of their thoughts on paper and may also write what they think their audience wants to hear (Culham, 2003). Using a writing format consistently across the curriculum can help students understand how writing functions in every content area (Grymonpre et al., 2012).

Four things that can help students improve their writing in any content area are having an authentic purpose, an audience, feedback, and clear performance expectations. Studies have found that utilizing authenticity can actually predict growth in literacy skills

and student writing improves when they are taught how to write for different purposes and how to use specific writing structures (Cervetti & Pearson, 2012; Shanahan & Shanahan, 2008). Having an authentic purpose for writing may help students appreciate and understand the writing process more than if they think they are only writing because it was assigned. Giving students an audience to write to is an important part of their learning process and emphasizes the importance of communicating their results (Tower, 2005). Writing for classmates and reading the writing of others helps students clarify their own knowledge of topics (Hand et al., 1999). It is important for students to receive feedback on both scientific content and writing mechanics in order to support their progress in both areas (Ellis, Taylor & Drury, 2007). Knowing performance expectations helps students take charge of their own learning since they know beforehand exactly what is required (Thier 2010). When students clearly understand the goals of their writing, their performance generally shows improvement (Ellis et al., 2007).

Research has identified how different content areas use reading and writing to meet their specific needs. For example, scientists tend to look for credibility and procedures, while historians pay attention to the author's perspective and source documents (Cervetti & Pearson, 2012). Science is a language that requires evidence to back up claims and logic, but also requires imagination. Logical thinking, arguments and skepticism combine to create the best explanations of natural phenomena. Even "science" is not one general field, but contains many specialized disciplines with their own procedures and expectations. Each field has specific vocabulary scientists routinely use in their writing and communication (Prain, 2006; Hand et al., 1999).

There is growing awareness of the connection between understanding discipline literacy needs and developing disciplinary knowledge. The Framework for K-12 Science Education (2012) notes that literacy activities make up large amounts of scientists and engineers' work (Cervetti & Pearson, 2012). Students need to be taught how professional scientists deal with the different literacy needs of various science disciplines (Shanahan & Shanahan, 2008). All scientists use questions and evidence, but discipline specific knowledge will guide students to the questions they need to ask and what is considered evidence for the various areas of science (McNeill & Krajcik, 2009).

Understanding science literacy requires scaffolding to connect science to students' daily experiences as well as the language they use (Prain, 2006). Scaffolds are tools that support students as they learn increasingly difficult material and can be used both for content specific writing and generically across the curriculum (McNeill & Krajcik, 2009). Growing evidence identifies the importance of using scaffolding to help students connect their new knowledge of science to their everyday experiences. It is important for them to create connections with new concepts using their own particular process for making meaning and building relationships with prior knowledge. Scaffolding can help students move beyond basic technical vocabulary and toward more richly diverse texts (Prain, 2006). Research supports students organizing their thoughts about content area knowledge through writing (Ende, 2012). Also, scaffolding prompts help students include the necessary evidence and reasoning to support scientific arguments and claims (Hohenshell & Hand, 2006). While scaffolding benefits students for writing in science, there is some discussion about what format that scaffolding should take.

There is no set standard for how science writing should be approached, but there are proponents for two main groups, those that believe in traditional writing styles and those that promote more diversified styles. Advocates of traditional science writing argue that understanding the customary writing of the scientific community will help students become more scientifically literate. They question whether diversified styles give students the proper background to understand how formal scientific writing genres work. Supporters of diversified writing argue that students should experience a range of writing styles using every day language to become scientifically literate (Prain, 2006). Diverse writing styles emphasize the writing process to help students improve writing skills. Examples of diverse writing done by scientists include emails, books, articles, and writing to inform or persuade. Each of these has a specific purpose and students need opportunities to work in these formats (Tower, 2005).

Arguments for using traditional formats in science are based on the premise that the best way for students to learn writing for science is to imitate the work of scientists. Students need to understand and practice writing styles that are expected by the scientific community, especially writing based on scientific explanations (Hand et al., 1999). Science writing includes specific language and organization which are not necessarily comparable to everyday language. Everyday language can be a place to start from but students need to know the meanings and correct usage of scientific vocabulary and concepts. Traditional science writing has developed over the centuries as science developed and has evolved certain grammar and formats to provide structure for scientific argument and reasoning. These formats not only include technical concepts and language but also interpretation, argumentation, habits of mind, and communication

(Prain, 2006). A writing formula, like a traditional lab report, can serve as a scaffold for struggling writers and be useful at times for all writers as a fallback plan when they are unsure about how to proceed (VanDeWeghe, 2008).

Diversified writing proponents contend students learn more when they write for authentic purposes and actual audiences. Authentic writing experiences can include brainstorming, predicting possible results, creating explanations and adjusting them to incorporate new evidence. Scientific writing actually includes more forms than the traditional lab report based on the scientific method format. Working scientists employ various types of formal and informal writing, as well as various literary devices like metaphors (Prain, 2006). Modern science is a community of specialists working collaboratively to solve problems and create explanations (McNeill & Krajcik, 2009). While the classroom environment is not exactly a professional scientific community, student interactions do parallel professionals in a number of ways, such as clarifying and modifying ideas, persuading others, justifying viewpoints, and communicating ideas to others (Prain, 2006). To write effectively, students need to understand there are many types and formats of writing depending on what they want to express and to whom they wish to communicate (Hand et al., 1999).

Scientific language mixes everyday language and specialized science vocabulary. Everyday language can help students with explanations of scientific concepts. The more meaning they can connect using different scenarios, the more they will understand about the science concept. Using writing as a tool helps students understand science concepts in and out of the classroom. Studies have found students felt that using their own language to make sense of what they were learning, as well as defending their positions,

helped them understand science concepts. Students also reported they felt more positive about these experiences than when completing more traditional writing assignments. As students are learning new science concepts, it is important for them to experience a variety of formats and situations so they can understand and integrate science ideas as their understanding of the nature of science and scientific inquiry increases. Research shows there are benefits to using different writing formats to help students understand and integrate scientific learning into their personal schema. This in turn helps students learn how to think scientifically. Increasing evidence shows gains in learning outcomes when students are given guidance and support structures for planning and revising their writing. Students also show gains in learning regarding scientific concepts when they need to use language to explain, justify, and examine their understanding through different writing tasks and for different purposes and audiences (Prain, 2006).

Scientists do not always write in traditional formats. Limiting students to only using these formats does not give them the complete picture of how scientists work. It is beneficial for students to use every day language while they develop science knowledge and vocabulary. Researchers feel that diversified writing activities should be added to classes to help enhance traditional science writing. To take advantage of the benefits of writing in science, students need to practice a variety of styles and write for a variety of reasons. Twenty-first century skills require that students have a well-rounded approach to knowledge instead of focusing solely on separate subjects. Writing is necessary for scientific literacy and working with different writing formats support students with diverse ways of expressing their thinking (Hand et al., 1999; Wheatley et al., 2010).

METHODOLOGY

My action research-based classroom project focused on improving my students' writing abilities while also familiarizing them with the general type of questions they would encounter on the eighth grade Measurement of Student Progress (MSP). This state assessment covers content from sixth, seventh, and eighth grade science in the general areas of inquiry, application, and systems. Possible subject matter includes Earth and space science, life science, and physical science. Portions of each content area are taught during each of the three years. The assessment is broken into two general types of questions, multiple choice and short answer essay.

I also wanted to incorporate strategies students were learning in their language arts class, as I was focusing on writing. In 8th grade writing for the Common Core State Standards (CCSS), students focus on argumentation and using evidence. The CCSS Writing Anchor #1 states that students will "Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence" (NGSS, 2013). Argumentation is one of the commonalities between the Next Generation Science Standards (NGSS) and the CCSS. The 2012 Framework for K-12 Science Education, the basis for NGSS, includes "Engaging in Argument from Evidence" as one of the science and engineering practices. Specifically, "The study of science and engineering should produce a sense of the process of argument necessary for advancing and defining a new idea or an explanation of a phenomenon and the norms for conducting such arguments" (NGSS, 2013). This format is similar to the MSP in that students are required to provide details and evidence to support claims. I worked with our writing teacher to understand how she coached students and used the mnemonic device PEEL to

help them formulate their writing. The letters stand for Point, Evidence, Explanation, and Link (back to the Point) (Orman, 2013). This format was incorporated into science writing to explain phenomena students observed in various labs and simulations. 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).

In order to track progress on treatment tests, I grouped one hundred of my students into subgroups based on special needs or seventh grade writing MSP test scores. Group HICAP contained students identified as Highly Capable ($n=4$). Group SPED was identified as needing special education services for reading, written language, and/or study skills ($n=7$). Group ELL included students identified as English Language Learners ($n=6$). One of these students had a home language of Spanish and five students had a home language of Russian/Ukrainian. Remaining students were grouped in three groups by seventh grade writing MSP scores. The rationale for using this method to create further subgroups was that writing MSP scores would reflect students' general writing abilities and the smaller groups were more apt to show possible change over the treatment. Group L4 scored at a level four (high score), which was 11-12 out of 12 points ($n=41$). Group L3 scored at a level three (passing score), which was 9-10 out of 12 points ($n=35$). The final group, Group L2, scored a level two (not passing) which was 7-8 out of 12 points ($n=7$). There were no level one scores, 0-6 out of 12 points, in this classes' writing MSP. Students without special status or writing MSP scores were not included in sample groups. The questions selected for this classroom-based action

research project utilized writing skill and I wanted to see if student writing abilities contributed to their writing in science.

Previously, writing in my science classes focused on the traditional scientific method and working with questions presented in our textbooks. The responsibility of preparing my classes for the 8th grade science MSP, which includes three years' worth of content, led me to explore different options to help my students better express what they know. The treatment included writing in both the traditional scientific method and the PEEL format throughout the school year (September through April). During the beginning of the year the classes reviewed the standard scientific method structure, which is used throughout science classes from fifth grade. This year students completed a new unit that broke the scientific method down to focus on the component parts, which were practiced separately. At the same time they were learning the PEEL process in writing class. As we worked through the scientific method connections were made whenever possible to the PEEL process, especially using evidence to support a claim such as scientific reasons supporting the hypothesis and conclusions supported by data. Successive labs throughout the year were structured according to the standard scientific method but emphasis was placed on those areas where students could employ PEEL, especially when writing conclusions.

A second change in writing practice was to modify lessons and assessments to include writing opportunities that would fit in with the PEEL process as much as possible. Activities and simulations included paragraph summations, which allowed students to explain the phenomena they observed. Assessments were modified to include questions that would lend themselves to the PEEL format. The important components of

PEEL paragraphs and argumentation writing, specifically using evidence to support a claim, were reviewed periodically throughout the year. Additionally, during this time students had completed two large argument papers and number of PEEL paragraphs in writing class.

Tests used to gather student performance data were a combination of 2012 MSP released questions and Powerful Classroom Assessments (PCA), which were created in a format similar to the MSP. Question format on the PCAs and released items differed slightly but both asked students to use information from a given experiment to create a conclusion or solve a problem, and then directed them to create a new experiment within given parameters. For every required component, questions were scored with either one point for correct or zero points for incorrect.

In September, students were given the PCA “What’s Your Angle” to gather pre-treatment data (Appendix B). This assessment consisted of two questions. The first was the conclusion type question where students were given an experiment and asked to write a conclusion to the following investigative question: “What is the effect of the angle at which light strikes a wooden block on the surface temperature of that block?” The conclusion was worth four points in total, one point for each required component. Students were expected to (1) answer the investigative question with a conclusive statement, then use data from the data table provided to identify the range of data with (2) high data and (3) low data. Finally, students must write (4) an explanatory sentence that connects the supporting data to the conclusive statement. In the second question, students were asked to create an experiment for the investigative question “How does the angle at which sunlight strikes the Earth affect the length of shadows cast on the

ground?” This question contained nine required components for a possible nine points: hypothesis including a scientific reason, materials, and procedure (logical steps for the investigation, controlled, manipulated, and responding variables, recording measurements, and repeated trials). Questions were scored using the scoring rubrics established for this test by the Washington Office of Superintendent of Public Instruction (OSPI) (Appendix C). Since test questions were scored with either one or zero, data was compared for analysis using the mean. The data sets were quantitative ratio variables and contained no outliers.

In January students took the PCA “In the Doghouse”. This test had the same format and contained the same components as “What’s Your Angle.” Students wrote a conclusion for the question “How does insulating the walls and ceiling of a doghouse model with different materials (none, foam, and cardboard) affect the inside temperature of the doghouse model?” The new experiment was set up to answer the investigative question “How does the size of an insulated doghouse model affect the inside temperature of the doghouse model?” Like the previous test, this was scored using the OSPI scoring rubric and the mean was used to compare data for analysis.

Beginning with “In the Doghouse” and after each successive test, students completed an Inquiry Interest Survey tailored to each test (Appendix D). Questions surveyed ability and/or confidence writing a detailed conclusion to an experiment (conclusion, data, and explanation) and writing the components of a standard inquiry lab report (hypothesis, materials, procedure, and measurement). The survey used a Likert scale to rate student responses. Likert scale categories were *I don’t know how to do this/not confident* (1); *I’m not sure/not very confident* (2); *OK, I can give this a try/unsure*

(3); *I think I can do this/confident* (4); and *I know I can do this/very confident* (5).

Median values were calculated for each question within the groups because the qualitative data was both categorical and ordinal.

In February students completed the 2012 Released Item “Hot Lamp” (Appendix E). For this test students did not write a conclusion for the sample investigation, “What is the effect of different lid colors on the air temperature inside a glass jar exposed to a lamp?” Instead they applied the results of this experiment to describe the best paint color for a doghouse. Students were expected to choose a paint color from a list and describe how that color would affect the inside of the doghouse. Results from the sample experiment were used to support their choice. This question was worth three points and, like the PCAs, students could earn one point for each required component: making a conclusion, using experimental data, and explaining how data supports the conclusion. The second question concerned planning a new investigation for “What is the effect of different amounts of water in a jar on the time for the water to reach 50° C?” Each required component for this section was worth one point for a total of six points. The components included: controlled, manipulated, and responding variables, recording measurements, repeated trials, and logical steps. Again, this test was scored using an OSPI scoring rubric and the mean was used to compare data for analysis (Appendix F). The Inquiry Interest Survey for Hot Lamp was tailored to fit the two test questions and scored accordingly.

In April students completed the “What’s Your Angle?” PCA as a post-treatment test. This test was scored using the same rubric as the pre-treatment test and students also completed the Inquiry Interest Survey for What’s Your Angle along with interview

questions about their feelings regarding the PEEL writing process, how they'd used it across the curriculum throughout the year, and how it applied to their writing in science (Appendix G). Data sources are summarized in Table 1.

Table 1
Data Source Table

Focus Question	Data Source 1	Data Source 2	Data Source 3	Data Source 4	Data Source 5
<i>Primary Question:</i> 1. Will incorporating ELA writing strategies in science writing increase student ability and confidence on practice science assessments?	Pre-treatment test to establish benchmark scores.	Student surveys to determine student confidence completing test questions.	Periodic tests during treatment.	Post-treatment test.	Student interviews after completing the post-treatment test.

DATA AND ANALYSIS

As an entire group, the 8th grade class increased total test scores across the treatment ($N=100$). The total score, including both conclusion and procedure sections, increased from 36% to 56% correct answers from the “What is Your Angle?” pretest to the posttest. The conclusion section showed the greatest increase, from 26% to 58% correct answers between pretest and posttest, while the procedure section rose from 40% to 55% correct answers. The third test, “Hot Lamp”, showed the greatest increase in the conclusion section, 51% higher than the pretest and 18% higher than the next largest

score, the posttest (Figure 1). This test was the only Measurement of Student Progress (MSP) released item format.

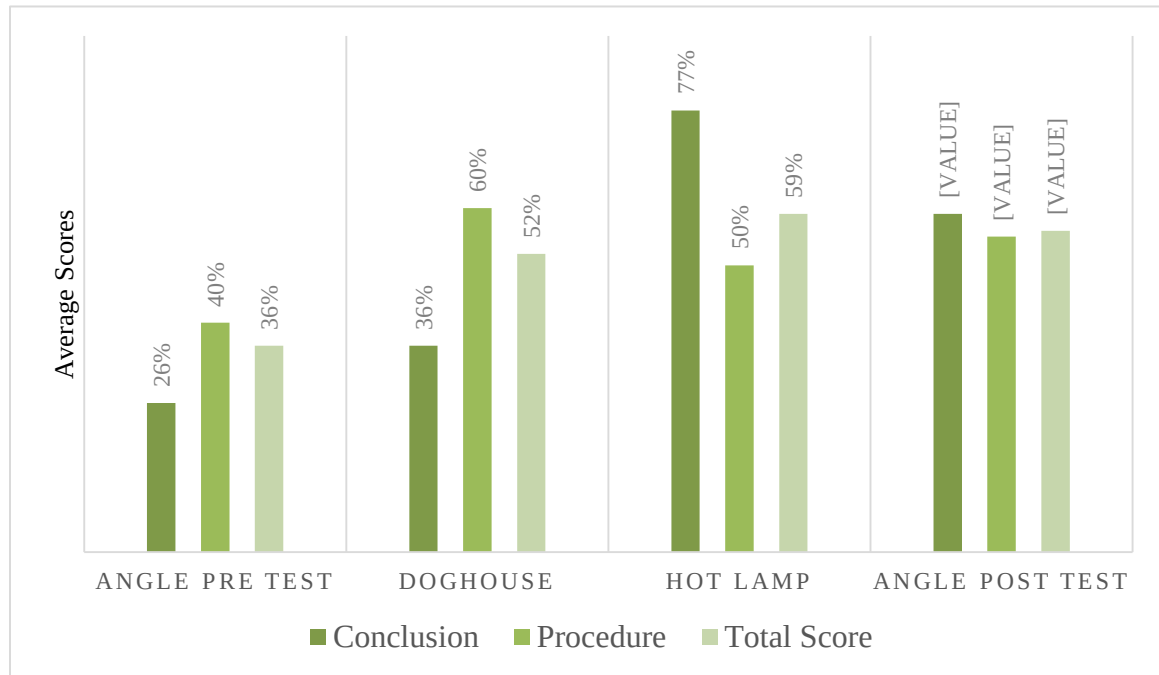


Figure 1. 8th Grade Test Results, (N=100).

In the conclusion section, all student groups except the highly capable (HICAP) group scored higher on “What’s Your Angle?” posttest than they had scored on the pretest (Figure 2). The HICAP group total score for the posttest was 12% lower than the pretest score, with the explanatory language section decreasing from 75% to 0% for the posttest.

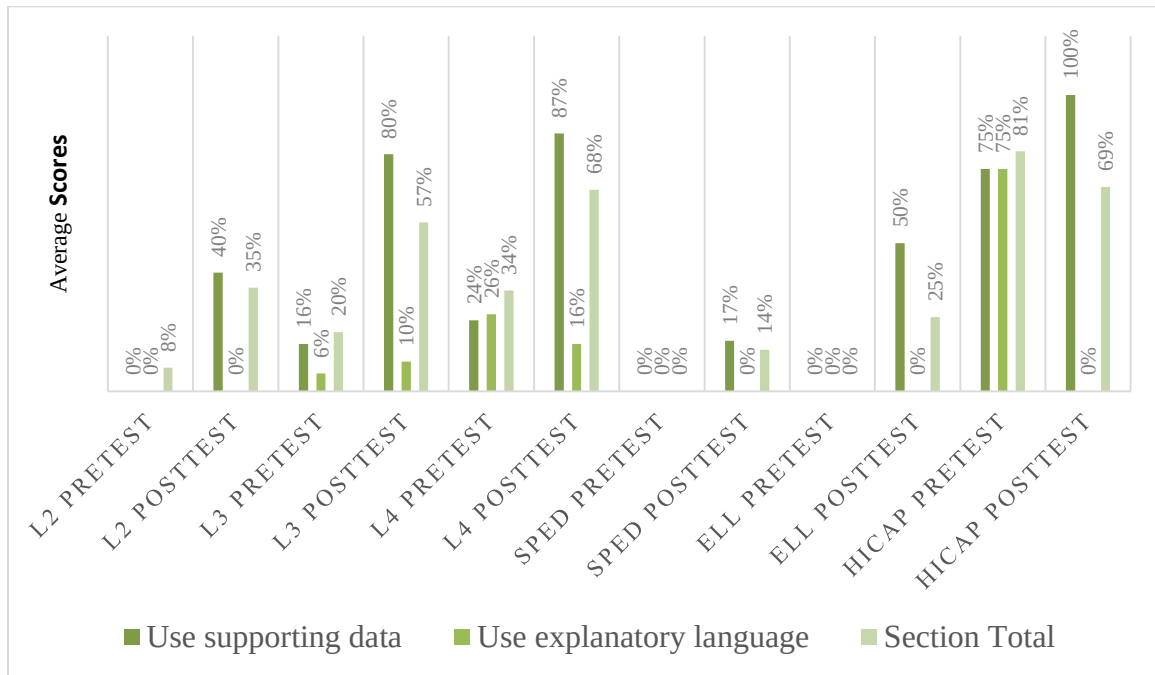


Figure 2. Pretest and Posttest Scores by Subgroup, (N=100).

L2 = Not passing 7th grade Writing MSP (7-8 out of 12 points) (n=7)

L3 = Passing score 7th grade Writing MSP (9-10 out of 12 points) (n=35)

L4 = High score 7th grade Writing MSP (11-12 out of 12 points) (n=41)

SPED = Receiving special education services in reading, written language, and/or study skills (n=7)

ELL = Identified as English Language Learners (n=6)

HICAP = Identified as Highly Capable (n=4)

The highest increase in all groups was in the category of using supporting data.

Three groups, students receiving special education services (SPED), English Language Learners (ELL), and students not passing the 7th grade Writing MSP (L2), all scored 0% on the supporting data pretest questions. The ELL group increased 50% at the posttest, while L2 increased 40% and SPED increased 17%. The greatest increase in supporting data scores belonged to the group of students that achieved passing scores on the 7th grade Writing MSP (L3), increasing from 16% to 80%.

The following two figures are a sample test from a student in the high score group from the 7th grade Writing MSP (L4). On the pretest, the student attempted to write a

conclusion but did not include supporting evidence from the experiment (Figure 3). On the posttest, the student included a conclusive statement and specific data from the experiment to support that conclusion (Figure 4). While the student did use an explanation to link the evidence back to the conclusive statement, the scoring rubric required that the explanation contain numerical data to be awarded a point.

What's Your Angle?, a Middle School Powerful Classroom Assessment (PCA)

4 Write a conclusion for this investigation.

In your conclusion, be sure to:

- Answer the investigative question.
- Include **supporting** data from the Angle Light Strikes Block vs. Block's Surface Temperature table.
- Explain how these data **support** your conclusion.

Question: What is the effect of the angle at which light strikes a wooden block on the surface temperature of that block?

First off, the effect of the angle at which light strikes a wooden block on the surface temperature of that block, is that when Amy and Chris do the experiment; after each time they measure (or record) they tilt the block a degree higher so it effects the light on the "earth" or the wooden block.

Figure 3. Student Pretest, High Score 7th Grade Writing MSP Group (L4).

What's Your Angle?, a Middle School Powerful Classroom Assessment (PCA)

4 Write a conclusion for this investigation.

In your conclusion, be sure to:

- Answer the investigative question.
- Include **supporting** data from the Angle Light Strikes Block vs. Block's Surface Temperature table.
- Explain how these data **support** your conclusion.

Question: What is the effect of the angle at which light strikes a wooden block
on the surface temperature of that block?
The effect of the angle at which light strikes a wooden block on the surface temperature of that block is the greater the angle, the higher the temperature will be. This is true, because at 15°, the temperature (average) was 36° after 5 minutes with the light on. However 30° the average temperature was 41°. 60° angle on average (after 5 minutes in light) was 46°. Last (the greatest angle) the 90° angle (after 5 minutes in the light was on average 56°. This data supports my conclusion because the angle effected the surface temperature of the block.

Figure 4. Student Posttest, High Score 7th Grade Writing MSP Group (L4).

Figure 5 is a pretest from a student receiving special education services in reading, written language, and/or study skills (SPED). On the pretest (Figure 5), this student only attempted a single sentence answer which did not address the temperature change of the wooden block. In the posttest (Figure 6), this student restated the question and then provided evidence regarding the temperature change of the block. While this student's answer only met one of three points required by the rubric, this answer includes much more information than the pretest answer.

What's Your Angle?, a Middle School Powerful Classroom Assessment (PCA)

4 Write a conclusion for this investigation.

In your conclusion, be sure to:

- Answer the investigative question.
- Include **supporting** data from the Angle Light Strikes Block vs. Block's Surface Temperature table.
- Explain how these data **support** your conclusion.

Question: What is the effect of the angle at which light strikes a wooden block
on the surface temperature of that block? It hits the
block at 15°

Figure 5. Student Pretest, Student Receiving Special Education Services in Reading, Written Language, and/or Study Skills Group (SPED).

What's Your Angle?, a Middle School Powerful Classroom Assessment (PCA)

4 Write a conclusion for this investigation.

In your conclusion, be sure to:

- Answer the investigative question.
- Include **supporting** data from the Angle Light Strikes Block vs. Block's Surface Temperature table.
- Explain how these data **support** your conclusion.

Question: What is the effect of the angle at which light strikes a wooden block on the surface temperature of that block? The effect at the angle at which light strikes a wooden block on the surface temperature of the block will partially cover the back of the paper. Then after about 2.5 min the degrees go up to 31 and then at 5 min it goes to 36 Degrees. Then at the end when the angle of the light is at 90° the starting with starts at 28 then at 2.5 min it will be at 46 then at 5 min 56 Degrees which is the highest.

Figure 6. Student Posttest, Student Receiving Special Education s Services in Reading, Written Language, and/or Study Skills Group (SPED).

Scores for use of explanatory language rose slightly on the Powerful Classroom Assessments (PCAs) from pretest to posttest for L3 (4%) (Figure 7). This score remained

at 0% for the L2, ELL, and SPED groups, while it decreased from 75% to 0% for the HICAP group and from 26% to 16% for the L4 group. Use of explanatory language scores for the 2012 MSP Released question, Hot Lamp, showed higher scores than either pretest or posttest. Scores for this section were 57% (L2), 91% (L3), 83% (L4), 80% (SPED), 100% (ELL) and 75% (HICAP). Out of all the subgroups, this score was only equal to the pretest score for the HICAP group.

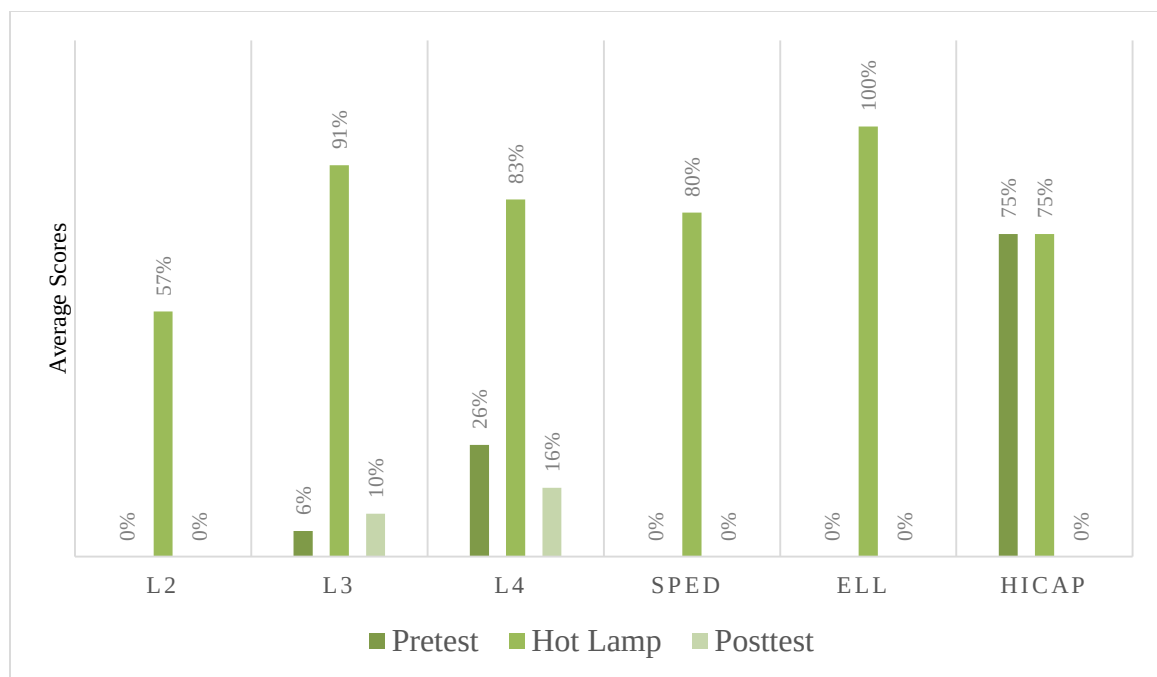


Figure 7. Comparison of Explanatory Language Scores, (N=100).

L2 = Not passing 7th grade Writing MSP (7-8 out of 12 points) (n=7)

L3 = Passing score 7th grade Writing MSP (9-10 out of 12 points) (n=35)

L4 = High score 7th grade Writing MSP (11-12 out of 12 points) (n=41)

SPED = Receiving special education services in reading, written language, and/or study skills (n=7)

ELL = Identified as English Language Learners (n=6)

HICAP = Identified as Highly Capable (n=4)

When asked to rate their confidence writing portions of the conclusion and procedure sections of the tests, the median rating across the treatment for five of the six groups were rated between *OK/unsure* (3) to *confident* (4). The SPED group had a

median of *not very confident* (2) to almost *unsure* (3). Likert scale categories were *I don't know how to do this/not confident* (1); *I'm not sure/not very confident* (2); *OK, I can give this a try/unsure* (3); *I think I can do this/confident* (4); and *I know I can do this/very confident* (5).

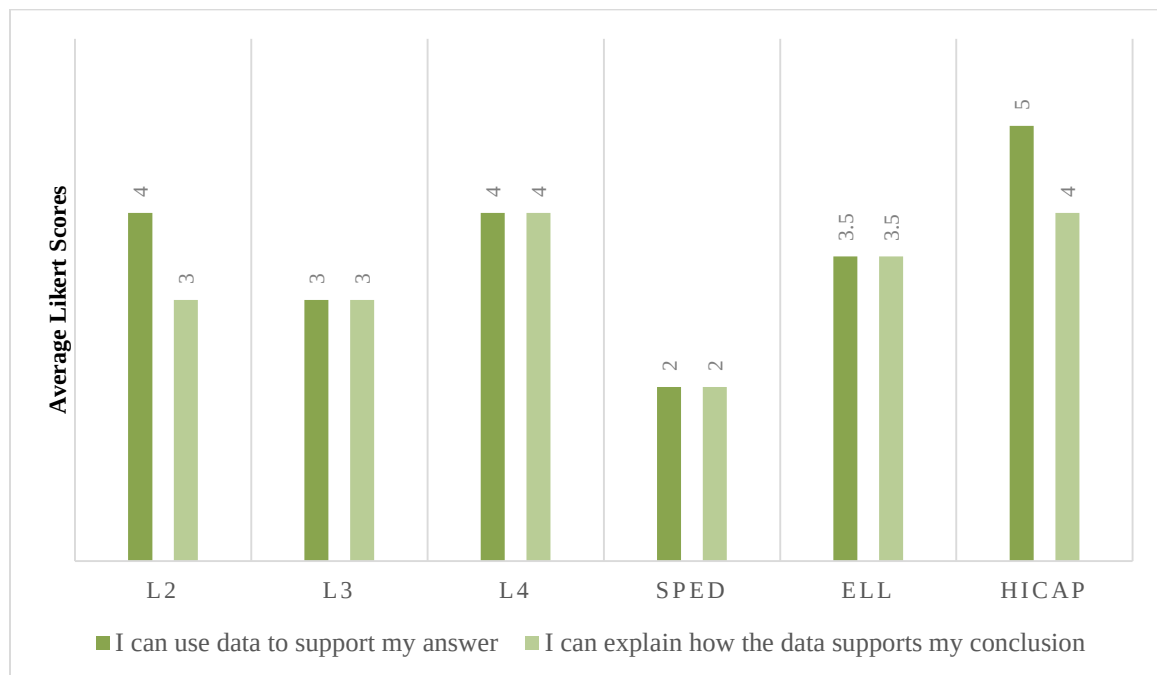


Figure 8. Median Confidence Scores for “What’s Your Angle?” Posttest, (N=100).

L2 = Not passing 7th grade Writing MSP (7-8 out of 12 points) (n=7)

L3 = Passing score 7th grade Writing MSP (9-10 out of 12 points) (n=35)

L4 = High score 7th grade Writing MSP (11-12 out of 12 points) (n=41)

SPED = Receiving special education services in reading, written language, and/or study skills (n=7)

ELL = Identified as English Language Learners (n=6)

HICAP = Identified as Highly Capable (n=4)

Out of the students who voluntarily participated in the post treatment survey, 76% found the Point, Evidence, Explanation, and Link (PEEL) paragraph writing process helpful and 91% had used the process in a class outside of writing (N=45). When asked if the PEEL process had helped in writing class, positive student responses included,

“Yes because when you forget what the format is supposed to be you can go to PEEL” (L4); “Yes because it have (sic) given me structure” (L3); “Yes, I think it was. I think it did because how my grades have been changing when I write a (sic) essay” (SPED); “Yes, a little bit. It helped me by showing me the steps to write” (ELL). On the other hand, comments from students who did not have such a positive experience included “No, because I don’t understand it really well. It just messes me up” (L3) and “No. It gives structure but I do not do well with that format” (HICAP).

When asked if the PEEL process works for writing in science, 64% of students responded positively and 18% of student felt that it was useful “sometimes.” When asked if they thought that the PEEL process works for the writing used in science, positive comments included “Yes, because with your conclusion you have to back it up with evidence” (L3) and “Yeah because it covers everything” (L3). Some students felt that this was not the best format for all science writing: “Not that much it is sort of unneeded. Because (sic) most of the big paragraphs we write are procedures and they have an order” (L3); “I think it somewhat helps, but I also think science has a different way of doing it, so yes, I guess” (L4); “It does and it doesn’t like for the procedure it doesn’t help at all but for the conclusion definitely” (L4); and “Yes but I do not like using it. Another format would be better for science” (HICAP). Some students didn’t feel that the PEEL process helped them with science writing, for example “No, because you don’t really have evidence so you can’t really explain” (L3) and “I don’t know because, sometimes I don’t get what to write and I look at the question a million times” (SPED).

INTERPRETATION AND CONCLUSION

The results of this classroom-based action research project showed some positive results and identified a number of areas that need additional focus. Student scores showed improvement for conclusion questions, specifically providing evidence to support a claim. However, students still need guidance and practice explaining exactly how their evidence supports the claim. The research says that this is a difficult skill for students. The next step will be introducing scaffolding and practice to help with this process, especially explaining how scientific principles add support to the claim. The project results showed that using similar scaffolding across the curriculum helped student writing improve.

Similar successes were not seen with the procedure questions, which led to the conclusion that the writing style for procedures does not benefit from this same practice. These results are in line with the portion of the literature that contends science writing has specific qualities not found in more generalized writing formats. In hindsight, it may have been more informative to compare student progress between the writing supported across the curriculum versus more focus on the traditional lab format taught exclusively in science class.

The most surprising results were the great difference in conclusion scores between the PCAs and the released item. From the perspective of the question content, both tests were similar in that they required students to use data to explain their conclusion. However, as shown in Figure 4, student explanatory scores for the released item (Hot Lamp) were far greater than similar questions on the PCA (What's Your Angle?). Students were interviewed and samples of responses are included in Table 2

(Appendix H). In general students felt that the question from the released item test was easier to understand and explained more precisely what was expected for the answer. They felt that the question alone in the PCA was difficult to understand and were unsure what to include in their answer. This difference in test questions was a surprising but important result of this action research project. After analyzing the Science MSP scores in the fall and comparing them to practice test scores, I will be able to see how I might adjust practice tests to both prepare students for format and help them feel successful about their writing abilities.

Table 2
Sample Student Responses on Question Difficulty

In your opinion, how are these questions different? (Pink packet = PCA, yellow packet = released item)	Why do you think students may have scored better on the released item conclusion?
The questions are different because the pink packet question was far more wordy (sic) and a little confusing, while the yellow packet is straight forward and not confusing at all.	I think students may have scored better on the yellow test because of its simplicity and the style of question and its data on the previous pages.
The yellow one seems easier because it's simpler because they pretty much give you the answer all you have to do is explain. The pink one is more complex. You have to think harder.	I think students scored better on the yellow sheet because it's not as hard.
The question on the yellow test is a broad question with a couple words and is more simple (sic). The pink one is big and drawn out and longer and it isn't as simple.	Because the question is really simple and easier.
Pink: harder question; not to the point; have to read it a few times Yellow: simple; goes to the question; easier to understand	People probably scored better on the yellow sheet because they question is straight to the point and more simple (sic).
In my opinion, they aren't any different. But, if I was to guess, I would say that the yellow packet's question is more simple (sic) than the pink packet's question so the students find it easier. The pink question is bigger, more complicated and you have to think harder about what to write.	

VALUE

The results from this classroom based action research project have shown that some writing skills can be utilized across the curriculum. I think that this wider use of writing skills benefited my students because they learned a life skill, not just a skill used in school. While a lot of student work happened in other core classrooms, it supported the idea that writing skills do need to develop over time with multiple opportunities for practice. As we begin to implement Common Core Standards for English Language Arts, reading and writing skills will need to be prevalent across multiple subjects. It is good to know that students will progress with these skills when the scaffold is utilized throughout their core classes. These research results benefitted my teaching team because they highlight the advantage of having a separate writing class. Students can learn the skills they need in writing and then practice them in other classes like science and history. Participating in this action research process has helped jump start my appreciation of what will be required to implement and integrate these skills into my current science content.

Implementing this project and analyzing the results has caused me to parse apart the writing skills that my students will need in science and single out the individual components of writing tasks. It also showed me the different writing skills that are required when you dissect a traditional lab report and how these skills differ from those needed for more descriptive writing using evidence. This will change my teaching in that I will need to include more opportunities for students to read, analyze, and write about science content. I will need to find more science content expressed as non-fiction writing that will allow students to work in this new format required by the Common Core for

English Language Arts. Another reality of writing is the amount of time required for practicing new skills and providing constructive feedback, then making sure that students have a chance to implement that feedback into their practice. In order to achieve this effectively for over one hundred students, most like approaching one hundred fifty next year, I will need to change my teaching to include peer review and editing. This seems to be one of the ways to help students improve their writing while also getting feedback to them in a timely and effective manner. Additionally, I will need to work with my grade level team to create activities that can be shared across the curriculum. Sharing activities would lessen the workload for both teachers and students.

The analysis of results have also led me to plan how to help the lowest performing groups, special education students and English language learners, be successful in writing for science. At this time these students receive support in reading and writing, either in their literacy classrooms or with an additional specialized class. These same supports are not available during science class, where both reading and writing can be demanding even for students without additional challenges. In order to achieve this end, I will need to come up with a way to differentiate assignments and instruction for these students so that they can feel successful in science. The format of science textbooks alone can be challenging for middle school students, let alone students that face additional difficulty with the material. I need to work with the reading and writing teachers on my team for strategies to help these students work through the challenges of the language in order to understand the science concepts. Reading and writing scaffolds are even more important for these students and it is helpful to know what skills they can build on in multiple classes.

Exploring the literature available on writing in science was very enlightening. What stood out for me the most was the idea that the literacy skills needed in middle and high school are not necessarily the same as those student learned in primary school. Upper level science can be very focused on the large amount of content to be taught during a school year. Teaching the more complex reading skills, in addition to the writing skills I have identified through this project, will be a new challenge. Through this research project I learned that I will need to become more of a reading and writing teacher, as well as a science teacher, to be effective for my students. The new requirements of the Common Core for English Language Arts reach out from the language classrooms and call for more from science teachers than just traditional content. Although my actual certificate and training is K-8, I have always been more focused on teaching science and math. Now I will need to revisit and relearn skills for teaching reading and writing. I have always felt uncomfortable teaching writing, mostly due to teaching and correcting student voice, which I view as personal to the writer. However, the emphasis on non-fiction reading and writing relies on claims, evidence, and explanation more than voice. The next steps in this process will be to study literacy techniques, as well as finding and/or adapting non-fiction articles related to my content for students to work with in class. Also, I need to find and implement cooperative learning strategies to help students become peer editors and support each other during the writing process. At this time this seems to be one of the best ways to ensure work is evaluated in a timely manner. Also, the literature and anecdotal evidence point to students producing better work when writing for peers. Cooperative learning strategies may also help my special education and English language learners with both science

content and literacy. Although I am more comfortable teaching science concepts than pursuing language arts skills, this research project has shown me the benefits and necessity of introducing more language skills into my science classroom.

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APPENDICES

APPENDIX A

CONCLUSION AND PROCEDURE QUESTIONS

WHAT'S YOUR ANGLE?, A MIDDLE SCHOOL POWERFUL CLASSROOM
ASSESSMENT (PCA).



INSTITUTIONAL REVIEW BOARD

For the Protection of Human Subjects

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MEMORANDUM

TO: Christine Jones and John Graves

FROM: Mark Quinn, Chair *Mark Quinn CJ*

DATE: December 3, 2012

RE: *"Using Science Inquire Teaching Strategies will Increase Student Ability and Comfort Addressing Inquiry and Design Application Questions on Model Assessments Based on Washington State Science Measurement of Student Progress"* [CJ120312-EX]

The above research, described in your submission of December 3, 2012, 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.

APPENDIX B

CONCLUSION AND PROCEDURE QUESTIONS

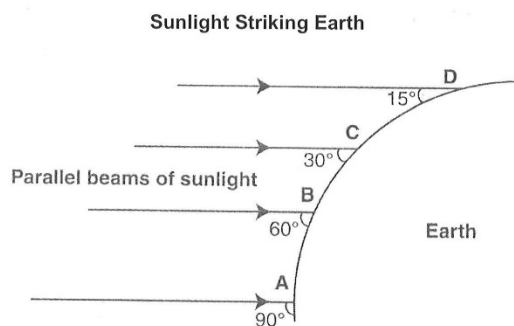
WHAT'S YOUR ANGLE?, A MIDDLE SCHOOL POWERFUL CLASSROOM
ASSESSMENT (PCA).

What's Your Angle?, a Middle School Powerful Classroom Assessment (PCA)

What's Your Angle?

Directions: Use the following information to answer questions 1 through 10 on pages 4 through 11.

Sunlight strikes Earth at different angles due to the shape of Earth, as shown below.



Two students, Amy and Chris, wanted to know if the shape of Earth affects surface temperatures on Earth. They investigated this phenomenon with a model of the Earth-Sun system as described in the Earth-Sun Model.

Question: What is the effect of the angle at which light strikes a wooden block on the surface temperature of that block?

Hypothesis (prediction): As the angle that the light strikes the block increases to 90° , the block's surface temperature will increase because the light will strike the block more directly.

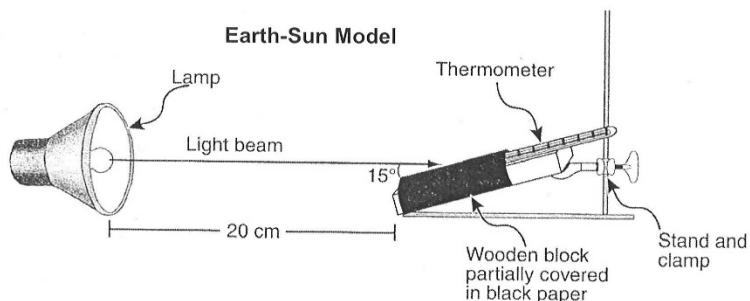
Materials:

wooden block
 thermometer
 black paper
 lamp
 protractor
 meter stick
 stand and clamp
 timer



What's Your Angle?, a Middle School Powerful Classroom Assessment (PCA)

Investigation Setup



Procedure:

1. Lay the thermometer on the wooden block.
2. Cover the lower end of the thermometer with black paper and attach the paper to the wooden block.
3. Tilt the block so the light beams will strike at a 15° angle as shown in the Investigation Setup diagram.
4. Record the starting temperature of the block's surface.
5. Turn on the lamp. Record the temperature after 2.5 minutes and again after 5 minutes.
6. Turn off the lamp and wait 10 minutes for the thermometer to return to room temperature.
7. Repeat steps 3 through 6 using 30° , 60° , and 90° angles. Keep the lamp at the same distance from the wooden block for each condition.
8. Repeat steps 1 through 7 two more times as trials 2 and 3.

Data:

Angle Light Strikes Block vs. Block's Surface Temperature

Angle Light Strikes Block (degrees)	Block's Surface Temperature (degrees Celsius)		
	Starting	2.5 minutes	5 minutes
15	26	31	36
30	27	35	41
60	28	38	46
90	28	46	56

Note: Temperatures are the averages of the three trials.



What's Your Angle?, a Middle School Powerful Classroom Assessment (PCA)**4** Write a conclusion for this investigation.

In your conclusion, be sure to:

- Answer the investigative question.
- Include **supporting** data from the Angle Light Strikes Block vs. Block's Surface Temperature table.
- Explain how these data **support** your conclusion.

Question: What is the effect of the angle at which light strikes a wooden block on the surface temperature of that block?



What's Your Angle?, a Middle School Powerful Classroom Assessment (PCA)

10 Plan a new investigation to answer the new question printed in the box.

In your plan, be sure to include:

- Hypothesis (prediction)
- Materials
- Procedure that includes:
 - logical steps to do the investigation
 - one controlled (kept the same) variable
 - one manipulated (changed) variable
 - one responding (dependent) variable
 - how often measurements should be taken and recorded

Question: How does the angle at which sunlight strikes Earth affect the length of
shadows cast on the ground?
Hypothesis (prediction):
Materials:
Procedure: You may use this space for a labeled diagram to support your procedure.



What's Your Angle?, a Middle School Powerful Classroom Assessment (PCA)

Procedure (continued):

APPENDIX C

SCORING RUBRIC

WHAT'S YOUR ANGLE?, A MIDDLE SCHOOL POWERFUL CLASSROOM

ASSESSMENT (PCA)

What's Your Angle? PCA Scenario Map, Results, and Scoring Rubrics

Scoring Rubric and Results for Item 4: Write a Conclusion (continued)

Attributes of a Conclusion for Awarding Value Points		
Note: The italicized print is the part of the "Example" credited for the value point		
Performance Description	Value Points	Typical Results
Conclusive statement correctly answers the investigative question (or correctly states whether the hypothesis/prediction was correct); <i>The larger the angle of light striking the block the higher the temperature of the block.</i> Attribute Notes: 1. A vague conclusive statement (e.g. <i>the angle of light did affect the temperature</i>) cannot be credited, but other value points can be credited. 2. A response with an incorrect conclusive statement or no conclusive statement may not be credited any value points.	1	68%
Supporting data should at least be over the entire range of the conditions investigated. Thus, the minimum reported data are the lowest and highest conditions of the manipulated variable for quantitative data (responding variable when the manipulated variable information is descriptive).		
Supporting Data for 15° Angle: <i>The smallest angle tested was 15° and the temperature increased from 26° to 36° C.</i>	1	38%
Supporting Data for 90° Angle: <i>The largest angle tested was 90° and the temperature increased from 28° to 56° C.</i>	1	38%
Explanatory language, separate from the conclusive statement, is used to connect or compare the supporting data to the conclusive statement: <i>The temperature was 20° warmer for the largest angle.</i> Attribute Notes: 1. This point can only be credited when at least one numeric value (or the text from a descriptive data table) for the manipulated or responding variable is included in the response. 2. A copy of the conclusive statement cannot be credited for explanatory language. However, a re-phrased credited conclusive statement can be credited. 3. Explanatory language comparing the range of the manipulated and/or responding variables may be credited (e.g. <i>When the angle was 15°, the temperature was the lowest, 36° C.</i>). 4. If a response misquotes trend data between the highest and lowest conditions, this value point cannot be credited. 5. Transitional words (e.g. <i>however, therefore, because, so, then, clearly, but</i>) cannot be credited as explanatory language even when added to a conclusive statement. 6. A compound sentence as a conclusive statement may be read as two separate sentences.	1	30%
Total Possible Value Points	4	



What's Your Angle? PCA Scenario Map, Results, and Scoring Rubrics

Scoring Rubric for Item 10: Plan an Investigation

Performance Description	Value Points	2006 Results
		Mean = 1.50 pts
A 4-point response demonstrates the student understands the GLE Planning and Conducting Safe Investigations IN02e (2.1.2) Understand how to plan and conduct scientific investigations BY constructing a logical plan for a controlled or field investigation.	8-9	6%
A 3-point response demonstrates the student partially understands the GLE.	6-7	26%
A 2-point response demonstrates the student has limited understanding of the GLE.	4-5	18%
A 1-point response demonstrates the student has very little understanding of the GLE.	2-3	9%
A 0-point response demonstrates the student has almost no understanding of the GLE.	0-1	36% Blank = 5%

Attributes of a Controlled Investigation for Awarding Value Points

Investigation Attributes	Description of Attribute	Value Point	Typical Results
Prediction	The prediction portion of the hypothesis must answer the given question including the effect of the manipulated (changed) variable (<i>angle at which sunlight strikes Earth</i>) on the responding (dependent) variable (<i>length of shadows case on the ground</i>).	1	55%
Prediction Reason	A hypothesis must give a related reason for the prediction (e.g. <i>...because the light will be striking Earth more directly</i>). Attribute Note: This point cannot be awarded without an attempt at a prediction.	1	20%
Materials	A list of the minimum materials needed to perform the procedure (e.g. <i>lamp, protractor, meter stick, object to cast a shadow, a stand and clamp to hold this object</i>). Attribute Notes: 1. The "right" amount of ingredients (e.g. "x" mL or "y" grams) needed to carry out the procedure does not need to be given in the materials list. 2. A measuring device listed as minimum may not be needed in the materials list if the list includes pre-measured amounts of a material coupled with an appropriate procedure that does not call for using the device. 3. Standard Classroom Materials do not need to be listed: paper, pencil, and safety equipment (e.g. goggles, aprons, gloves, tongs).	1	38%



What's Your Angle? PCA Scenario Map, Results, and Scoring Rubrics

Scoring Rubric for Item 10: Plan an Investigation (continued)

Attributes of a Controlled Investigation for Awarding Value Points (continued)			
Investigation Attributes	Description of Attribute	Value Point	Typical Results
Procedure	The written or diagrammed procedure is evaluated as follows:	up to 6	
One Controlled (kept the same) Variable	One controlled variable must be identified or implied in the procedure or the materials list (e.g. <i>distance of the lamp from the object, same lamp</i>).	1	50%
Manipulated (changed) Variable	Only one manipulated variable (<i>angle at which sunlight strikes Earth</i>) is identified or implied in the procedure or data table (if given).	1	52%
Responding (dependent) Variable	The responding variable (<i>length of shadows</i>) is identified or implied in the procedure or data table (if given).	1	48%
Record Measurements	The procedure states or implies measurements are recorded periodically or gives a data table. Attribute Note: 1. If artificial data for the responding variable is given, no value point may be awarded. 2. The phrase 'take measurement' cannot be used to mean record.	1	42%
Trials are Repeated	More than one trial for all conditions is planned, or implied in a data table, to measure the responding variable.	1	16%
Logical Steps	The steps of the procedure are detailed enough to repeat the procedure effectively (examples of illogical steps: no ending time indicated; states <i>Set up as diagrammed</i> , but diagram is inadequate; recording vague data or results).	1	8%
Total Value Points Possible		9	



APPENDIX D
INTEREST SURVEY FOR
IN THE DOGHOUSE, A MIDDLE SCHOOL POWERFUL CLASSROOM
ASSESSMENT (PCA)

INQUIRY INVESTIGATION SURVEY

In The Doghouse Powerful Classroom Assessment

*****Completing this survey is completely voluntary and will have no effect on your grade. However, your answers are greatly appreciated! Thank you for taking a few minutes to think about these ideas.*****

Use the scale to rate your feelings about each question.

I don't know how to do this (not confident)	I'm not sure (not very confident)	OK, I can give it a try (unsure)	I think I can do this (confident)	I know I can do this (very confident)
1	2	3	4	5

Test question 4: I have an answer for the investigative question.

1 2 3 4 5

Test question 4: I can use information from the data table to support my answer.

1 2 3 4 5

Test question 4: I can explain how the data supports my conclusion.

1 2 3 4 5

Test question 10: I can write a hypothesis based on the investigative question.

1 2 3 4 5

Test question 10: I can list all of the materials I need for this investigation.

1 2 3 4 5

Test question 10: I can write a complete procedure with logical steps and variables.

1 2 3 4 5

Test question 10: I can describe how measurements will be taken and how often.

1 2 3 4 5

APPENDIX E

CONCLUSION AND PROCEDURE QUESTIONS

HOT LAMP, A 2012 MSP RELEASED ITEM

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Hot Lamp

Directions: Use the following information to answer questions 1 through 5.

Brandi and Jerry did the following controlled experiment to find out how the color of an object affects its temperature.

Question: What is the effect of different lid colors on the air temperature inside a glass jar exposed to a lamp?

Hypothesis: The darker the lid color, the greater the increase in air temperature in the glass jar, because darker colors absorb more energy.

Materials:

glass jar

lamp

four colored lids: black, dark gray, light gray, and white

thermometer

meterstick

stopwatch

Controlled Experiment Setup

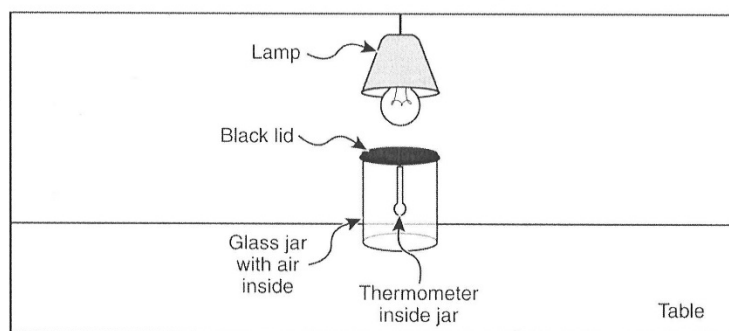


Diagram not to scale

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Procedure:

1. Put the black lid with the attached thermometer on the glass jar.
2. Make sure the starting temperature inside the jar is 24° C.
3. Place lamp 5 centimeters away from the lid and turn on the lamp.
4. After 10 minutes measure the air temperature inside the glass jar and record as Trial 1.
5. Turn off lamp and wait until the air in the jar returns to the starting temperature.
6. Repeat steps 2 through 5 for Trials 2 and 3.
7. Repeat steps 1 through 6 for the dark gray, light gray, and white lids.
8. Calculate and record the average air temperature for each lid color.

Data:

Lid Color vs. Air Temperature Inside Glass Jar

Lid Color	Air Temperature Inside Glass Jar After 10 Minutes (° C)			
	Trial 1	Trial 2	Trial 3	Average
Black	54	52	54	53
Dark gray	48	48	48	48
Light gray	44	45	46	45
White	42	43	41	42

Note: Starting temperature was 24° C for every trial.

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- 3** Brandi and Jerry were designing a doghouse. Use the results from the experiment to describe the best paint color for the doghouse.

In your description, be sure to:

- Choose a paint color.
- Describe how that color might affect the inside of the doghouse.
- Use results from the experiment to support your description.

[illegible]

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- 5** Plan a controlled experiment to answer the question in the box. In your procedure, you may use any materials and equipment.

Be sure your procedure includes:

- logical steps to do the experiment
- one controlled (kept the same) variable
- one manipulated (independent) variable
- one responding (dependent) variable
- how often measurements should be taken and recorded

[illegible]

APPENDIX F

SCORING RUBRIC

HOT LAMP, A 2012 MSP RELEASED ITEM

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Scoring Rubric for Item 3: Color for a Doghouse

Performance Description																	
A 2-point response demonstrates the student understands the Content Standard APPE: Scientists and engineers often work together to generate creative solutions to problems and decide which ones are most promising. Item Specification 2: Describe a reason for choosing a solution given possible solution(s) and a problem that can be solved using a technological design process. The response uses the results from the experiment to describe the best paint color for the doghouse by choosing a color and: Describing how that color might affect the inside of the doghouse AND Using results from the experiment to support the description. Examples: <table> <tr> <th>Choose a color</th><th>Describes how that color might affect the inside of the doghouse</th><th>Uses results from the experiment</th></tr> <tr> <td>Black</td><td><i>The doghouse will be warmer.</i></td><td><i>The black lid made the jar warmest</i></td></tr> <tr> <td>Dark gray</td><td><i>The inside will be a little warmer, but not too hot.</i></td><td><i>The dark gray lid increased 6° C more than the white.</i></td></tr> <tr> <td>Light gray</td><td><i>The inside will stay cooler, but not too cool.</i></td><td><i>The light gray lid was 8° C cooler than the black.</i></td></tr> <tr> <td>White</td><td><i>The inside will be cooler.</i></td><td><i>The white lid only went up to 42° C.</i></td></tr> </table>			Choose a color	Describes how that color might affect the inside of the doghouse	Uses results from the experiment	Black	<i>The doghouse will be warmer.</i>	<i>The black lid made the jar warmest</i>	Dark gray	<i>The inside will be a little warmer, but not too hot.</i>	<i>The dark gray lid increased 6° C more than the white.</i>	Light gray	<i>The inside will stay cooler, but not too cool.</i>	<i>The light gray lid was 8° C cooler than the black.</i>	White	<i>The inside will be cooler.</i>	<i>The white lid only went up to 42° C.</i>
Choose a color	Describes how that color might affect the inside of the doghouse	Uses results from the experiment															
Black	<i>The doghouse will be warmer.</i>	<i>The black lid made the jar warmest</i>															
Dark gray	<i>The inside will be a little warmer, but not too hot.</i>	<i>The dark gray lid increased 6° C more than the white.</i>															
Light gray	<i>The inside will stay cooler, but not too cool.</i>	<i>The light gray lid was 8° C cooler than the black.</i>															
White	<i>The inside will be cooler.</i>	<i>The white lid only went up to 42° C.</i>															
A 1-point response demonstrates the student has partial understanding of the Content Standard. The response chooses a color and describes how that color might affect the inside of the doghouse BUT the results from the experiment are missing OR The response chooses a color and includes results from the experiment BUT the description of how that color might affect the inside of the doghouse is missing.																	
A 0-point response demonstrates the student has little or no understanding of the Content Standard.																	

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Scoring Rubric for Item 5: Hot Lamp New Procedure (page 1 of 2)

Performance Description	Attributes
A 2-point response demonstrates the student understands the Content Standard INQB: Different kinds of questions suggest different kinds of scientific investigations. Item Specification 1: Describe a plan for a controlled experiment.	5–6
A 1-point response demonstrates the student has partial understanding of the Content Standard.	3–4
A 0-point response demonstrates the student has little or no understanding of the Content Standard.	0–2

Attributes of a Procedure

Procedure Attributes	Description of Attribute	Attributes
One Controlled Variable	At least one controlled variable is identified or implied (e.g., <i>same jar</i> , <i>same lid</i> , <i>same heat source</i>).	1
Manipulated Variable	Only one manipulated variable (amount of water) is identified or implied in the procedure or data table (if given).	1
Responding Variable	The responding variable (time to heat to 50° C) is identified or implied in the procedure or data table (if given).	1
Record Measurements	The procedure states or implies measurements are recorded periodically or gives a data table. Attribute Notes: 1. If artificial data for the responding variable is given, this attribute may not be awarded. 2. The phrase <i>take measurement</i> cannot be used to mean <i>record</i> .	1
Trials are Repeated	More than one trial for all conditions is planned, or implied in a data table, to measure the responding variable.	1
Logical Steps	The steps of the procedure are detailed enough to repeat the procedure effectively (examples of illogical steps: no ending time indicated, recording vague data or results).	1
Total Possible Attributes		6

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APPENDIX G
POST TREATMENT
STUDENT INTERVIEW QUESTIONS

STUDENT INTERVIEW QUESTIONS

1. Has using the PEEL paragraph process helped you in writing class? How?
2. Have you used the PEEL process in any of your other classes? (Science, Reading, History, etc.)
3. When have you used it? (What kind of assignments)
4. Do you think that the PEEL process works for the writing that you do in science?
5. (If you answered “yes” to #4) What kind of writing assignments work well with the PEEL process?
6. (If you answered “no” to #4) Why do you think it doesn’t work well?
7. Do you think that it’s helpful to have a writing format like PEEL to work with? Why?

APPENDIX H
STUDENT SURVEY
COMPARING CONCLUSION QUESTIONS

Please take a few minutes to compare the PCA conclusion question (pink) and the released item conclusion question (yellow).

When students took both of these assessments, they were more successful answering the questions from the released item (yellow).

In your opinion, how are these questions different?

Why do you think students may have scored better on the released item conclusion (yellow)?

(Remember that they were both scored on including evidence from the experiment in the answer and explaining how that answer supported their claim.)