UNIVERSITY OF CALIFORNIA, SAN DIEGO

Writing for Science Literacy

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by

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The Thesis of Shannon Marie Chamberlin is approved and it is acceptable in quality and form for publication on microfilm and electronically:

Chair

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DEDICATION

This thesis is dedicated to my ever patient husband, John Thiede, who accepted this as an inevitability with no questions asked. For your love, support, and ability to be both dad and mom to our girls, I am forever grateful.

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ABSTRACT OF THE THESIS

Writing for Science Literacy

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Scientific literacy is the foundation on which both California's currently adopted science standards and the recommended new standards for science are based (CDE, 2000; NRC, 2011). The *Writing for Science Literacy (WSL)* curriculum focuses on a series of writing and discussion tasks aimed at increasing students' scientific literacy. These tasks are based on three teaching and learning constructs: thought and language, scaffolding, and metacognition.

To this end, *WSL* is focused on incorporating several strategies from the *Rhetorical Approach to Reading, Writing, Listening and Speaking* to engage students in activities designed to increase their scientific literacy; their ability to

both identify an author’s claim and evidence and to develop their own arguments based on a claim and evidence. Students participated in scaffolded activities designed to strengthen their written and oral discourse, hone their rhetorical skills and improve their metacognition. These activities required students to participate in both writing and discussion tasks to create meaning and build their science content knowledge.

Students who participated in the *WSL* curriculum increased their written and oral fluency and were able to accurately write an evidence-based conclusion all while increasing their conceptual knowledge. This finding implies that a discourse rich curriculum can lead to an increase in scientific knowledge.

I. INTRODUCTION

I spent my first six years as a teacher in a middle school science classroom in a large urban school district. The district had a large English Language Learner population and I quickly learned the importance of discussion and inquiry activities to help these students grasp the science content. Lecture was insufficient because I didn't speak Spanish and they were still learning English. I discovered I had to show them science, not just tell them about it. Over the course of my six years in the classroom I developed a discourse rich curriculum that focused on all four language domains, speaking, listening, writing, and reading.

After six years in the classroom I transitioned to an academic resource position. In this new position I served as both a coach and curriculum writer for science teachers in the district. In this capacity I have observed dozens of teachers in all the schools in the district. I was shocked by how many science teachers did not teach science labs, or really any form of scientific inquiry besides the steps of the scientific method. In addition, the writing in these classes was limited to answering questions or an occasional warm-up or exit ticket. Lastly, the instructional format was predominately lecture with the students taking notes for the majority of the period. I had naively assumed that all science teachers conducted science investigations.

At the same time I was making my startling discoveries, the district was undergoing an enormous pedagogy shift in English courses. Teachers were no longer teaching novels and were moving toward teaching expository text. The texts included informational texts, op-ed pieces, newspaper articles and they were taught from the perspective of argument. The underlying theory was that every text (including graphs and pictures) makes an argument. The job of the reader is to determine what that argument (or claim) is and evaluate whether the author's evidence was strong enough to support their claim. It struck me that these English teachers were doing what the National Science Education Standards had been calling for since 1995; they were teaching scientific literacy. They were giving students the skills necessary to read an news article or opinion statement and evaluate the argument for credibility.

My strong belief in the expository movement combined with what I was seeing in the science classroom in my district convinced me to pursue an educational doctorate. I knew science curriculum had to change if we had any hope of preparing students for 21st century challenges: the need for international collaboration to develop creative and innovative solutions to global issues. In the process of writing my thesis the Next Generation Science Standards (2012) were released in draft form. These standards call for a shift in the way we teach science to students. Furthermore they clearly define inquiry:

> Our expectation is that students will themselves engage in the practices and not merely learn about them secondhand. Students cannot comprehend scientific practices, nor fully appreciate the nature of scientific knowledge itself, without directly experiencing those practices for themselves (p. 3).

The ability to accurately summarize a scientific argument and then write your own argument based on evidence is a critical step in the inquiry process. This thesis documents my attempts to enrich science curriculum with scaffolded oral and written discourse rich activities. I hope that the work I have done will in some way move teachers closer to graduating students prepared for the rigors and demands of the 21^{st} century.

II. NEEDS ASSESSMENT

Scientific literacy, as defined by the National Science Education Standards (1995), "implies the capacity to pose and evaluate arguments based on evidence and to apply conclusions from such arguments appropriately" (p. 22). This type of literacy requires not only science content knowledge but an ability to both read and write expository text. Today's high school graduates show a consistent lack of proficiency in all of these areas. The most recent Trends in International Mathematics and Science Study (TIMSS) data (2009), which measures science achievement among U.S. fourth and eighth graders, indicates that only 10% of participating students scored at or above the advanced international benchmark in science. Furthermore, the scores for US students have not significantly changed in the last 12 years (TIMSS, 2009). On the 2009 *National Assessment of Educational Progress* for twelfth grade science only 21 percent of assessed students scored at or above proficient (NAEP, 2009).

The 2004 report *The Facts about Science Achievement* (NAEP), produced by the U.S. Department of Education states:

> The longer students stay in the current system the worse they do. According to the 1995 Third International Mathematics and Science Study, U.S. fourth graders ranked second. By twelfth grade, they fell to 16th, behind nearly every industrialized rival and ahead of only Cyprus and South Africa.

The report goes on to summarize former President Bush's plan to improve the Nations' state of science education via the *No Child Left Behind Act of 2001*.

Recommendations in the report included rewarding states for increasing student enrollment in higher level math and science courses, rewarding states for increasing passing Advanced Placement rates on science exams, and requiring federal funding go only to math and science programs that are evidenced-based, meaning they have data to prove their efficacy. Unfortunately, despite the recommendations laid out by *No Child Left Behind* a decade ago, students do not seem to be improving in science. This failure in science education comes at a time when the world is becoming increasingly dependent on science technology. The U.S. Commission on National Security in the Twenty-First Century (2001) reports:

> The inadequacies of our systems of research and education pose a greater threat to U.S. national security over the next quarter century than any potential conventional war that we might imagine. If we do not invest heavily and wisely in rebuilding these two core strengths, America will be incapable of maintaining its global position long into the 21st century (p. ix).

Questions arise as to whether U.S. students will ever be prepared to compete in an increasingly technical international marketplace unless we significantly alter the way we teach science. Our current system that teaches a series of disconnected science facts and gives little attention to creating scientifically literate citizens cannot succeed.

In the Partnership for 21st Century Skills report on *Employers' Perspectives on the Basic Knowledge and Applied Skills of New Entrants to the 21st Century U.S. Workforce (2006),* 89.7 percent of employers rank writing in English a very important skill for college graduates. Of all the 21st

century skills listed in the report, writing in English and written communication consistently ranked among the highest (2006). The report surveyed over 400 perspective employers from fields including science, engineering and health care, who agreed that written communication was the most deficient skill in their new employees regardless of their education level.

Both the *21st Century Skills Map* (Partnership for 21st Century Skills, 2006) and the *Common Core State Standards* (Common Core State Standards Initiative, 2010) call for an integration of literacy into core content areas. Literacy is defined as reading, writing, listening, speaking and language (p. 4). The argument put forward by these two reports is that literacy goes beyond the responsibility of the English teacher and extends to all content areas. The Common Core Standards for science are exclusively literacy skills and are intended as an addition to content standards (p. 4). Both the Common Core Standards and the National Assessment of Education Progress Reading Framework (2009) will require a significant increase in the amount of expository (or informational) writing required in grades K-12. These literacy needs are underscored at both a state and local level.

The National Institute for Literacy (2007) reports that subject-related writing continues to be a challenge for high school students. Applebee and Langer's most recent study (2011) concluded that high school student writing in science class is most often limited to a page or less. The same study reports that middle school students spent only 2.2 percent of science class time writing a paragraph or more in length (p.16). The most common explanation given for this lack of writing is that most high stakes tests are multiple choice so teachers spend their class time focusing on recall type questions and shy away from time-consuming, critical thinking essay questions that are not going to appear on state exams (p.18).

The State of California STAR Test for 2011 reports reading, writing and math scores for all 7th grade students across the state (Department of Education, 2011). According to the Department of Education, the state average correct for written conventions was 67% and Writing strategies was 60%. While the study district has consistently shown growth over the last three years (DOE, Star Reports 2009, 2010, 2011), the average percent correct for written conventions is still only 65% and 59% correct for writing strategies. Thus, 41% of the study districts seventh graders tested cannot choose the proper writing strategy when given an essay question (DOE 2011). In order to improve students' scientific literacy, science teachers must embrace the role of reading and writing teacher by integrating basic skills instruction (reading and writing) into science content instruction. Zwiers (2008) claims, "Writing pushes students to use language to organize facts, concepts, and opinions in strategic ways" (p. 195). So the question arises, can increasing the regularity of expository writing in a middle school science class, increase conceptual knowledge of science content ultimately resulting in a more scientifically literate student?

III. A REVIEW OF RELEVANT LITERATURE

Thought and Language

The relationship between thought and speech was best described by Russian psychologist Lev Vygotsky, “Thought undergoes many changes as it turns into speech. It does not merely find expression in speech; it finds its reality and form” (Vygotsky, 1986). Vygotsky also described how the relationship between inner thought and language was mediated by our sociocultural experiences. Thus language, developed for use in a society, influences our thinking via the words we use to describe it. Therefore, language and thought are reciprocally dynamic both developing and relying on one another (Wink & Putney, 2002).

The relationship between language and thought is intuitive to new mothers. Young children are encouraged to speak early and often. Parents put labels and names on every new thing a child experiences. We put our children in pre-schools and schedule “play dates” in an effort to increase their communication skills and knowledge of the world. As adults we engage our friends and colleagues in debates on politics, social media and the latest Hollywood gossip. As a society, we understand the need for social interaction and dialogue to increase our own knowledge of our world. Yet, our school system is not organized in a way to encourage this thought-language interaction. Within the school setting, teachers talk and children listen. How can we expect students to learn when we never let them discuss what they are learning?

Language in Science

Learning science has often been compared to learning a foreign language. The concepts and processes described within a science class have their own vocabulary and often, unique meanings. In science classes, students must not only master the principles and concepts that describe our world, they must also learn a new vocabulary to accurately describe those concepts. Yore, Bisanz, and Hand (2010) describe the unique relationship between language and science; “language is a means to doing science and to constructing science understandings” (p.691). The very nature of science is one of observation, experimentation and debate. “The role of language in shaping what is viewed as legitimate understanding within a scientific community becomes a paramount factor in the construction of knowledge” (Kittleson and Southerland, 2004). Scientific progress would not be possible without meaningful discourse, both oral and written. Science discourse can be viewed as rhetoric in that it creates an argument and attempts to persuade others of the argument’s validity (Yore, 2010). Thus discourse becomes the way in which we construct scientific understanding (Kittleson, 2004). This is the definition of discourse used throughout this thesis.

Writing in Science

The current method of teaching science is heavily dependent on input; teachers relay knowledge via lecture or textbooks and students passively listen, read and memorize what has been relayed (Shy-Jong, 2007). This method of teaching is very superficial with students focusing on a series of disconnected facts and never really reaching deep conceptual understanding of the underlying processes that define our natural world. In order to achieve understanding students must receive input and produce output (Tsui, 2002). According to Tobin and Tippins (1993), scientific knowledge results from constructing meaning in a social setting. This would require that students are producing output (speaking and writing) within a collaborative group. Numerous studies have validated the use of both discussion and writing to increase students understanding in science (Ash, 2004; Kittleson, 2004; Wellington & Osborne, 2001). Rivard & Straw (2000) concluded that a curriculum that included both talk and writing increased students' understanding.

Writing tasks in science need to move beyond the traditional lab analysis questions to embrace the definition of scientific literacy. Hand, Lawrence and Yore (1999) define scientific literacy as the ability to "construct science understanding, the big ideas of science, and the communications to inform others about these science ideas and to persuade them to take informed actions" (p.1021). Thus scientific writing goes beyond an ability to articulate one's own thinking; true scientific literacy requires knowledge of scientific rhetoric, the ability to make a scientific argument backed by proper evidence and claims. This definition of argument differs from a lay definition where an argument can be a simple disagreement based on personal experience and/or opinion. Several studies argue that a rhetorical approach to science writing is required to achieve true scientific literacy (Hand, 1999; Prain and Hand, 1996; Yore et al, 2003). Thus students need to learn not only science facts (as with the current method of teaching) but also how to communicate that knowledge to persuade others to make informed decisions. This type of argumentation structure is the basis of scientific discourse. It is the means by which scientific progress progresses closer to "truth." Conclusions drawn by one expert are challenged and built upon by the next expert and as a result our entire body of knowledge grows. This process must be explicitly taught in a way students can internalize it.

Scaffolding

Instructional scaffolding is a tool used to help students engage in learning tasks that they are unable to perform on their own. Scaffolds are seen as temporary structures used to help students' bridge the gap between what they can do and what they cannot yet do alone. According to Bransford (2000), "Scaffolding allows learners to participate in complex cognitive performances, such as scientific visualization and model-based learning that is more difficult or impossible without technical support" (p. 243). The use of scaffolds is not uncommon in teaching and numerous research articles have been written on their effectiveness. Both Patterson (2001) and Hand (1999) studied the use of concepts maps as a scaffold to writing. Patterson found:

> The use of structured context (concept) maps resulted in the production of ideas that also went beyond what they could have known from their own experience or from the teaching that they had received. The pupils had therefore applied a process of reasoning, in which they utilized their existing knowledge and understanding, resulting in the generation of new ideas of hypotheses (p. 15).

According to Hand, Lawrence and Yore, the discussion-based nature of concepts maps is what makes them an effective tool for student understanding. Students come to understand that their own perspective can be broadened and their knowledge deepened through the process of negotiation (p.1031).

Scaffolding can also be an effective tool for teachers who are unfamiliar with a particular pedagogy. In the case of rhetorical writing, science teachers may lack the knowledge and pedagogical skills to teach writing within the context of a science class. Therefore, scaffolding writing tasks becomes not only critical to aid student learning but also necessary to ensure proper instruction.

Metacognition

Metacognition is often described as thinking about your own thinking. It is the means by which a learner differentiates what he does and doesn't know. Yore and Treagust (2006) describe metacognition as consisting of three types of knowledge:

> Declarative knowledge refers to the knowledge that one has about oneself as a learner and the factors that affect performance. Procedural knowledge is the knowledge about strategies that can be employed to improve performance. Conditional knowledge refers to an awareness of why, when, and where to use a particular strategy.

All three of these types of knowledge must be explicitly taught in order for students to fully embrace their metacognitive abilities and learn to teach themselves (Bransford, p.50). In a science course declarative knowledge may be a student's ability to differentiate between what he does and does not need to study for a test or realizing that completing assigned homework results in higher performance on a test. Procedural knowledge would include the use of pneumonic devices or study guides to help improve performance. Conditional knowledge includes knowing when to apply a specific procedure to a laboratory experiment or how to use inquiry to solve novel problems. Conditional knowledge is especially important for today's students' as they no longer need to remember random science facts and formulas. This type of content specific information is readily available on the Internet. Rather, how to apply a scientific principle to an ecological crisis or how to evaluate the scientific argument proposed in a newspaper article are critical 21st century skills.

In the next chapter I will review the existing science curriculum available in the study district. The curriculum must be reviewed with the above constructs in mind and they are critical to building scientific literacy.

IV. REVIEW OF EXISTING CURRICULUM

The California State Science Content Standards were established in 2003 to standardize the content of science education and to outline, "The essential skills and knowledge students will need to be scientifically literate citizens in the twenty-first century" (California State Science Content Standards, p. vii). Despite the strong importance of scientific literacy detailed in the document, there are very few standards related to literacy (reading/writing). For example, in Seventh Grade Science there are 7 standards broken down into 45 objectives. Of these 45 objectives, only three address literacy:

- Use a variety of print and electronic resources (including the World Wide Web) to collect information and evidence as part of a research project.
- Communicate the logical connection among hypotheses, science concepts, tests conducted, data collected, and conclusions drawn from the scientific evidence.
- Communicate the steps and results from an investigation in written reports and oral presentations.

To address this lack of literacy in the content standards, California has agreed to adopt the *Common Core State Standards for Literacy in History/Social Studies, Science and Technical Subjects* beginning in 2013. These standards do not include any science content; rather they are strictly reading and writing skills, which will be embedded within science content. The standards apply to grades 6-12 and include ten reading standards and ten writing standards. The writing standards focus on text types and purposes, production and distribution of writing, and research to build and present knowledge. These standards are specifically aimed at teaching students to write scientific arguments for a variety of audiences. The ability to write a scientific argument based on evidence is at the heart of scientific inquiry. Students in the 21st century must learn this skill in order to guide public policy, decipher scientific fact from opinion, and successfully solve today's ecological, medical, and financial problems. None of these literacy standards are included in the state's currently adopted textbooks for science nor are they currently included in the study districts science course descriptions.

Within the study district, General Science 1 (Life Science) is considered a laboratory science and is an A-G prerequisite course; meaning students must take it to be considered ready for high school biology. In order to be accepted into any California public college or university, students must complete seven pre-requisite courses labeled as A-G. High school biology is a one of these required courses. Due to the study district's adoption of support classes for math and English, curricular sacrifices had to be made and science was heavily impacted. Seventh grade students only have room in their schedule for one elective class, which would normally be one semester of health (a state required course) and one semester of an art or computer class. Students taking math and/or English support do not have room in their schedules for an elective, which creates a problem since health is a required course. To get around this issue, the study district combined seventh grade science and health into one yearlong course. The course is required for all seventh grade students in the study district. The course covers sixty percent of the state content standards for science and thirty percent of the state content standards for health. The course is also supposed to include a laboratory component that is integrated into each unit of science instruction. There is no standardized assessment or grading policy within the district with four exceptions. Every student is required to take two quarterly (midterm) exams that the teacher may or may not count in the student's grade. They must also take two end-of-course (final) exams that must be counted as some percent of the student's final grade. The format of all these exams is multiple-choice with the vast majority of questions scoring on the lower end of Bloom's taxonomy. For example, the function of mitochondria is to a) digest dead cell parts, b) create energy for the cell, c) provide structure for the cell, and d) give instructions to the cell. This type of question relies on a student's ability to recall information, and not apply or generate comparisons, or manipulate the knowledge in any way.

The following curricular review will analyze the available district curricula, CPO Focus on Life Science and The Write Path, across the three focus constructs: language and thought, scaffolding, and metacognition, as they relate to written and oral discourse as defined in this curriculum.

General Science 1 (GS1) – CPO Focus on Life Science

The adopted text for GS1 within the study district is *CPO Focus on Life Science* (2007). This textbook offering is vastly different from what is normally provided by publishers. Instead of providing supplemental resources for teachers in the form of curriculum guides, leveled readers, or vocabulary builders, the publisher provides laboratory equipment. Thus, the textbook adoption includes a student text, a teacher text (which does not include any of the material in the student text, rather it is a lesson plan book), a laboratory manual, and laboratory equipment.

The text is organized into six units spanning eighteen chapters. Each chapter is followed by an assessment consisting of multiple choice and short answer questions. There is also a “math and writing skills” topic included in every chapter assessment. The writing skills questions require students to write anywhere from one paragraph to one page in order to cover the topic. For example;

- Write a paragraph describing how your pet, or a friend’s pet, meets the criteria of a living thing.
- Imagine you are Antoine van Leewenhoek and you have just observed the first blood cells. Write a letter to a friend describing your amazing discoveries.

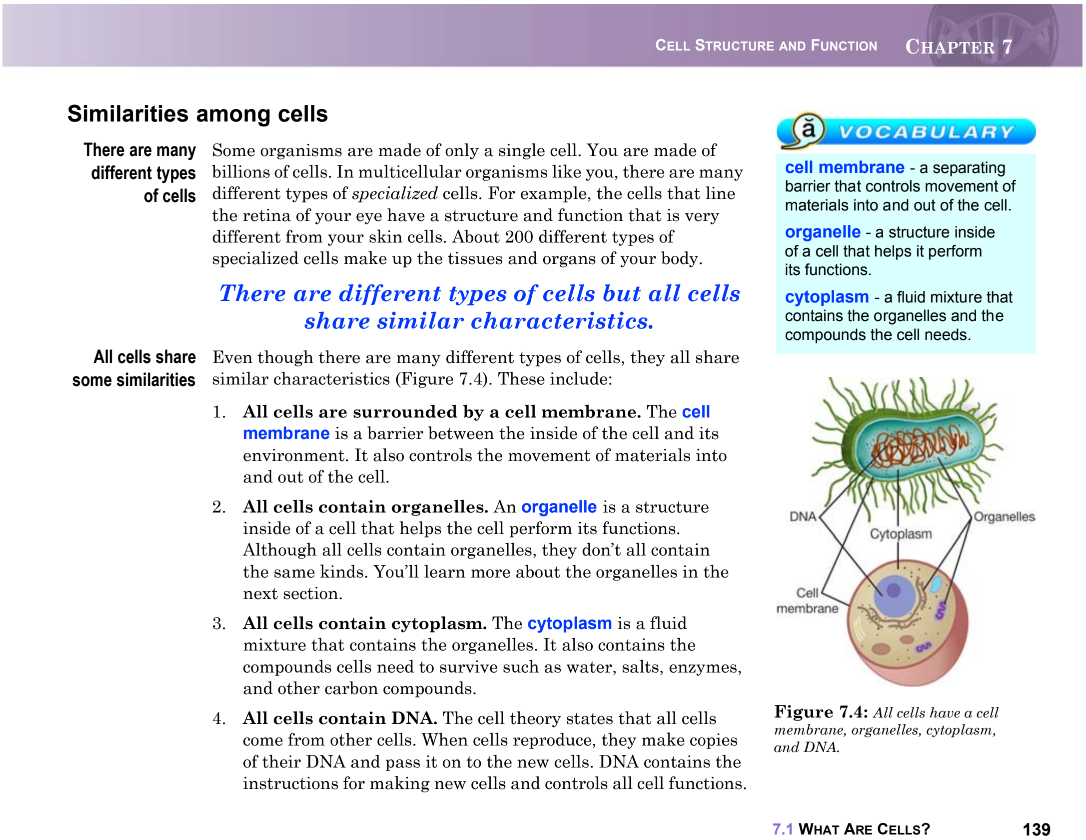
While these writing assignments do require students to write something, they do not meet the standards for creating a scientifically literate student as laid out by the National Science Education Standards: the capacity to pose and evaluate arguments based on evidence and to apply conclusions from such arguments appropriately. The rigor of text's writing prompts is too low and their goal is not to write a scientific argument.

Language and Thought

Like most textbooks, *Focus on Life Science* does not specifically address discourse strategies in the student edition of the text. The teacher's edition is organized into a five point lesson plan for each chapter of the student text. Each lesson plan offers teachers either suggestions for supplemental books that pertain to that topic (these supplemental books are not provided by the publisher and are the responsibility of the teacher to obtain) or information on word origins. CPO is an inquiry based curriculum. The connection between language and thought occurs via the science investigations which are integrated into every chapter of text. The publisher relies on these laboratory investigations to provide discourse and content knowedge acquisition to students. While teachers are occasionally prompted as to what questions they should ask, there are no tips or instructions on generative questioning strategies. Also missing is any discussion acitivities for the students.

Scaffolding

The textbook provides more scaffolding for the students than is generally seen in a science textbook. The student text is organized in Cornell Notes layout with bolded headings for each paragraph of text. Additonally, any "science vocabulary" is defined in the right margin of the same page it appears. Lastly, the text is designed around a "one-concept, one-page" model. All of these organizational tools are provided to help students access the textbook. Figure 1 provides an example of the student text layout.



CELL STRUCTURE AND FUNCTION CHAPTER 7

Similarities among cells

There are many different types of cells Some organisms are made of only a single cell. You are made of billions of cells. In multicellular organisms like you, there are many different types of *specialized* cells. For example, the cells that line the retina of your eye have a structure and function that is very different from your skin cells. About 200 different types of specialized cells make up the tissues and organs of your body.

There are different types of cells but all cells share similar characteristics.

All cells share some similarities Even though there are many different types of cells, they all share similar characteristics (Figure 7.4). These include:

1. **All cells are surrounded by a cell membrane.** The **cell membrane** is a barrier between the inside of the cell and its environment. It also controls the movement of materials into and out of the cell.
2. **All cells contain organelles.** An **organelle** is a structure inside of a cell that helps the cell perform its functions. Although all cells contain organelles, they don't all contain the same kinds. You'll learn more about the organelles in the next section.
3. **All cells contain cytoplasm.** The **cytoplasm** is a fluid mixture that contains the organelles. It also contains the compounds cells need to survive such as water, salts, enzymes, and other carbon compounds.
4. **All cells contain DNA.** The cell theory states that all cells come from other cells. When cells reproduce, they make copies of their DNA and pass it on to the new cells. DNA contains the instructions for making new cells and controls all cell functions.

VOCABULARY

cell membrane - a separating barrier that controls movement of materials into and out of the cell.

organelle - a structure inside of a cell that helps it perform its functions.

cytoplasm - a fluid mixture that contains the organelles and the compounds the cell needs.

Figure 7.4: *All cells have a cell membrane, organelles, cytoplasm, and DNA.*

7.1 WHAT ARE CELLS? 139

Figure 1: CPO Student Textbook Layout

Scaffolding is provided to teachers in terms of how to teach the science content. As previously mentioned, the teacher text provides a five-point lesson plan for each chapter of text. These lesson plans include sections on motivation, exploration, explanation, extension and assessment. Within the various lesson plans are teacher tips which include questions to ask students, origins of science words, common student misconceptions, or background information regarding the science content. There is no scaffolding provided for structuring discussions or helping students access the textbook which is interesting because the student text is specifically designed to help facilitate student access.

Metacognition

In writing the *Focus on Life Science* textbook, there was little attention paid to metacognitive strategies. The only evidence besides the general chapter questions, is an occassional reference to procedural knowledge provided by describing the purpose of a venn diagram or a mnemonic device. While these are important procedural knowledge strategies, their impact is limited by the method in which they are implemented. They will be much less effective if they are done in isolation without the benefit of other students' ideas and input. There is no evidence of declarative or conditional knowledge within the student text.

Conclusion

Overall, *Focus on Life Science* is written in an atypical format. It goes to great lengths to appear accessible to students, however it fails to present literacy or discourse strategies. If a science teacher planned on addressing anything beyond basic science content, they would have to look to another source, as this publisher provides no teacher resources. The most troubling feature of this text is that it relies heavily on inquiry-based instruction, without including any of the literacy or discourse supports upon which such instruction is based. Additionally, while there are many lab investigations included, if a teacher chooses not to use these labs, this textbook becomes nothing more than a reference manual for science content.

The Write Path

There are science curricula available in Surf District that is designed to emphasize writing in science. One in particular is *The Write Path* written by Molloy, et al (2003) and offered by the Advancement via Individual Determination (AVID) Center. The impetus for developing *The Write Path* came out of AVID's collaboration between high school and college instructors and a desire to teach students to "write like scientists" (p.3). The curriculum is divided into six chapters:

- How to travel the path
- Writing preliminaries
- Writing in science
- Experimental design writing
- Reading and note-taking in science
- Additional active reading graphic organizers
- Discussion in science

Language and Thought

The Write Path curriculum promotes the interplay between language and thought by introducing both structures and strategies designed to promote discussion, reflection, and written revision. One structure suggested is oral response groups where students are clustered according to level of expertise.

The participants act as peer editors and take turns reading their writing pieces aloud and receiving feedback from the group (p.17). Many of the recommended strategies incorporate a group discussion component to help students broaden their thinking on a particular topic.

Scaffolding

One of the nicer features of this curriculum is that it provides a student sample after each activity. Also provided are teacher tips from practitioners who have used the activities in their own classes. Both of these features are helpful for teachers implementing the activities for the first time. The amount of scaffolding for students varies depending on the activity. Many of the suggested activities require a great deal of reading which may be difficult for some students. In addition, the activities seem to be randomly placed throughout each section with no level of difficulty noted.

Metacognition

This curriculum is targeted at science writing and claims to emphasize the process of writing as much as the product (p. 14). There are numerous activities that require students to summarize (Cornell notes, lab reports, news articles) which would be thinking about product. However, the metacognition related to process seems to be limited to rubrics and peer review with little emphasis on reflection or error analysis, which are activities designed to focus on thinking about processes.

Conclusion

The stated goal of *The Write Path* is to increase students' comfort and ability with science writing (p. 3). Several intriguing activities are presented but overall *The Write Path* is more a series of disjointed activities than a scientific literacy curriculum. The structure of the text would make it easy to incorporate within an existing science class but it is not a science textbook, thus it lacks any type of scientific content. Furthermore, since it is presented as a series of activities, rather than a cohesive curriculum, professional development is required to familiarize teachers with the scope and nature of the activities.

Rhetorical Approach to Reading, Writing, Listening and Speaking

Recently, Surf District has developed supplementary materials in the *Rhetorical Approach to Reading, Writing, Listening and Speaking* for all English courses. The material was developed in conjunction with San Diego State University and is based on the California State University Expository Reading and Writing Course (ERWC). The materials are outlined and presented in the *Teachers Toolkit 2.0* written by Surf District teachers and published by Pearson Learning Solutions, © 2011. The curriculum framework outlines six essential rhetorical approach skills (p.v)

- Annotate for various purposes
- Write summaries for a variety of purposes
- Analyze and create arguments
- Use and reference the words of others
- Analyze and create workplace, public and consumer documents

- Use academic language

The *Toolkit* is divided into three main sections: reading rhetorically, connecting reading to writing, and writing rhetorically. The writing portion of the curriculum is further divided into prewriting, writing, and revising/editing. Included are teacher tips for helping students develop a strong thesis statement (argument), organize their essay, and develop their content. It also includes peer-editing protocols.

Language and Thought

All units within the *Toolkit* are designed using the ERWC framework that guarantees strategic development of academic language through listening, speaking, reading and writing. Thus student input and output is required within every curriculum unit (p. xvii). Each unit culminates in a writing task and teachers are encouraged to consider what culminating writing task students will produce to demonstrate understanding and proficiency of standards and skills when writing curricular units (p. xvii). Each grade level is organized around interdisciplinary themes that are based on a series of guiding questions. One example is Grade 10 as seen in table 1.

Table 1: Interdisciplinary Themes Grade 10

Interdisciplinary grade level theme and thematic questions (TQ)	Quarterly Anthology Topics
Thematic Focus: Change, Cause and Effect TQ1: Do similar causes always lead to predictable consequences? TQ2: Is change temporary or enduring? TQ3: How can change be natural or human-made? TQ4: Is change inevitable? TQ5: How can change lead to new structures? TQ6: When is change evolutionary or revolutionary?	Topic 1: Need for change and systems of power: exploring social and political needs for change. Topic 2: Going to extremes and survival: exploring the extremes of war. Topic 3: Leaders and heroes: exploring how there are two sides to a hero. Topic 4: Society and science: exploring the impact of scientific advances on people and nations.

As previously mentioned the unit framework is divided into three sections: reading rhetorically, connecting reading to writing, and writing rhetorically. Within each section teachers are provided with guiding questions and activities that promote discussion amongst students (think-ink-pair-share, brainstorming, three-step interview, collaborative poster, etc.)

Scaffolding

The *Toolkit* is scaffolded for both teachers and students. Within each section are “Teaching Tips” designed to help teachers implement the ERWC framework. These tips highlight problem areas for students, methods to teach a particular strategy and ideas to promote discussion and learning. Scaffolding is provided for students in a variety of ways. First, specific activities are suggested to help promote thinking, for example brainstorming, collaborative posters, semantic maps and graphic organizers. Second, sentence frames are provided to scaffold thinking to writing. Lastly, the structure of the units themselves are a scaffold to the writing process beginning with pre-reading activities, reading activities, transitioning from reading to writing and finally writing activities.

Metacognition

Metacognition is addressed within the *Toolkit* in a variety of ways. Throughout the unit plans, students are encouraged to reflect on their thinking of both content and skills via questions embedded into daily lesson plans. For example, who is the intended audience for this text, what can I predict about this text based on the title, or why did the author choose to use this writing strategy? These questions are designed to encourage students to reflect on what they already know about the content or skills being learned and decide what they need to learn to master the content.

Metacognition is also the underlying theory behind the rhetorical approach utilized by the *Toolkit*. The rhetorical approach to reading and writing requires students to analyze the arguments made by writers and to structure their own writing rhetorically focusing on three elements: logos (logic), ethos (ethics), and pathos (emotions). The approach is designed to "move students through the traditional rhetorical appeals to progress from a literal to an analytical understanding of the reading material" (p.13).

Conclusion

While the *Rhetorical Approach to Reading, Writing, Listening and Speaking* curriculum has many of the elements required for scientific literacy, it is an English curriculum. It is designed to work with the currently existing English content standards. It would be difficult to import this curriculum into a science class where there are already a staggering number of science content standards to cover. In order for this curriculum to be effective in a science course, it would need to be pared down and altered to be used with science content.

Conclusion

While scientific literacy is a stated goal in the California Science Content Standards, it appears that the adopted seventh grade science textbook has focused on teaching science content standards with little of no attention to the literacy component. A review of curriculum available to science teachers in the Surf District reveals that while literacy materials are available, it would require teachers to implement and integrate curriculum designed for English courses. In order to achieve the literacy outcomes proposed in this project, a curriculum that integrates teaching writing within the science context, is necessary. This curriculum would need to focus on both language and thought (via appropriate student discourse) and metacognition while providing scaffolding for both students and teachers who are not familiar with how to teach literacy (specifically writing). More specifically, this curriculum needs to provide specific writing activities that are scaffolded for both student success and teacher use. Students need to be introduced to the style of writing expected in science (claims based on evidence) and science teachers need to be shown how to teach writing in a science class.

V: WRITING FOR SCIENCE LITERACY

The *Writing for Science Literacy (WSL)* curriculum focuses on a series of writing and discussion tasks aimed at increasing students' scientific literacy. I designed the curriculum based on several teaching and learning constructs: thought and language, scaffolding, and metacognition. Scientific literacy is the foundation on which both California's currently adopted science standards and the recommended new standards for science are based (NRC, 2011; CDE, 2000). To this end*, WSL* focuses on incorporating several strategies from the *Rhetorical Approach to Reading, Writing, Listening and Speaking,* and *Critical Reading: Deep Reading Strategies for Expository Texts* to engage students in activities designed to increase their scientific literacy, as well as to develop their ability to both identify an author's claim and evidence, and to create their own arguments based on a claim and evidence. Students participated in scaffolded activities designed to strengthen their written and oral discourse, hone their rhetorical skills and improve their metacognition. These activities require students to participate in both writing and discussion tasks to create meaning and build their science content knowledge.

Goals

WSL activities are designed to increase students' content literacy through scaffolded writing and discussion tasks. This curriculum is specifically focused on the idea of scientific literacy through the achievement of three goals;

1) Students' conceptual knowledge will increase as a result of writing evidence-based conclusions.
2) Students will strengthen their oral discourse as a result of
    a) increasing the amount of time they spend in class discussing science content
    b) providing structured student interactions.
3) Students will strengthen their written discourse as a result of
    a) increasing the amount of time they spend in class writing about science content
    b) practicing power writing.

The overview of goals, constructs, and features of *WSL* are provided in Table 2.

Table 2: Curricular Goals

Goal for Students	Research Construct	Curriculum Feature
Students' conceptual knowledge will increase as a result of writing evidence-based conclusions (Common Core Reading Standards for Literacy in Science and Technical Subjects 6-8.1).	• Scaffolding • Metacognition	• Paragraph Frames • Annotating Text (Reading with a purpose) • Writing with a purpose • Paragraph frames
Students will strengthen their oral discourse as a result of a) increasing the amount of time they spend in class discussing science content and b) providing structured student interactions.	• Language and Thought • Scaffolding	• Reciprocal discussion of text. • Increased structured student interaction time
Students will strengthen their written discourse as a result of a) increasing the amount of time they spend in class writing about science content and b) practicing power writing.	• Language and Thought • Metacognition • Scaffolding	• Power Writing • Paragraph Frames • Increased instructional time

Goal 1: Students' conceptual knowledge will increase as a result of writing evidence-based conclusions.

The ability to write an evidence-based conclusion is the cornerstone of scientific literacy (Hand, Lawrence, and Yore, 1999). Scientific conclusions not only summarize an authors argument, they provide the starting point for further investigation and experimentation in order to fuel discovery. The process of writing valid conclusions is not intuitive and must be scaffolded for students, especially English Language Learners. Bransford (2000) writes extensively on the importance of scaffolds when learning complex cognitive tasks. In terms of the *WSL* curriculum, scaffolding is dually important as teaching writing is not typically a part of science teacher preparation. Thus the scaffolding provided within the writing tasks (Power Writing, Reciprocal Teaching, Text Summaries) serves both the learner to achieve the complex task of writing evidence-based conclusions, and the teacher, to ensure correct instructional delivery in writing.

The second construct operationalized in this goal is metacognition, the way that the learner thinks about his own thinking. *WSL* incorporates this construct through the use of procedural and conditional knowledge. Procedural knowledge is achieved by providing students with successful strategies to use when reading and writing on an expository (science) text; text annotations and the reciprocal teaching summary. Conditional knowledge is learned through the teaching of these strategies, where and when to use them.

Goal 2: Students will strengthen their oral discourse as a result of a) increasing the amount of time they spend in class discussing science content and b) providing structured student interactions.

According to industry leaders in scientific research, “effective communication is central to scientific research practices” (Partnership for 21st Century Skills, 2009). Students learn science through participating in it via observation, exploration, and discussion. Given the strong connections between thought, language, and learning it is essential that students are provided opportunities to discuss and document their conceptual understandings (Vygotsky, 1986). In her work on academic literacy, Scarcella describes the linguistic components of Academic English as including; a lexical component- the forms and meanings of words used in academic disciplines, a sociolinguistic component- knowledge of language functions including expository and argumentative text, and the discourse component- transitional devices and organizational features that help English Learners develop ideas and transitions (2003). All of these linguistic components are practiced when students engage in scaffolded peer discussion. Through this practice students strengthen or increase their academic oral fluency. Content discussion is a critical element within the *WSL* curriculum. Students were provided numerous opportunities to engage in peer discussion during reciprocal teaching activities (described below). Furthermore, these discourse opportunities were appropriately scaffolded to allow students maximum engagement.

Goal 3: Students will strengthen their written discourse as a result of a) increasing the amount of time they spend in class writing about science content and b) practicing power writing.

The importance of strengthening (or improving) students' written discourse has extensive support in educational research (Deno, Marsten, & Mirkin, 1980; Elbow, 1981; Fisher and Frey, 2007; Moxely et al., 1995). In addition, numerous studies have validated the use of both discussion and writing to increase students' understanding in science (Wellington & Osborne, 2001; Ash, 2004; Kittleson, 2004). Rivard & Straw (2000) concluded that a curriculum that included both talk and writing increased students' understanding.

This goal also encompassed metacognition through declarative knowledge. The structure and purpose of Power Writing allows students to continually reflect on their own writing fluency. This reflection provides each student with constant feedback about his or her own learning, a critical component of metacognition (Yore and Treagust, 2006).

WSL addresses this goal via two main curricular activities, Power Writing- where students' focus on writing prompts that review recently covered material and summary writing. These activities require an increase in the amount of instructional time dedicated to writing. Both of these activities are further described in the curricular activities.

Curricular Activities

Power Writing

Power Writing consists of three one-minute timed writing sessions designed to increase fluency (Fisher & Frey, 2007). The teacher provides students with a writing prompt or sentence starter. For example, "The most important part of the circulatory system is… because…" After one minute of writing the students stop wherever they are and count the number of words they have written. Words are counted to determine if students are able to strengthen the amount of content related writing they are conducting. The entire process is repeated two more times using the same prompt. At the end of the three sessions, students fill in a graph of their best word count for the activity.

Reciprocal Teaching

Reciprocal Teaching is an instructional strategy first coined by Brown and Palinscar (1982). The process provides students with cognitive strategies and a structure for text comprehension. When used in *WSL*, the goal of reciprocal teaching is for students to make meaning of the presented text via discourse with group members rather than strictly relying on their comprehension of the words on the page.

WSL uses Reciprocal Teaching activities to promote student discussion and metacognition. Students work in groups of three to four to divide text into logical sections and complete specific tasks on a rotating basis. The tasks include: text reading and vocabulary identification, paraphrasing, asking a text-based question and answering the previously asked question. Instructions and note-making guides for Reciprocal Teaching can be found in the appendix of this thesis. This task was used four times to facilitate students' understanding of science content.

Rhetorical Reading/Annotating Text

One of the most powerful metacognitive strategies students can utilize when learning to write is text annotations (LeMaster, 2011). Annotations are developed as students examine the macro and/or microstructure of a text. Annotations include circling key vocabulary, underlining authors' claims and evidence and summarizing paragraphs in the text margins. Annotating allows students to analyze the choices an author makes when writing a text. According to LeMaster (2011), this "will help them understand the types of choices they can make in the papers they write." (p. 99). By focusing on both the structure and content of a text, students are able to reflect and analyze the structure and content of their own writing.

Students engage in text annotations numerous times within the *WSL* curriculum. While the type of text varies from informational to opinion-based, the students follow the same procedure of circling key vocabulary, underlining main ideas, identifying claims and evidence and summarizing in the text margins. At the completion of reading and annotating, students use a teacher-provided paragraph frame to write a summary paragraph of the reading.

Rhetorical Writing/Lab Summaries

The foundations of scientific literacy require students to differentiate claims based on evidence versus those based solely on opinion (CDOE, 2000). When students conduct laboratory investigation in their science courses they have an opportunity to practice real science, connect science concepts to their physical world and make a hypothesis (claim) based on the evidence provided in the investigation. Unfortunately, in my experience, evidence-based conclusions are often missing in students' laboratory reports or text summaries. While most lab investigations require students to answer analysis questions or write a lab conclusion, the conclusions I see are more often based on regurgitating memorized science facts than on the evidence they have just produced in the actual investigation. The purpose of an experiment is to test a hypothesis. While students understand this conceptually, they have extreme difficulty viewing the experimental results as evidence to support or negate their hypothesis. Often times, students need specific scaffolding and peer discussion to see this connection.

WSL promotes strengthening students' thought/ language connection, metacognition, and content knowledge in a safe, discourse-rich environment. Tasks are structured to optimize peer-to-peer discussion and to encourage students to think about their knowledge of science and specific reading and writing strategies to further their own fluency.

VI: IMPLEMENTATION AND REVISION OF THE *WRITING FOR SCIENCE LITERACY* CURRICULUM

The *Writing for Science Literacy* curriculum was implemented over the course of six weeks during two separate units of study for a General Science 1/Health class. The content used during the implementation was taken from the California state seventh grade science and health education content standards (California Department of Education, 2000 & 2009). Table 3 summarizes the national and state standards covered in the *WSL* curriculum.

Table 3: California and National Standards in Writing for Science Literacy

California State Science Standards (7^{th} Grade)	California State Health Education Standards (7^{th} & 8^{th} Grade)	National Science Education Standards
5. The anatomy and physiology of plants and animals illustrate the complementary nature of structure and function. As a basis for understanding this concept: c. *Students know* how bones and muscles work together to provide a structural framework for movement. 6. Physical principles underlie biological structures and functions. As a basis for un-derstanding this concept: h. *Students know* how to compare joints in the body (wrist, shoulder, thigh) with structures used in machines and simple devices (hinge, ball-and-socket, and sliding joints). i. *Students know* how levers confer mechanical advantage and how the application of this principle applies to the musculoskeletal system. j. *Students know* that contractions of the heart generate blood pressure and that heart valves prevent backflow of blood in the circulatory system.	1.3.G Explain the effectiveness of abstinence in preventing HIV, other STDs, and unintended pregnancy.1 1.5.G Explain the effectiveness of FDA-approved condoms and other contraceptives in preventing HIV, other STDs, and unintended pregnancy.2 1.6.G Identify the short- and long-term effects of HIV, AIDS, and other STDs.3	Science Inquiry Grades 5-8: 4. Skills necessary to become independent inquirers about the natural world. Life Science Grades 5-8: Structure and function in living systems Reproduction and heredity

School Environment Where Curriculum was Implemented

The *Writing for Science Literacy* curriculum was implemented at Beachside Middle School in the Surf School District.

Surf School District

The Surf School District serves over 43,000 students in twelve middle schools, twelve high schools, and seven alternative schools. White students make up 8.5% of students in the district, Latino students make up 74% of students in the district, and Asian students make up 2% of students in the district. The remaining 15.5% come from other ethnic backgrounds. English Language learners constitute 23.5% of the student population and 11% of the student population qualify for Special Education services.

Beachside Middle School

Beachside Middle School is located in a beach community within the Surf District in a large urban city. Beachside is one of twelve middle schools in the district. Of the 43,000 students serviced by Surf School District, Beachside has 1,061 in both seventh and eighth grade. The mission of Beachside, as described in their mission statement is, a vibrant oasis of student learning serving a diverse beach and border community, is to prepare students for a successful future through an inspiring system of learning distinguished by:

- An engaging and rigorous standards based curriculum
- Welcoming and involving parents as active participants
- Providing all necessary learning resources

- Staff that models lifelong learning through professional growth
- Promoting a supportive school culture
- Ensuring a safe school environment
- Providing academic support that meets the needs of all students

While all forty-seven teachers at Beachside Middle School are fully credentialed, only 56% are considered highly qualified according to the No Child Left Behind criteria, defined as having at least a bachelor's degree, an appropriate California teaching credential, and demonstrated core academic subject area competence. Latino students make up 74% of the student population while 11% are White, 1% are Asian, and the remaining 14% are made up of other ethnicities or more than one ethnicity. Forty-two percent of the student population is English language learners, 13% are students with disabilities and 72% are socioeconomically disadvantaged. The vast majority of English language learners come from Spanish-speaking homes.

In 2011, Beachside Middle School earned an API (Academic Performance Index) of 767. A school's API is based on the results of statewide testing with the purpose of measuring a school's academic performance or growth. The API index is a single number ranging from 200 (low) to 1000 (high). "The API is based on an improvement model. The API from one year is compared to the API from the prior year to measure improvement. Each school has an annual target, and all numerically significant subgroups at a school also have targets" (California Department of Education, 2011, p. 4). Schools who do not meet their growth targets are considered “program improvement” schools. 2011 marked Beachside Middle School’s fifth year in program improvement status with 64% of the students scoring either proficient or advanced on the California Standards Test (CST) in science. Thirty-four percent of the English language learners and 0% of the students with disabilities (defined as having either an Individualized Education Plan or a 504 plan) were proficient or advanced on the same CST test. It is the low scores of these subgroups that prevent the school from exiting program improvement status. Schools that have been in program improvement for five years or more are subject to alternative governance by the state including the closing of the school and re-opening as a charter, elimination of most of the staff, and/or take over by a federal agency.

General Science/Health Classroom

The *Writing for Science Literacy* curriculum was implemented in a sixth period Structured English Immersion seventh grade science class. The District offers Structured English Immersion classes when either there are not enough parents who sign a bilingual-education waiver or the language level of the students is above the beginning English stage. I was not the teacher of record for this class, rather I co-taught the curriculum with the regular teacher. Both the regular teacher and myself were present for all curriculum activities. While we traded off who taught the lesson (depending on the classroom teachers comfort with the curriculum), we were both available for student questions and group supervision. While the average class size for science classes at Beachside Middle School is twenty-eight students this class had thirty-five students of which thirty-two are English language learners, two are reclassified English proficient and one is an English only speaker. Thirty-three of the students are socioeconomically disadvantaged as defined by the state of California and four students are classified as special education (two of which are mild-moderate). The class met for 54 minutes every day with a shorter, 35-minute period, every other Friday.

The classroom teacher is in her second year of teaching and has worked at Beachside Middle School for both years. The teacher, Ms. Henry, has great rapport with her students and they seem to really like her. Her instructional routine is well established and the students know what is expected of them daily. Because I serve as the District Resource Teacher for Beachside Middle School, Ms. Henry has approached me in the past about including alternative instructional strategies as she fears “she does the same thing every day.” She was also concerned that her SEI class was not achieving at the level of her other classes. The daily classroom routine was as follows; students entered the classroom and began to write out their "quick questions" in their notebooks. The quick questions were always three questions that remind students’ of the previous days learning and that preview the current lesson. Following the quick questions, students recorded the daily learning target (DLT) and then the students chorally read the DLT. Ms. Henry would then call on volunteers to answer the quick questions aloud. The students would then begin to take Cornell notes from the prepared PowerPoint. After 5-6 slides, the teacher had the students stand up and answer two check-in questions with a partner. After about one minute they would all sit down and the teacher called on volunteers to answer the check-in questions. The class continued in this matter until the bell rang 54 minutes later. This is what the students did every day unless there was a lab or a test.

Ms. Henry's is not bound by a departmental instructional routine. She has developed this pattern of "lecture every day" because she feels it is the only way to cover the entire required course content. She does not routinely teach laboratory investigations or have the students participate in discussion-based activities because she feels they take too much time. Her perspective and approach to teaching science is very common in the Surf District.

Implementation

Prior to implementing any curriculum in Ms. Henry's class I spent several hours observing her teaching style and the students' learning needs. Ms. Henry is what I would describe as a safe teacher; she is very concerned that she covers all the material the students may be tested on. To that end, she is willing to sacrifice individual student understanding in favor of moving the content forward. However, she enjoys her job immensely and seems to truly care about her students so the decision to cover more content was not made easily by her and it is something she has shared her concerns about with me. As a result of Ms. Henry's decision to cover all the content, students were not receiving a lot of language support. When this class, also a

Structured English Immersion class, fell behind the other classes, she would skip lab investigations in favor of more direct instruction. While she was open to other curricular approaches, her desire to implement them often conflicted with the need she felt to cover the material. She was very forthright with me regarding her concerns for her students and was open to an alternative approach; she just needed to see it modeled. All of these factors were taken into account when I designed and implemented *Writing for Science Literacy* in her classroom.

The remainder of this chapter will describe each activity that was implemented in the curriculum. Each section consists of a description of what occurred, the data that were collected, and modifications that were made during implementation or intended for future implementations.

Activity One: Power Writing

The first activity implemented in *Writing for Science Literacy* was power writing. This activity was completed twice a week, at the end of class, for the duration of the implementation. I conducted the initial instruction on this activity and Ms. Henry took charge of the remaining implementations.

Before beginning the activity, I distributed small composition books to all the students. I also provided them with a graph to glue in the front of the book (appendix). This graph would be used to keep track of their Power Writing progress. The students were told that this activity would help increase their writing fluency. I then solicited definitions from the students on fluency. The instructions for the activity were that the students would be given a sentence starter on a topic we learned that day. They were told to write as much as they could about the topic for one minute. They were encouraged to keep writing even if they got stuck or needed to skip a word for lack of knowledge of an English equivalent. The students were then given the sentence starter and the timer began. After one minute, the timer sounded and I asked students to stop. This process was immediately repeated two more times for a total of three cycles (three minutes of writing). At the conclusion of the third cycle, students were instructed to count up the words for each section. They then graphed the highest total words on their graph under a column labeled with the date.

Modifications for Activity One. After the first two power writing sessions Ms. Henry reported that the students were having difficulty writing for all three minutes. They were complaining that their hands were hurting and the results were indicating that the second cycle was a higher word count than the third cycle due to fatigue. After some initial reservations, I decided to modify the activity to only two cycles of writing. I felt that the students had such limited practice with writing that three cycles was indeed asking too much of them. I communicated my modification to Ms. Henry. Interestingly, Ms. Henry either forgot about this change or decided against it because she never reduced the power writing cycles from three to two. After two more weeks of the activity, students had become accustomed to the writing and the third cycle was showing the greatest word count as predicted by Fisher and Frey (2007).

Activity Two: Reciprocal Teaching

This activity was completed four times during the *Writing for Science Literacy* curriculum implementation. The goal of this activity was to help students make sense of informational (expository) text so their adopted textbook, *CPO Life Science* was used for three cycles. The last cycle used an Op-Ed piece so the students had practice in using the strategy for a variety of text types. The first reciprocal teaching cycle was taught by me, with Ms. Henry teaching the remaining three cycles.

For this activity, students were given a Reciprocal Teaching Note-Making Guide and a scaffolded summary form (see Appendix). Students worked in groups of three or four according to their table assignments. Each table group was given four reciprocal teaching cards labeled A, B, C, and D. The cards were two sided with the letter on the front and the “role directions” on the back. Each role was modeled for the students prior to the activity. The activity used four roles as described in Figure 2.

A: Read/Vocabulary
- READS the text aloud
- IDENTIFIES any essential vocabulary in the selection

B: Summarize
- SUMMARIZES/PARAPHRASES what was read

C: Right There Question
- ASKS a question that can be answered from the reading

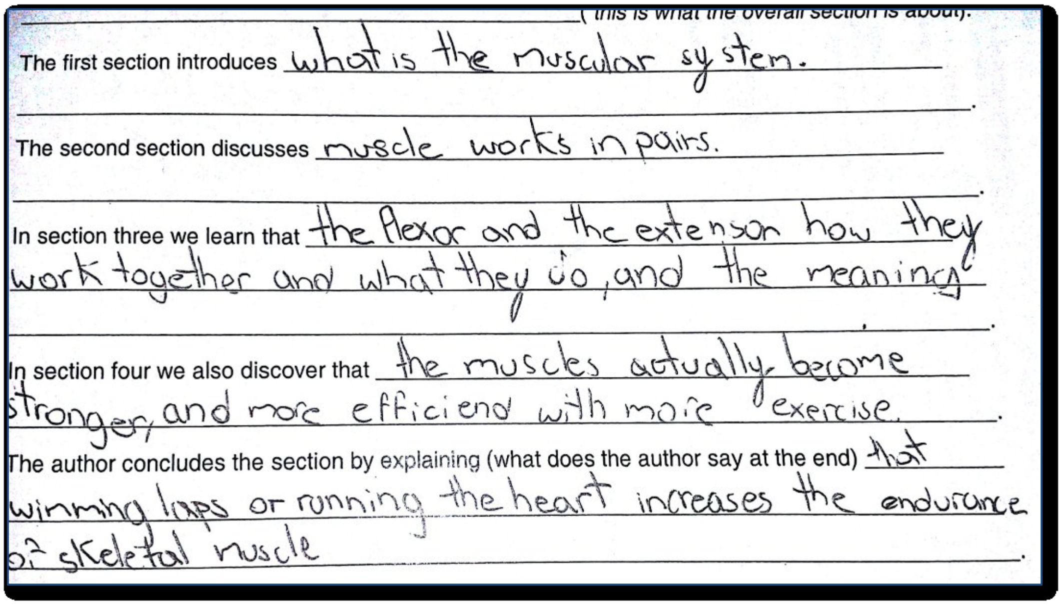
D: Answer the Right There Question
- Answers the question, gathers consensus from group

Figure 2: Reciprocal Teaching Roles

The groups' first job was to number each paragraph of their reading selection. They then needed to assign each participant a letter and take the appropriate card. Starting with paragraph one, participant A read the paragraph aloud and selected any essential vocabulary. Students were instructed in how to identify essential vocabulary in their textbook. Participant A presented their findings to the group and they were required to get agreement on the words selected. All participants then wrote the words on their note-making guide. Participant B then completed their required task. The cycle continued with each participant completing his or her task in turn. All participants were required to get group consensus before they all wrote down the required information on their note-making guide. Once all participants had completed their task, they rotated task cards clockwise and proceeded to read paragraph two.

When all the paragraphs had been read, the students were instructed to fill out their paragraph frame (Appendix) using the paragraph summaries on their teacher created note-making guide (Column B). The purpose of the paragraph frame was to provide a scaffolded approach to summary writing so students would see that a text summary is really only a collection of smaller paragraph summaries.

Modifications for Activity Two. The structure provided for reciprocal teaching worked perfectly. Students did need to be constantly reminded to come to consensus verbally rather than just copying each other's work. As long as students followed the instructions, the activity met its goal. I did end up making one modification during the implementation. The results of the first session showed that students simply copied their summary from their note-making guide regardless of whether it made sense in the paragraph frame. Figure 3 shows an example of this with KT's summary frame.



(this is what the overall section is about).

The first section introduces what is the muscular system.

The second section discusses muscle works in pairs.

In section three we learn that the flexor and the extenson how they work together and what they do, and the meaning.

In section four we also discover that the muscles actually become stronger and more efficiend with more exercise.

The author concludes the section by explaining (what does the author say at the end) that winming laps or running the heart increases the endurance of skeletal muscle.

Figure 3: Scaffolded Paragraph Frame Student Sample 1

The sentences KT added to the frame were simply copied from the note-making guide and she had not paid attention to the context of the information. To help students better understand the correct grammatical structure of their sentence an additional step was added to the process. After completing the paragraph frame, students were instructed to recopy the summary paragraph, paying close attention to whether or not the sentences made sense when read aloud. This additional step resulted in more concise, grammatically correct summaries. KT's rewritten summary is illustrated in Figure 4.

Rewrite the summary above in a paragraph on the lines below.

In this section entitled "Muscular System," the author is
informing us about the nuscular system and movement.
The first section introduces what is the muscular system?
The second section discusses that muscles work's in pairs.
In section four we also discover that the muscles actually become
stronger and more efficiend with more exercise.
The author concludes the section by explaining that swimming laps
or running the hearth increases the endurance of skeletal muscle.

Figure 4: Summary Paragraph Re-Write Student Sample 1

Activity Three: Rhetorical Reading/Annotating

This activity was completed three times during the implementation. I coached Ms. Henry on this strategy prior to this curriculum implementation so she taught the activity all three times. For this activity, students were provided with a text selection that related to the course content. Students were then instructed to annotate the reading selection using the following guidelines; underline the main claim of the article and any evidence which supported the main claim and circle any words they did not know.

Modifications for Activity Three. This activity worked as expected and no modifications were made.

VII. EVALUATION OF THE *WRITING FOR SCIENCE LITERACY* CURRICULUM

The overall purpose of the *Writing for Science Literacy* curriculum was to help students become more scientifically literate as defined by the National Science Education Standards, "the capacity to pose and evaluate arguments based on evidence and to apply conclusions from such arguments appropriately" (National Research Council, 1995). This purpose was accomplished by increasing the number and type of writing activities students completed, scaffolding the process of summarizing scientific text, and requiring students to write their own conclusions and summaries based on textual evidence. The specific activities implemented in *WSL* were designed to help increase oral and written fluency, as well as, reading and writing rhetorically within a science classroom via three specific goals:

> Goal 1: Students' conceptual knowledge will increase as a result of writing evidence-based conclusions.
>
> Goal 2: Students will strengthen their oral discourse as a result of a) increasing the amount of time they spend in class discussing science content and b) providing structured student interactions.
>
> Goal 3: Students will strengthen their written discourse as a result of a) increasing the amount of time they spend in class writing about science content and b) practicing power writing.

For the purpose of goals two and three strengthen was defined as a student's ability to accurately explain scientific concepts while appropriately utilizing academic vocabulary. A variety of data collection strategies were used including pre- and post-implementation surveys, pre- and post-implementation teacher interviews, power writing journals, reciprocal teaching summaries, teacher field and discussion notes, and quizzes as displayed in Table 4.

Table 4: Goals and Evaluation Alignment

Goal for Students	Data for assessment of Student Learning and/or evaluation
Students' conceptual knowledge will increase as a result of writing evidence-based conclusions (Common Core Reading Standards for Literacy in Science and Technical Subjects 6-8.1).	• Reciprocal Teaching summaries • Teacher interview • Power Writing Journals • Quiz scores
Students will strengthen their oral discourse as a result of a) increasing the amount of time they spend in class discussing science content and b) providing structured student interactions.	• Reciprocal Teaching summaries • Field notes • Teacher interview • Lesson Plan Analysis
Students will strengthen their written discourse as a result of a) increasing the amount of time they spend in class writing about science content and b) practicing power writing.	• Power Writing journals • Reciprocal Teaching summaries • Student surveys • Lesson Plan Analysis

This combination of student-produced writing, teacher observations, lesson plan analysis, and formative assessments provided the necessary information to evaluate the effectiveness of the curriculum.

Data Collection Strategies

Pre- and Post-Implementation Surveys

The pre- and post-implementation surveys asked the students to respond to five statements using a five-point Likert scale ranging from 1 (no way) to 5 (definitely).

1. Talking to someone about science helps me to understand it better.
2. When I read my science textbook, I understand it the first time.
3. I have an easier time writing in science if I talk to another student first.
4. I have an easier time remembering science if I write about it or take notes.
5. When I write in science I use skills or ideas learned in my English class, like annotating, summarizing, using evidence.

Students filled out the pre-implementation survey prior to engaging in any curriculum activities. The post-implementation surveys were completed two weeks after the last curriculum activity was implemented. There was a time delay due to spring break.

Pre- and Post-Teacher interview Surveys

I interviewed the classroom teacher prior to the implementation of the curriculum. The interview questions focused on the amount of time dedicated to, and scaffolding provided for both student discussion and writing tasks. The teacher was also asked what skills her students would need to become scientifically literate which was defined as the ability to break down a scientific argument in terms of claims and evidence and then to build their own argument based on claims and evidence. The post-implementation teacher survey focused on the following five questions:

1. What was successful about the curriculum and what evidence would you use to demonstrate that success?
2. What did you find challenging or difficult with this curriculum (in regards to both implementation and content)?
3. What kind of support was helpful to you in trying to implement a writing curriculum in a science class?
4. The goal of this curriculum was to increase the students' scientific literacy (their ability break down a scientific argument in terms of claims and evidence and then to build their own argument based on claims and evidence). Given this goal, how successful was this curriculum for your students?
5. Please give me any other feedback you have on this curriculum.

Power Writing Journals

Power Writing consisted of three one-minute timed writing sessions designed to increase fluency, defined as written discourse in this curriculum (Fisher & Frey, 2007). The teacher provided students with a writing prompt or sentence starter. For example, "Some of the differences between bacteria and viruses are…". The students were then instructed to write as much as they could, as well as they could for one minute. After one minute of writing the students stopped wherever they were and counted the number of words. The entire process was repeated two more times with the same prompt. At the end of the three sessions, students filled in a graph of their best word count for the activity. This activity was modified from the original Fisher and Frey model in that students were not instructed to underline grammatical errors. Since the focus students were English Language Learners I did not require the students to mark their grammatical errors. I wanted the students to focus on getting out as many words as they could in the given time. I didn't want them to be slowed down trying to translate into the correct grammatical format for English.

Text Annotation

Students engaged in text annotations numerous times within the *WSL* curriculum. While the type of text varied from informational to opinion-based, the students followed the same procedure of circling key vocabulary, underlining main ideas, identifying claims and evidence and summarizing in the text margins. At the completion of reading and annotating, students used a teacher-provided paragraph frame to write a summary paragraph of the reading.

Reciprocal Teaching Summaries

Brown and Palinscar (1982) first described Reciprocal Teaching as a process that provides students with cognitive strategies and a structure for text comprehension. The goal throughout the activity was for students to make meaning of a selected text via discussion with other students rather than strictly relying on their comprehension of the words on the page.

WSL used Reciprocal Teaching activities to promote student discussion and metacognition. Students worked in groups of three to four to divide a text into logical sections and complete specific tasks on a rotating basis. The tasks included: text reading and vocabulary identification, paraphrasing, asking a text-based question and answering the previously asked question. Instructions and note-making guides for Reciprocal Teaching can be found in the Appendix of this thesis. This task was used three times to facilitate students' understanding of science related text.

Quiz Scores

Throughout the unit, the classroom teacher assessed students using formative assessments/quizzes that she designed for use with all her science classes. Quizzes were usually given on Fridays to assess the students' comprehension for the week and consisted of approximately five to ten multiple choice questions. In *WSL* quiz scores were used as an additional way to assess science conceptual knowledge.

Observations and Field Notes

Throughout the course of the implementation I took notes on both the content, pace and structure of the class, as well as group discussion occurring during reciprocal teaching activities. The purpose of note-taking on the content, pace and structure of class was to determine if the amount of time dedicated to writing or discussion activities had increased throughout the implementation as opposed to the amount of time dedicated to these activities prior to implementation. Discussion notes allowed me to determine if the students were on task during the activity as well as to determine the quality and quantity of their group discussions. Field notes were taken during the course of class and were later analyzed and compared with other data to assess the effectiveness of WSL in meeting its sated goals.

Examining the Data

To evaluate the effectiveness of *WSL* a variety of data collection strategies were utilized including: pre- and post-implementation surveys, pre- and post-implementation teacher interviews, power writing journals, reciprocal teaching summaries, teacher field and discussion notes, and quizzes. All quantitative survey data were from the entire class of thirty-five students.

Goal 1: Students' conceptual knowledge will increase as a result of writing evidence-based conclusions.

To determine if this goal had been met, I analyzed four sources of data: the reciprocal teaching summaries completed by all students, teacher interview questions, power writing journals and quiz scores. The summary frames utilized in the reciprocal teaching activities suggested if the students were able to identify the evidence from the selected text and if they were able to use that evidence in writing their own conclusions. To determine the success of *WSL* in meeting goal 1, I used the teacher post-implementation survey, specifically question four, which reminded the teacher of the goal of this curriculum and then asked how successful this curriculum was for her students? I was also able to score the power writing journals for content accuracy. Lastly, I compared pre-implementation quiz scores with quiz scores during *WSL* implementation.

Finding 1: Students demonstrated an increased ability to write an evidence-based conclusion.

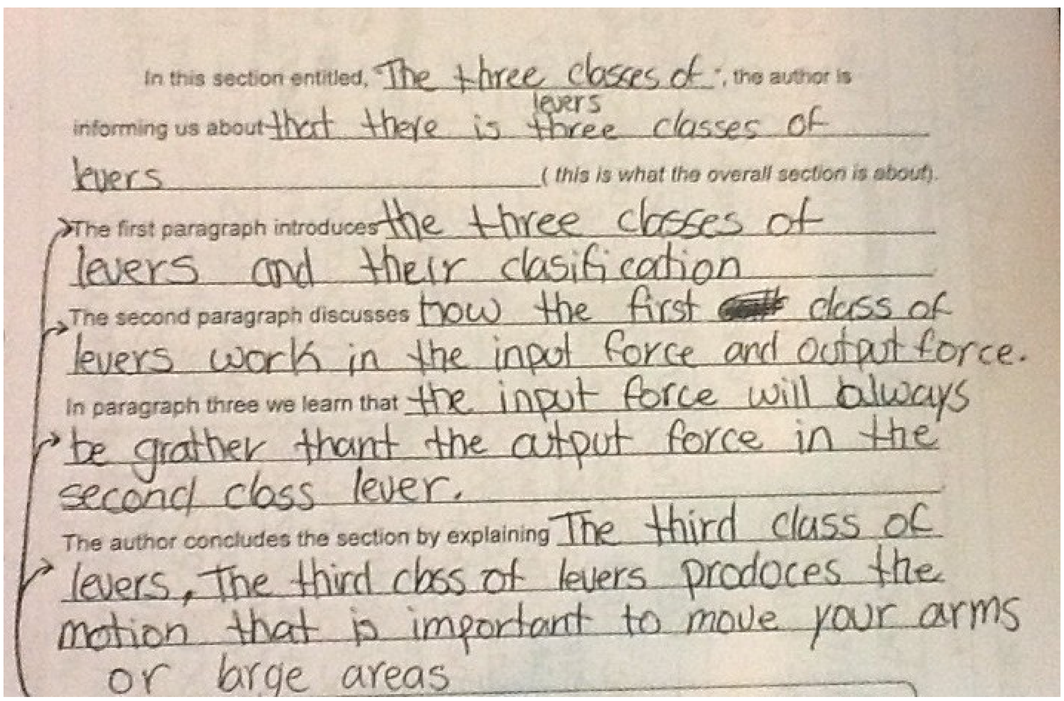
Prior to the implementation of *WSL*, the cooperating teacher spent very little class time having students summarize their reading. I was able to use one pre-implementation activity as a source of comparison for students' ability to write evidence-based conclusions. For the purpose of this curriculum, I defined an evidence-based conclusion as a summary that cited specific text features (evidence) to support the author's claim (the purpose of their text). The pre-implementation activity required students to annotate a visual text. As part of the assignment, students were asked to summarize their annotations into a purpose statement. The visual they were given illustrated the processes of true-breeding and cross-pollination in sweet peas. An accurate purpose statement should have something about the differences between the two types of pollination (or breeding). Figure 5 provides a sample of students' purpose statements.

Prompt: Write a sentence or two that identifies the purpose of the visual, and how the visual connects to the surrounding text.
JB: "The purpose of the visual is to self-pollinate." AE: "The purpose of the visual is that we know what we are reading." GR: "The purpose of the visual is to know what he means by doing what you are doing." VM: "The purpose of the visual is to see <u>how</u> they transferred."

Figure 5: Purpose Statements- Student Samples

As Figure 5 demonstrates, the purpose of the visual text was not clearly understood by the students. Additionally, none of the students addressed the second part of the prompt, explaining how the visual text connects to the surrounding text.

WSL required students to read a piece of science text (usually one to two pages) and summarize the material in the text into a conclusion. Figure 4 below shows a typical conclusion paragraph using a teacher provided scaffold. Although the pre and post samples were taken from two different class periods, the cooperating teacher confirmed that the results seen in the pre-implementation activity were typical of all her classes.


In this section entitled, The three classes of levers, the author is informing us about that there is three classes of levers (this is what the overall section is about).

The first paragraph introduces the three classes of levers and their clasification

The second paragraph discusses how the first class of levers work in the input force and output force.

In paragraph three we learn that the input force will always be grather thant the output force in the second class lever.

The author concludes the section by explaining The third class of levers, The third class of levers prodoces the motion that is important to move your arms or large areas

Figure 6: Scaffolded paragraph frame student 2 sample

As Figure 6 demonstrates, through the reciprocal teaching summary frame, the sample student was able to clearly extract the main point of each passage of text. She was also able to recreate the author's point into the provided summary frame in a grammatically correct manner. This result was typical of all the students in the class, although the correct use of grammar did vary based on the ELD level with level one or two students having more difficulty with the grammar than level five or six students.

The teacher post-interview confirmed these findings. In her own words:

> I believe the success of promoting and increasing students' scientific literacy was successful. Students were able to discover the main claim and the underlining evidence or support each statement (sic). They were also able to develop their own opinions toward these topics. This could be seen in the detailed nature of the summaries (post-implementation survey question four, May, 2012).

Finding 2: Students' knowledge of science content (conceptual knowledge) increased.

Students took three multiple-choice standards-based quizzes throughout the course of the implementation. For these three quizzes the average score was 74%. When these scores were compared to the last three quizzes prior to implementation (68% average score) there was an overall average increase of 6%. All six quizzes were the same format. When this data was compared to other class periods, which did not received the *WSL* curriculum, the results were dramatically different. As previously mentioned, *WSL* was implemented in Ms. Henry's General Science1/Health Structured English Immersion class. Her remaining four periods were regular General Science1/Health courses and they did not receive the *WSL* curriculum.

Structured English Immersion classes are designed to provide students with access to the core curriculum in a way that furthers their English language proficiency, specifically academic English (Echeverria and Short, 2010). Because students in these classes are still attempting to master academic English, their content assessments tend to be lower than English proficient students in the same course (Amaral, Garrison & Klentschy, 2002). When comparing the quiz scores for the same series of quizzes the scores increased in the implementation class and decreased (with one small exception in period 4) over time for the non-implementation classes as seen in Figure 7. This is the opposite of what you would normally expect to see.

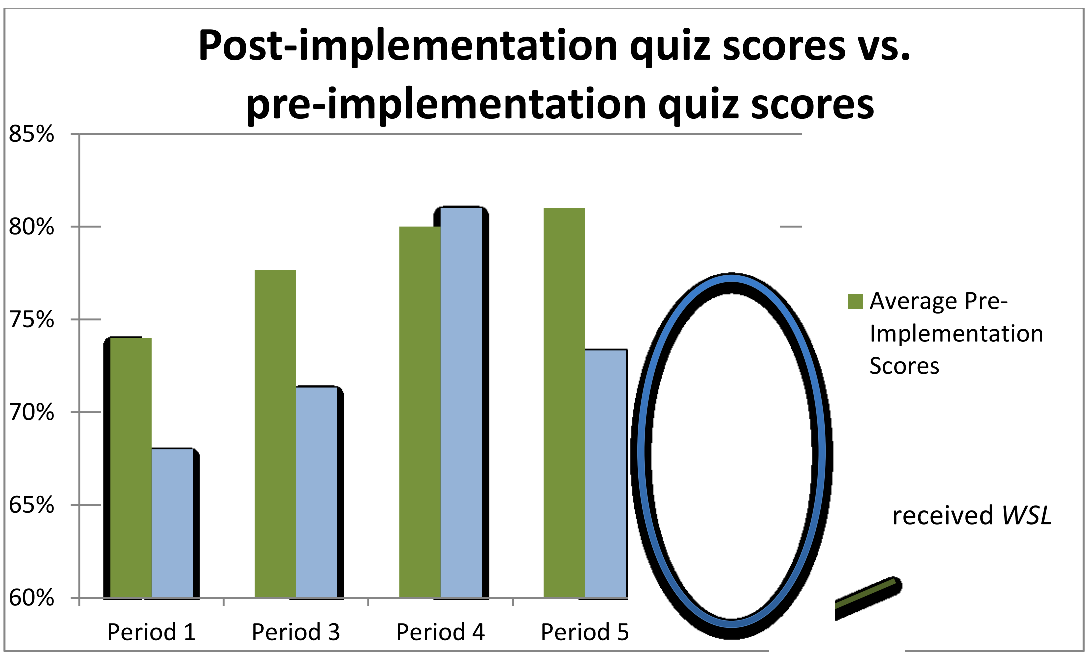


Figure 7: Quiz Score Comparison

A prominent feature of the *WSL* curriculum was the use of power writing journals. These journals were intended to increase students written fluency by having them write numerous times on the same topic. The journals were always used at the end of a class period and would review a concept learned that day. When I reviewed these journals for evidence of strengthened written discourse, I noted that the science content was accurate. I compared the number of content accurate entries to the total number of entries. Of the 282 total journal entries, 246 contained accurate science content or 87%. Figure 8 provides some excerpts from students' journals that illustrate content accuracy.

KC: "The skeletal system protects your heart and give you shape such as your hips widen for girls"

ML: "The muscular system is something in your body that lets you do movements"

NP: "A joint is when a ball and socket can move in a circle. Slide joint can let you slide and a pivot is when you move your head left, right, up and down."

TV: "Force is when u puch or pull an item you are extending force on to force is measured in N Newtons you exert 1n of force when u lift an apple."

Figure 8: Student power writing samples

Although there are numerous grammatical errors found in the students' writing, the content is scientifically correct. Thus, the students understand and accurately remember concepts learned during the class period.

Goal 2: Students will strengthen their oral discourse as a result of a) increasing the amount of time they spend in class discussing science content and b) providing structured student interactions.

For the purpose of this goal strengthen was defined as a student's ability to accurately explain scientific concepts while appropriately utilizing academic vocabulary. I determined that this goal was met by analyzing the reciprocal teaching field notes, lesson plans, and post-implementation surveys. The reciprocal teaching activity required students to discuss the text content throughout the course of the activity. This activity was completed four times during the *WSL* curriculum. Each time the activity was conducted, it took the students approximately forty-five minutes to complete it. For each paragraph of text, a student read the paragraph orally to their group, discussed critical vocabulary within the paragraph, negotiated a summary of the paragraph, and asked and answered a question within the paragraph. All of this work was done in groups of three or four and required group consensus before anything was committed to paper. During each reciprocal teaching activity I took field notes that were analyzed for both quality (questioning level, accuracy) and quantity (time on task) of oral discussion. Finally, since I had made several observations of this teacher prior to implementing *WSL*, I was able to compare the amount of time dedicated to oral fluency before and during implementation.

Finding 3: The amount of time students spent engaging in structured interactions increased as a result of increased lesson time allotted by the teacher.

Analyzing the amount of discussion time allotted in the teacher's lesson plans before and during implementation as well as the actual time in class allotted to student structured interactions supported this finding. Prior to the *WSL* curriculum, the teacher had a specific lecture routine. At the beginning of class students would write down the daily learning target and answer three to four warm-up questions. Students would then chorally read the daily learning target and the teacher would call on volunteers to share their responses to the warm-up questions. The teacher would then begin her lecture for the day that was always conducted via a PowerPoint display. After five to six slides, the teacher would have students stand up and answer a question in pairs for one minute. Questions were always simple recall. As no structure for the task was provided, all students would stand up at once. They may or may have not successfully located a partner. Both partner students would then talk at the same time (over each other) and no one was really listening to their partner as all students in class were talking at once. This process was repeated three to four times during the 55-minute period. So, at most, students had five to six minutes allotted to their own speaking during the course of any class.

WSL incorporated a discussion-based activity in the form of reciprocal teaching. This activity required an on-going student-to-student discussion over the course of the period. Each student had a specific role for each round of the activity. There were a minimum of four rounds per activity and each role took approximately 3 minutes to complete. Thus each student spoke a minimum of 12 minutes per class period. This does not include any time that students were asking questions or clarifying information outside of their specific group role.

Finding 4: The quality of student discussions increased over time as a result of more class time dedicated to discussion tasks.

The quality of student discussion continually increased over the course of the four reciprocal teaching activities. Quality was defined as the percentage of time students spent talking about science using appropriate academic language. During the first activity, students had a difficult time discussing the text. The majority of time was spent with one student reading or reciting their answer and then the other students copying those answers on their own paper. When questions were asked, they were limited to, “Do you all agree?” or “What did you write?” During the final implementation of rhetorical teaching, the quality of student-student discussion had dramatically increased. Rather than copying each other’s written work, students were orally repeating their answers for their fellow group members. Additionally, students were asking clarifying questions, using specific text references to answer questions, and using their own words to answer questions. I feel this increase in the quality of interaction was due to several factors. First, the student group remained the same throughout the course of the implementation. Therefore, students were able to build a discussion community and support each other when needed. Second, the activity provided a specific structure so students were always aware of the expectations, their role and task, and they were held accountable for the work they did. Figure 9 displays some student discussion noted during the final activity.

TA to group member: “Do we have to put words from the paragraph or can we use our own words?”

RB: “The question is what is the advantage of a lever?”

SE to AE: “I don’t think that is what third class levers are?”

AE: “Well it says right here that a third class lever has the fulcrum between the input and output force.”

SE: “Oh, I thought that was describing a first class lever.”

Figure 9: Discussion notes

Goal 3: Students will strengthen their written discourse as a result of a) increasing the amount of time they spend in class writing about science content and b) practicing power writing.

The success of this goal was determined by conducting a quantitative analysis of the word counts in the students Power Writing journals. I also analyzed the reciprocal teaching summaries for accuracy using a four-point rubric. For the purpose of this goal, just as with oral discourse, strengthen was defined for written discourse, as a student’s ability to accurately explain scientific concepts while appropriately utilizing academic vocabulary.

Finding 5: The word count for students increased over the course of the ten Power Writing sessions.

The word count for students increased from a mean of 18 words to a mean of 27 words over the course of the ten Power Writing sessions as displayed in Figure 10.

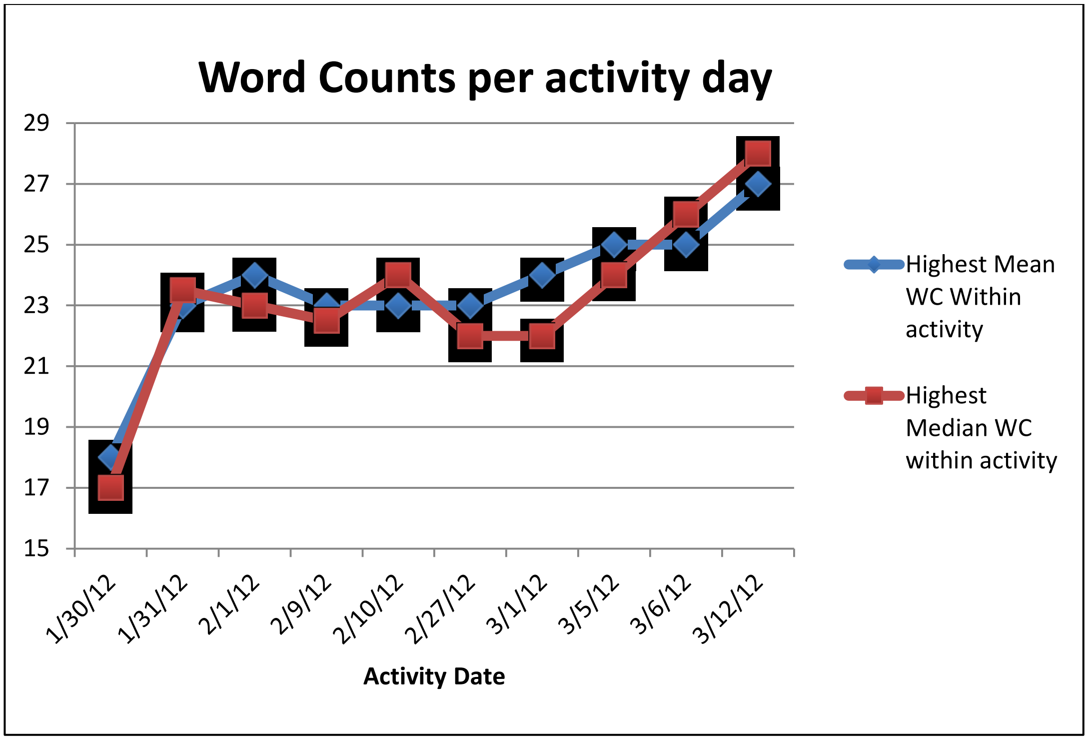
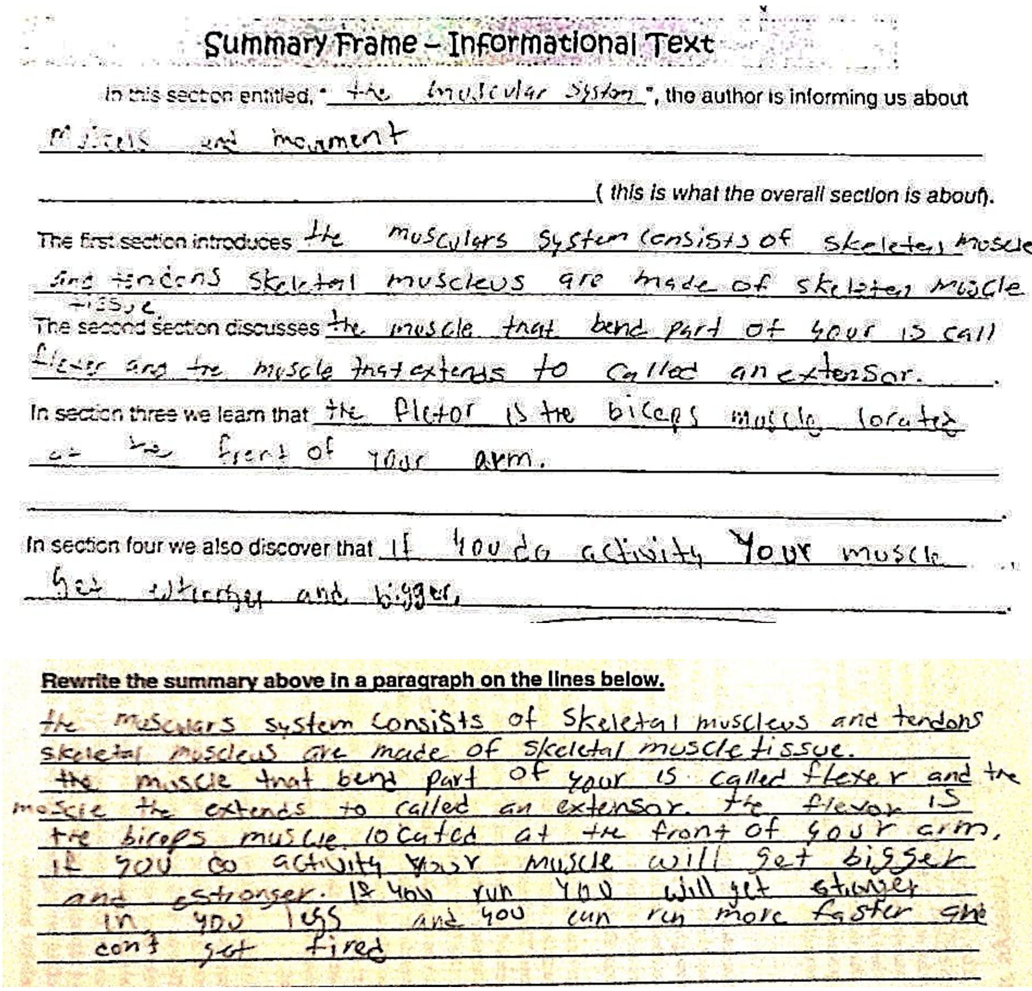


Figure 10: Power writing word counts

Both mean and median word counts were calculated to determine if there was a significant difference. If there were a difference between the mean and median it would indicate that there were a disproportionate number of high or low scores (outliers) as compared to the middle score in the range. As the graph displays, these two data sets were very close to each other that indicates that there was a fairly even distribution of scores with no significant outliers. As mentioned in Goal 1, Finding 2, the content accuracy of the power writing journals was also high. These findings indicate that the use of the Power Writing activity may have helped strengthen students' written discourse while maintaining their content accuracy.

Finding 6: The quality of student writing increased over time as a result of more class time dedicated to writing tasks.

The reciprocal teaching activity was conducted four times over the course of *WSL*. During the initial activity, students had a difficult time transferring the information written on the note-making guide into a grammatically correct summary paragraph. I believe this had to do with the structure of the paragraph frame utilized in the activity. After the curriculum was revised to include a second re-write, students were able to write more grammatically correct paragraphs as illustrated in Figure 11.



Summary Frame – Informational Text

In this section entitled, "the muscular system", the author is informing us about muscles and movement (this is what the overall section is about).

The first section introduces the musculars system consists of skeletal muscles and tendons skeletal muscleus are made of skeletal muscle tissue

The second section discusses the muscle that bend part of your is call flexer and the muscle that extends to called an extensor.

In section three we learn that the flexor is the biceps muscle located at the front of your arm.

In section four we also discover that if you do activity your muscle get stronger and bigger.

Rewrite the summary above in a paragraph on the lines below.

the musculars system consists of skeletal muscleus and tendons skeletal muscleus are made of skeletal muscle tissue. the muscle that bend part of your is called flexer and the muscle the extends to called an extensor. the flexor is the biceps muscle located at the front of your arm. if you do activity your muscle will get bigger and stronger. if you run you will get stronger in you legs and you can run more faster and cont get tired

Figure 11: Paragraph summaries- student sample 3

This example illustrates how the student was successfully able to transfer paragraph summaries from his note-making guide into the paragraph frame. The second step was to re-write the paragraph frame making sure that the paragraph contained the correct syntax. The student also successfully accomplished this task. The final reciprocal teaching summaries had an average rubric score of 3.6 out of 4. This demonstrates that students were able to accurately write a summary of a given science text. Prior to *WSL*, students were not able to accurately summarize a piece of text as demonstrated in the pre-implementation annotation activity previously mentioned.

Summary and Discussion

The overall goal of *Writing for Science Literacy* was to help students become more scientifically literate through scaffolded writing and discussion tasks. The specific activities implemented in *WSL* were designed to help increase oral and written fluency, as well as reading and writing rhetorically within a science classroom. Based on the data, students who participated in the *WSL* curriculum were able to increase their written fluency, increase their oral fluency, and accurately write an evidence based conclusion all while increasing their conceptual knowledge.

Writing for Science Literacy is grounded in four constructs: thought and language, scaffolding, fluency and metacognition. Throughout the course of the curriculum students increased the amount of time they spent both speaking and writing science information. Students were always given the opportunity to discuss content with a partner or group prior to committing thoughts to paper. The activities in *WSL* are scaffolded to optimize the engagement and success of the English Language Learners participating in the curriculum. All activities in the curriculum require students to listen, read, write, and speak in an effort to increase their oral and written fluency. Lastly, *WSL* encourages development of student's metacognition through the use of text annotation and note-making guides.

While *WSL* is an effective curriculum for increasing students' declarative, procedural, and conditional knowledge it is only one small step in a bigger curriculum picture. Throughout the implementation of this curriculum students were able to use discussion-based tasks to more effectively summarize scientific texts and arguments. The next step would be to broaden *WSL* to include laboratory conclusions. When students participate in an experiment, they are conducting scientific inquiry, a vital and relevant skill for today's students. If students can take the information gleaned from investigations and research and use it to create an argument that is supported by evidence then they have truly become scientifically literate citizens. This is who we need to think critically about and act upon today's and the future's global concerns.

VIII. CONCLUSION

Scientific literacy has long been a goal of science curriculum reform. The California State standards address the importance of literacy, and the Next Generation Science Standards further emphasize the need to teach students to read and write science, by clearly outlining the necessary skills required to achieve scientific literacy. My curriculum project clearly illuminated the need for professional development if we expect science teachers to pursue writing goals with their students. Throughout the course of the project I learned two important lessons. First, curriculum specifically geared toward writing and curriculum, which is scaffolded for English Language Learners, can improve both student's content knowledge and writing skills in a science course. Second, science teachers need substantial support if they are expected to teach true scientific literacy.

The world we live in is significantly different then it was only ten years ago. Information no longer has to be memorized; it is readily available via smartphones, iPads, and laptops. Educational pedagogy needs to catch up to our changing society quickly. Students need to be taught how to think critically, how to apply processes and skills to novel situations, and how to work as a team. These skills cannot be learned from a lecture; they must be experienced. By denying students opportunities to participate in experiments and think critically, we are denying them a successful future. More importantly, we are ensuring America's decline in the global marketplace.

WSL provides a clear indicator that content can be mastered in a discourse-rich curriculum without sacrificing standardized testing scores. In fact the students experiencing *WSL* actually scored higher on multiple-choice recall items than the students experiencing pure lecture. The Next Generation Science standards can hopefully bridge the content divide but professional development will also be a critical factor in changing our current reality with youth in our schools.

I selected my co-teacher because she had expressed a previous interest in incorporating more reading and writing into her courses. Although she was a fairly new teacher, she was very motivated to use strategies and structures within her classes to improve student learning. Despite a strong desire on her part to incorporate literacy, she had difficulty making time for it within her pacing guide. Throughout the implementation, she continued to view literacy as something additional to content curriculum as opposed to considering the literacy activities as part of the content. Even though the students' test scores consistently rose over the course of the implementation, she was never convinced that the increase was due to the discourse activities we had implemented.

If we expect science and social science teachers to tackle literacy, as required by the new Common Core Literacy Standards, then we have to provide professional development that supports this task. Furthermore, the professional development has to be provided in an ongoing support model.

This is a paradigm shift that will not happen over night. Teachers need to realize that time dedicated to discourse and inquiry strengthens their curricular goals and that standards based assessment and discourse are not mutually exclusive goals. The current feeling among many science teachers is that they need to cover every science standard and the only efficient way to do that is through lecture. The reality is, a curriculum consisting only of lecture will actually take longer to cover. The socio-cultural theory of learning holds that language and learning are intimately connected. Without discourse, there can be no deep learning. By denying students the opportunities for discourse, teachers are creating a never-ending cycle of failure. Sure, they may remember the content for the unit test, but next year when students need to build on pre-requisite skills, they are long lost from memory. That leaves next year's teacher having to re-teach material that the students could have mastered if they had only been allowed to talk about it. Implementing *WSL* was a strong reminder of the importance of continued professional development and improved teacher training for our profession. The advent of the Common Core State Standards for Literacy and the Next Generation Science Standards provides the opportunity and structure to redefine the way we teach science and more specifically, scientific literacy.

APPENDIX

Writing for Science Literacy

by

Shannon Marie Chamberlin

Appendix Table of Contents

Dear Fellow Educator,

As science teachers, we understand the importance of creating scientifically literate citizens. Society needs to be populated by a citizenry who can filter fact from fiction. The future will require people who can analyze what they are hearing in the media for accuracy and validity. No longer can we take what we see on the news or read in the paper at face value. Unfortunately the news media in this country is biased toward its political alliances and its advertisers. News programs sponsored by British Petroleum cannot be trusted to give an accurate account of the Deep Water Horizon Oil Spill. These “news agencies” are influenced by the money that funds them. Thus, the burden falls to us, as teachers, to create an educated populace that can dig deeper and not take what they hear at face value.

Unfortunately, we also have the responsibility to teach a staggering amount of science content. As a result, we often default to the quickest, most efficient means of disseminating information, lecture. Science lectures are not what inspired any of us to become science teachers, we loved the labs and the debate. We cannot cheat students of these opportunities to truly engage in science because we, as educators, feel too pressured to cover content.

Writing for Science Literacy was designed to help integrate discourse and literacy back into the science classroom. The activities presented can be incorporated into any unit of instruction. More importantly, they are intended to replace content lecture, not be given in addition to lecture. Through discussion of science texts and laboratory investigations, my hope if that students’ will construct their own science content knowledge. Obviously, there will always be a time and place for lecture but it is also critical that we create scientists and teach them how to identify an argument and evaluate its effectiveness. That is what true scientific literacy is. After all, it is our students who can hopefully fix the mess that has been made of our planet.

Sincerely,

Shannon Chamberlin

Teacher Pre-Implementation Survey

Writing in Science Curriculum - Interview Questions
Please answer the following questions as completely as you can.

1. How often do your students get a chance to discuss the science content you are teaching in pairs or small groups?

2. When your students are discussing science content, how do you scaffold their discussions (group roles, sentence frames, graphic organizers, etc.)?

3. How often do you assign a writing task to your students (one paragraph or more)?

4. When/If you do assign a writing task, do the students complete the assignment to your expectations?

5. When/If you assign a writing task, do you provide any scaffolding for the assignment?

6. What skills do your students need to be scientifically literate (able to break down a scientific argument in terms of claims and evidence and then to build their own argument based on claims and evidence)?

Teacher Post-implementation Survey

Please answer the questions focusing on the specific strategies we implemented in class, reciprocal teaching, rhetorical reading, summary writing.

1. What was successful about the curriculum and what evidence would you use to demonstrate that success?

2. What did you find challenging or difficult with this curriculum (in regards to both implementation and content)?

3. What kind of supports were helpful to you in trying to implement a writing curriculum in a science class?

4. The goal of this curriculum was to increase the students scientific literacy (their ability break down a scientific argument in terms of claims and evidence and then to build their own argument based on claims and evidence). Given this goal, how successful was this curriculum for your students?

5. Please give me any other feedback you have on this curriculum. You can be brutally honest… I can still write my paper even if it didn't work for you. ☺

Student Pre-Implementation Survey

Science – Pre Test
Please answer the following five questions by circling your answer. You will not put your name on this so please answer honestly.

	(1) No Way	(2) Not really	(3) I am not sure	(4) Yes, some	(5) Definitely
1. Talking to someone about science helps me to understand it better.	1	2	3	4	5
2. When I read my science textbook, I understand it the first time.	1	2	3	4	5
3. I have an easier time writing in science if I talk to another student first.	1	2	3	4	5
4. I have an easier time remembering my science if I write about it or take notes.	1	2	3	4	5
5. When I write in science I use skills or ideas I learned in my English class, like annotating, summarizing, using evidence.	1	2	3	4	5

Student Post-Implementation Survey

Science – Post Test
Please answer the following five questions by circling your answer. You will not put your name on this so please answer honestly.

	(1) No Way	(2) Not really	(3) I am not sure	(4) Yes, some	(5) Definitely
1. Talking to someone about science helps me to understand it better.	1	2	3	4	5
2. When I read my science textbook, I understand it the first time.	1	2	3	4	5
3. I have an easier time writing in science if I talk to another student first.	1	2	3	4	5
4. I have an easier time remembering my science if I write about it or take notes.	1	2	3	4	5
5. When I write in science I use skills or ideas I learned in my English class, like annotating, summarizing, using evidence.	1	2	3	4	5

Reading Rhetorically

How should students Mark the Text?

The key to this strategy (and all other strategies in this guide) is support. Help your students learn by modeling how to mark texts. Take it slowly. Teach them how to number paragraphs before moving into circling and underlining. Create opportunities for students to learn this strategy and allow time for rehearsal. Students will benefit from lots of practice. When introducing the strategy, have students first number the paragraphs and then read the text with their pencils down. Then, have them reread all or parts of the text, marking essential information as they reread. As students gain a deeper understanding of this skill, they will be able to mark essential information while reading a text for the first time.

Young readers will need a purpose for marking. In the beginning, they will need to be shown how to mark the text. As they mature into capable readers, they will be able to mark texts with less guidance. Mastery of this skill is achieved through consistency and repetition.

When should students Mark the Text?

Since marking the text is a fundamental skill, it ought to be used whenever students are asked to read. When students are reading copies of articles, newspapers, or other consumables, they should be given a reading purpose and encouraged (if not expected) to mark the text. Textbooks, novels, and other non-consumables are harder to mark. Sometimes it is valuable to photocopy sections of a textbook or novel, especially those passages that students must understand for tests, papers, or another assessment. Sticky notes work as a nice substitute for directly marking on the text. Whether working with consumables or non-consumables, it is necessary to find ways for students to actively mark the texts they read.

Why should students Mark the Text?

Students need to focus on the texts they read, and they need tools that will help them understand the complex ideas on the page. Marking the text gives students a way to isolate essential information that can be referenced quickly during writing tasks or class discussions. Students might also use their markings to assist in summary writing; to connect sections of the text; to investigate claims or evidence; or to engage in other types of analysis. Numbering paragraphs is also essential for class discussions. Once paragraphs are numbered, students can easily direct others to those places where they have found relevant information. Marking the text is a fundamental strategy that students must learn to do well.

LeMaster, J. (2011). *Critical reading: Deep reading strategies for expository texts teacher guide 7-12.* San Diego, CA: Avid Press.

Marking the Text

The following provides some effective ways teachers can introduce "Marking the Text" as a critical reading strategy.

Introducing Marking the Text

- Define the "Marking the Text" strategy and explain why it is important for readers to learn this skill. You will want to make copies of the Quick Reference you select or make the ideas on the handout available to students in some other way.
- Explicitly teach how to identify and number paragraphs. Try to have fun with this activity. You might ask students to call out paragraph numbers as you number them as a class. Or you can have students check each other's numbers to ensure they are numbering each paragraph accurately.
- Explicitly teach students how to identify essential information in the text. Students will need support as they learn how to identify claims, evidence, and other relevant information.
- Model for students how to mark the text using a document camera or overhead projector. Mark a section of the text, and verbally explain what you are doing and why you are doing it. Your decisions should be transparent and your explanations clear. Ask questions as you model this skill. Students should have a copy of the text so that they can imitate your markings.
- Select specific paragraphs or sections of text for students to analyze and evaluate in order to reduce the amount of text they have to read at one time.
- Ask students to read the text once without marking it. Then, have them reread the text, marking information relevant to the reading purpose.
- Engage students in various cognitive exercises. Ask questions such as, "How did this strategy improve your comprehension?" and "Why would readers want to use this strategy?" Other useful questions include, "How should we, for instance, mark or chart this text?" and "How could you use this strategy in English or biology?"
- Create opportunities for students to learn this strategy in small groups. Students can mark texts together, or they can discuss how and why they marked a particular section of a text.

Use the lines below to record successful strategies that you or your colleagues have developed and implemented.

LeMaster, J. (2011). *Critical reading: Deep reading strategies for expository texts teacher guide 7-12.* San Diego, CA: Avid Press.

Marking the Text: *Science* w/in text

This Strategy has three distinct marks:

1. Number the paragraphs. (1) Before you read, take a moment and number the paragraphs in the section you are planning to read. Start with the number one and continue numbering sequentially until you reach the end of the text or reading assignment. Write the number near the paragraph indention and circle the number; write it small enough so that you have room to write in the margin.

(2) As with page numbers, paragraph numbers will act as a reference so you can easily refer to specific sections of the text.

2. Circle key terms, cited authors, and other essential words or numbers.

You might circle…

• key concepts • content-based vocabulary • lesson-based vocabulary • names of people, theories, and/or experiments • properties • elements • formulas • units of measure • variables • values • percentages	• ________ • ________ • ________

3. Underline the author's claims and other information relevant to the reading purpose.

While reading informational texts (i.e. textbooks, reference books, articles, or journals), read carefully to identify information that is relevant to the reading task. Relevant information might include:

• concerns • claims • data • definitions • descriptions • evidence • examples • explanations	• guiding language • hypotheses • "if-then" statements • main ideas • methods • processes	• ________ • ________ • ________

Here are some strategies to help students identify essential information in the reading:

- Read the introduction to the chapter, lab, or article.
- Scan the text for visuals, vocabulary, comprehension questions, or other reading aids..
- Review your notes for key concepts.
- Preview chapter or unit reviews.

Note: If you are not working with consumables, consider photocopying sections of a text that are essential to labs, course content, exams, or other class activities.

LeMaster, J. (2011). *Critical reading: Deep reading strategies for expository texts teacher guide 7-12.* San Diego, CA: Avid Press.

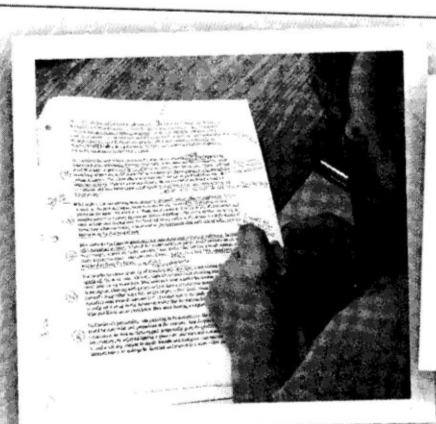
AVID
Decades of College Dreams

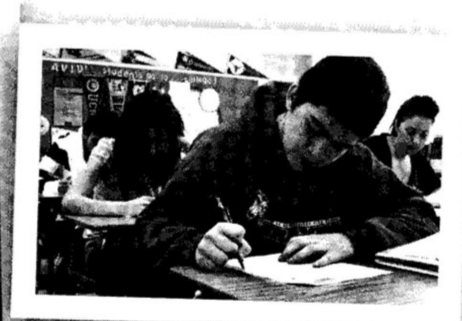
QUICK REFERENCE 5.8

Marking the Text:
Additional Ways to Isolate Key Information

As students learn how to read and mark texts with greater proficiency, they will develop the need to expand their thinking about what to mark and how to mark it. As reading and writing assignments become more sophisticated, they will need to read a text for various purposes. The three original marks—numbering, circling, and underlining—may not offer enough flexibility for students who are reading for various purposes. For this reason, students should learn a few additional markings that will help them differentiate between one type of information and another. There are three new marks to consider:

[Bracket] information when underlining has been used for another purpose.	Students should use brackets to isolate relevant information that has not already been underlined. In fictional texts, students might underline descriptions of characters and bracket figurative language. While reading arguments, students might underline claims and bracket evidence. And in science, students might underline definitions and bracket data.
Write labels in the margins | *claim*	Writing labels in the margins is a strategy used by readers who mark the text and write in the margins. Labels are often double underlined so that they stand out from other marginalia (i.e. notes, comments, analysis, or drawings). When writing labels in the margins, draw a vertical line along the edge of the text in order to isolate the section of text being labeled. Readers will also use labels when charting the macrostructure of the text or when keeping track of shifts—places in the text where the author takes readers in a new direction or presents a new focus.
Box words when circling has been used for another purpose.	Sometimes readers need to keep track of two different types of words or ideas. For example, a reader might choose to circle key terms and keep track of an author's use of descriptive language. Having two distinct marks will make it easier to reference the material later.





LeMaster, J. (2011). *Critical reading: Deep reading strategies for expository texts teacher guide 7-12.* San Diego, CA: Avid Press.

Teaching Tip
When you are considering pre-reading activities, consider the argument and author's purpose for the text that the students are about to read in addition to the culminating writing that is at the end of the unit.

The goal is that over time, the scaffolds are gradually taken away to foster independence.

Find samples and templates on the Tool Kit Website

All bullets that describe each stage of the template are from the ERWC "Annotated Template."

How To Get Started Teaching Pre-Reading

SPED students need to draw upon the knowledge of their peers because ideas are not always obvious to them; therefore, there must be peer and group discussions through structured interaction so that the ideas are readily available. In addition, **ELLs** need frontloading of vocabulary and intensive background information because they have not had the same cultural experiences.

Check for Understanding is through schema building, we are building a conceptual understanding through posing relevant questions, making connections to student experience so that the learning is through the students' frame of reference.

Structured Interaction: students will need to do continual paraphrasing and be provided with appropriate scaffolds be provided with appropriate scaffolds to be able to participate in active language discussions. Pre-reading prompts must be aligned to the big ideas and essential questions of the unit and designed to spark student exploration around the topic.

Getting Reading To Read

Building schema and motivating students for the reading by helping your students:

- making a connection between their own personal world and the world of the text.
- activating prior knowledge and experience related to the issues addressed in the text.
- Sharing their knowledge and vocabulary relevant to the text.
- generating questions that anticipate what the text is about.

Additional Strategies

- Anticipatory Guide
- Brainstorming
- KWL
- KPM
- Think, Ink, Pair, Share
- Quick Write-Everything You Know About..
- Rally-Robin

Sweetwater Union High School District (2011). *Teacher toolkit 2.0: The rhetorical approach to reading, writing, listening, and speaking.* Boston, MA: Pearson Learning Solutions.

Introducing Key Concepts

Deepening schema through concept development by:

- Identifying and discussing a key concept or term in such activities as defining, discussing denotation and connotation, and comparing and contrasting
- Using a pre-reading activity—such as rankings and rating scales, graphic organizers, role-play activities, and scenario discussions and readings—to activate prior knowledge, provide background information and schema, motivate your students to become interested in the text, and capture their opinions or biases before reading
- Organizing key concepts by categorizing them and the key terms, using sorting activities, semantic maps or webs, or charts

Additional Strategies

- Concept Map/ Web
- Semantic Map
- Mind Map
- Realia, Visuals and Video Clips
- Sorts
- Value Lines
- Role-Play/Scenario
- Three-Step Interview
- Knowledge Rating Sheet
- Collaborative Poster
- Categories on the Wall

Surveying the Text

Getting and overview of what the text is about based upon its structure and features for the purpose of making predictions and asking questions by:

- Looking for titles and subheadings
- Looking at the length of the reading
- Finding out about the author through library research or an Internet search and discussing the results with the class
- Discovering when and where the text was first published
- Noting the topics and main ideas

Additional Strategies

- Labeling Text Features
- Circling Key Words in the Title
- Annotating Source and Author Information
- Scan for Words that Signal
- Organizational Patterns

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Making Predictions and Asking Questions

Invoking student curiosity and interest by asking:

- What do you think this text is going to be about?
- What do you think is the purpose of this text?
- Who is the intended audience for this piece? How do you know?
- Based on the title and other features of the text, what information or ideas might this essay present?
- After reading the first few paragraphs of the text (depending on where the introduction ends) and the first sentence after each subheading or, in the case of a short text, the first sentence of each paragraph. Then ask them to address the following questions:
- What is the topic of the text?
- What is the author's opinion on that topic?
- What do you think the writer wants the reader to do or believe? How did you come to this conclusion?
- How could you turn the title into a question (or questions) to answer as you read the essay?

Additional Strategies

- Think, Ink, Pair, Share
- KPM
- Foldable
- Rhetorical Triangle
- Numbered Heads Together
- Question/ Prediction Analysis Pizza

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Introducing Key Vocabulary

Choosing key words that will be later reinforced throughout the reading:

- Provide your students with the meanings of key words.
- Ask your students to record in a vocabulary log the meanings of key words from the context of the reading.
- Assign your students to work in small groups to look up key vocabulary words.
- Study key words as a class project.

Additional Strategies

- Choral Response
- Vocabulary Rating Chart
- Vocabulary Note Book
- Verbal Visual Word Association
- Kinsella Vocabulary Chart
- Compare/Contrast Matrix
- Cognate Pyramid
- Types of Cognates Chart
- Word Trees
- See Appendix B of ERWC

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How To Get Started Teaching Reading & Re-Reading

Depending on the needs of the **SPED** student, teachers will need to tap into additional learning modalities through auditory, visual, and kinesthetic activities. Both **SPED and ELLs** will benefit from a metacognitive approach to reading whereby the teacher uses a think-aloud to model "a strong reader's" thinking process, making the invisible visible. ELLs will often get confused about who is doing what action in addition to picking up on the author's tone and nuance because they are managing the language on a surface level. Therefore, ELLs need explicit instruction in syntactic (e.g. grammar, word order), semantic (e.g. idioms, multiple meaning words) and cultural (e.g. social and cultural history) structures.

> **Teaching Tip**
> Think-Alouds should be done in small, manageable chunks.

Check for Understanding: Throughout the reading, there needs to be continuous checks for understanding built into the lesson to ensure that all students comprehend the text before they are asked to analyze and respond to it. Students and teachers will check for understanding by comparing their annotations to another.

Structured Interaction is focused on drawing meaning, what the author is saying and doing through annotation of the text. When students are comparing their annotations, a consensus is reached about the reading. Therefore, each read must have a purpose; the guiding questions and peer and class dialogue must focus and connect to the purpose for the reading.

> Teachers must develop a reading prompt that sets the expectations/purpose for the reading that states what students should think about and do as they read. See Critical Reading Strategies (3).

First Reading

Confirming predictions and getting the gist of what is being said (aka "reading with the grain" or "playing the believing game"):

- Which of your predictions turned out to be true?
- What surprised you?

Additional Strategies

> Strategies are matched to purpose for the reading.

- Book marks
- Chunking
- GIST (Generating Interactions between Schemata and Text)
- Graphic organizers
- Quick Writes
- Reciprocal Teaching
- Say, mean, matter
- SQP2RS (Survey, Question, Predict, Read, Respond, Summarize)
- Talking to the te[x]
annotating the t[e]
/ highlighting
- Think aloud/Sha[r]
Reading

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Lesson Topic: Joints **Created by: Shannon Chamberlin**

CA Content Standard(s):	Essential Question:	Daily Learning Target:
LS PP 6.h Compare joints in the body with structures used in machines and simple devices. CCLS R2 Determine the central ideas or conclusions of a text; provide an accurate summary of the text. CCLS W2.c Use appropriate and varied transitions to create cohesion and clarify the relationships among ideas and concepts.	Why do we have different types of joints?	Students will explain the different types of joints as evidenced by a share out of their reciprocal teaching summary.

Lesson Sequence	Scaffolds	Gradual Release of Responsibility	Strategies/Plan
Task 1: Warm-Up: *Text Features* Time: 10 min	☒Modeling ☐Bridging ☐Contextualization ☐Text Representation ☐Schema Building ☒Meta-cognitive Development	☒Teacher does(I Do) ☐Teacher-students do (We Do) ☐Students do collaboratively (You do) ☐Student does individually (You do)	Review the features of the text section we will be reading in Task 2. Potential Misconceptions:
Guiding Question(s): What type of text is this? What clues do we get from the text? What kind of information should we be looking for in this text?		**Sentence Frame(s):** I know this is ___ text because…	**Checking for Understanding:** ☐Physical:________________ ☒Verbal:**Elbow Partners**__________ ☐Written:________________

Lesson Sequence	Scaffolds	Gradual Release of Responsibility	Strategies/Plan
Task 2: Reciprocal Teaching Time: 25 minutes	☐Modeling ☐Bridging ☐Contextualization ☒Text Representation ☐Schema Building ☒Meta-cognitive Development	☐Teacher does (I Do) ☒Teacher-students do (We Do) ☒Students do collaboratively (You do) ☐Student does individually (You do)	Students will work in groups of four to conduct a reciprocal teach of page 371 of the CPO text book. Students will assume responsibility for completing all four tasks. Potential Misconceptions: If this is the first time students have completed this task so the teacher will need to circulate amongst the groups to make sure all students are accountable for all tasks. Teacher will also need to discuss consensus making.
Guiding Question(s): What does consensus mean? What does it sound like when we have a consensus?		**Sentence Frame(s):**	**Checking for Understanding:** ☐ Physical____________________________ ☒ Verbal: **Negotiating with their partners**______ ☒ Written: **Completion of the Reciprocal Task Note Making Guide**______________
Lesson Sequence	**Scaffolds**	**Gradual Release of Responsibility**	**Strategies/Plan**
Task 3: Summary Frame Time: 20 minutes	☒Modeling ☐Bridging ☐Contextualization ☒Text Representation ☐Schema Building ☒Meta-cognitive Development	☐Teacher does (I Do) ☒Teacher-students do (We Do) ☐Students do collaboratively (You do) ☒Student does individually (You do)	As a class, we will complete the Informational Text Summary Guide. Teacher will call on volunteers to read their summary paragraphs to class. Potential Misconceptions:
Guiding Question(s): What is the difference between summarizing and copying? What does it mean to paraphrase?		**Sentence Frame(s):** See Summary Frame	**Checking for Understanding:** ☐Physical:___________________________ ☒Verbal:_Share Out___________________________ ☒Written:_Summary Frame________________

Reciprocal Teaching (RT) Guidelines

Major uses:

- Collaborative reading of text
- "first read" for comprehension
- "second read" for analysis
- "focused read" for synthesis and evaluation

Process:
Students work in groups of 3-4 (or pairs of 2) to divide text into logical sections and complete specific tasks on a rotating basis. Students should develop expertise in the process of Reciprocal Teaching so they can apply it in new and varied situations. Almost any text can be processed using RT.

Students assume responsibility for completing one (or more) of 3-4 key tasks for each text section as they collectively read a shared text. Students rotate through these tasks so they get the opportunity to learn and practice new skills.

Key considerations:

- Group composition requires careful consideration.
- The purpose of the activity requires careful consideration
- The level of difficulty of the text requires consideration.
- Specific tasks should help students achieve specific goals.

Tasks: For a typical "first read" activity, students may perform four tasks

- First, **Student A** READS the given selection (usually one paragraph) aloud while students B, C and D follow along by placing their fingers on the text being read.
- Next, all students discuss the text, ask/answer questions and note new/unfamiliar vocabulary. If appropriate, students write down these words and then guess about their meanings (given the context in which the words appear).
- Then, **Student B** offers a SUMMARY or PARAPHRASE of the selection read by Student A.
- Students discuss the offered summary/paraphrase and develop a version on which they can all agree. If appropriate, all students write this summary in a log/note-taking guide.
- Then, **Student C** asks a "right there" question. The answer to this question appears "right there" in the text and students should be able to POINT at the answer(s) to this question.
- Students discuss answers to the previous question. If appropriate, students write down this question.
- Finally, **Student D** answers the "right there" question and all students accept an answer on which they can agree.

Important pointers:

- Individual accountability is key. This means EACH student should be responsible for recording information along the way and this information should be submitted to teacher for "quality control" and review. See next page for sample notetaking guide. Consider entering key elements (like vocabulary) if it helps students to scaffold the task.
- Clear understanding of the tasks is imperative. Consider labeling index cards with A, B, C and D – and then summarizing the task on the back side of the card. Students should ROTATE the cards, physically, so responsibility for tasks is clear.

Reciprocal Teaching Note Making Guide Section Title:

Paragraph	Vocabulary	Paraphrase/Summary	"Right There" Question	Answer
1				
2				
3				
4				

Name ________________________ Per. _____

Summary Frame – Informational Text

In this section entitled, "__________________________", the author is informing us about

____

____(*this is what the overall section is about*).

The first paragraph introduces ____

____.

The second paragraph discusses ____

____.

In paragraph three we learn that ____

____

____.

In paragraph four we also discover that ______________________________________

____.

The author concludes the section by explaining (what does the author say at the end) ___________

____

____.

Rewrite the summary above in a paragraph on the lines below.

____
____
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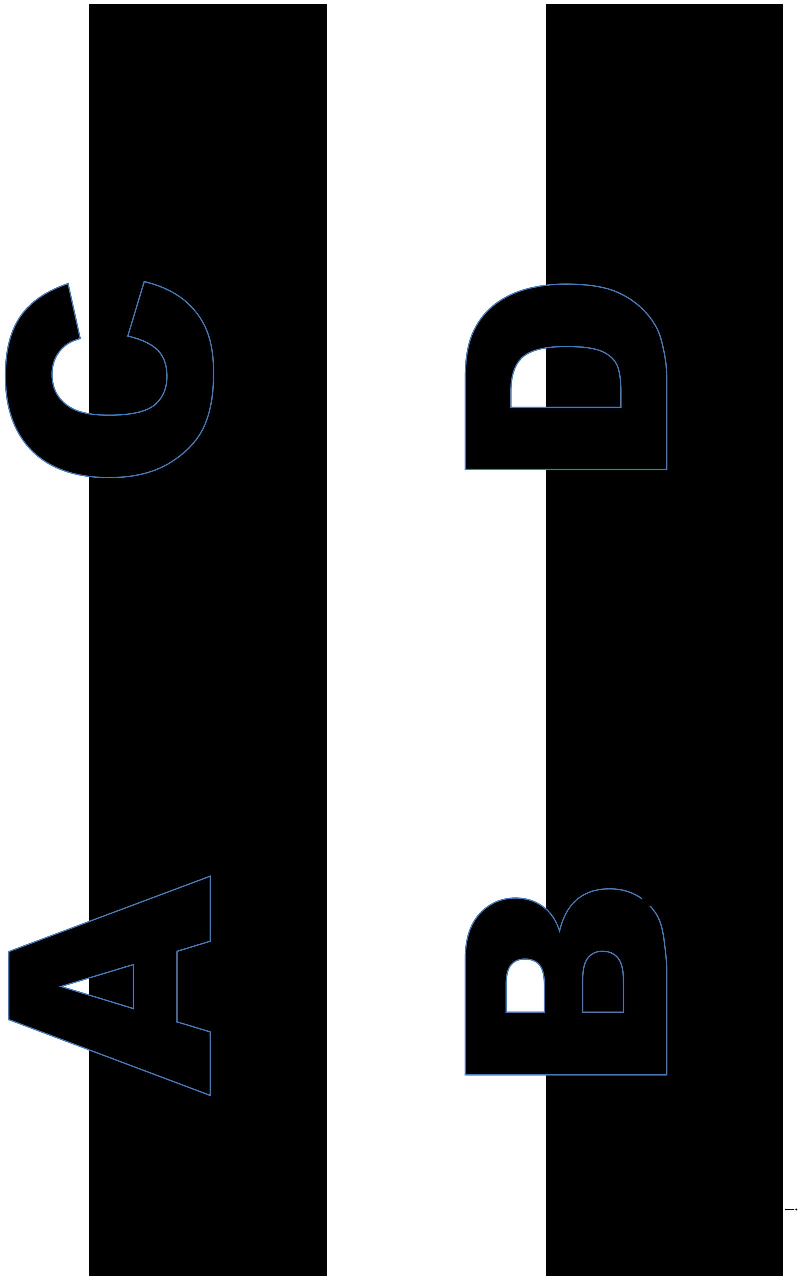

A
B
C
D

[redacted]
READS the text aloud

[redacted]
SUMMARIZES what was read.

[redacted]
ASKS a question that can be
answered from the reading

[redacted]
Answers the question, gather
consensus from group

[redacted]
READS the text aloud

[redacted]
SUMMARIZES what was read.

[redacted]
ASKS a question that can be
answered from the reading

[redacted]
Answers the question, gather
consensus from group

[redacted]
READS the text aloud

[redacted]
SUMMARIZES what was read.

[redacted]
ASKS a question that can be
answered from the reading

[redacted]
Answers the question, gather
consensus from group

[redacted]
READS the text aloud

[redacted]
SUMMARIZES what was read.

[redacted]
ASKS a question that can be
answered from the reading

[redacted]
Answers the question, gather
consensus from group

Reading & Responding

RHETORICALLY

Name ______________________

Period ________ Date 3/22/12

Expository Texts

After Reading: Summarizing and Responding

(a)Title: ______________________

(b)Author: ______________________

(c)Genre: ☐article, ☐essay, ☐editorial, ☐report, ☐blog, ☐biography, ☐speech, ☐other:__________

(d)Main Claim/Argument/Idea: ______________________

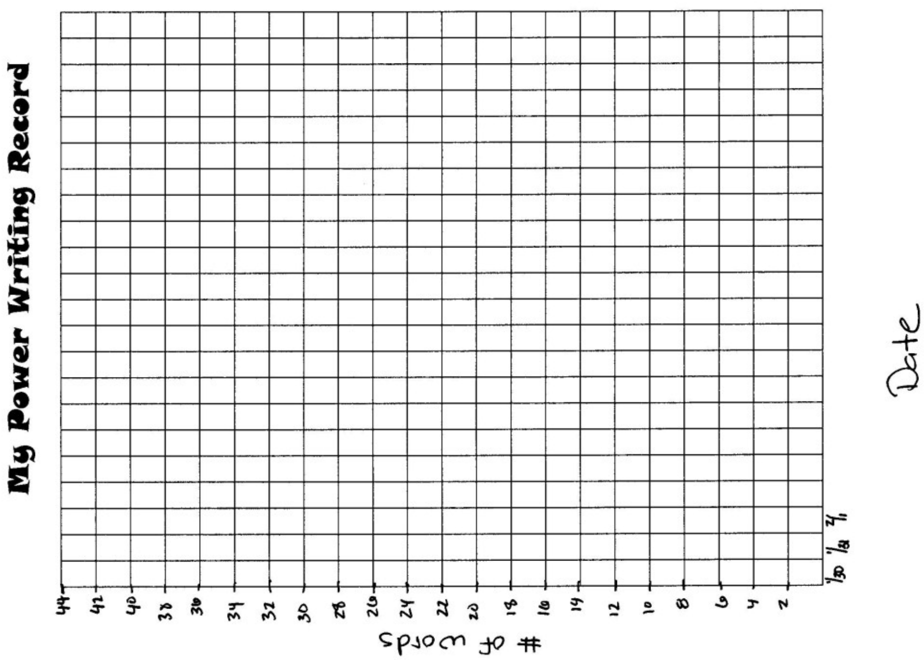
____

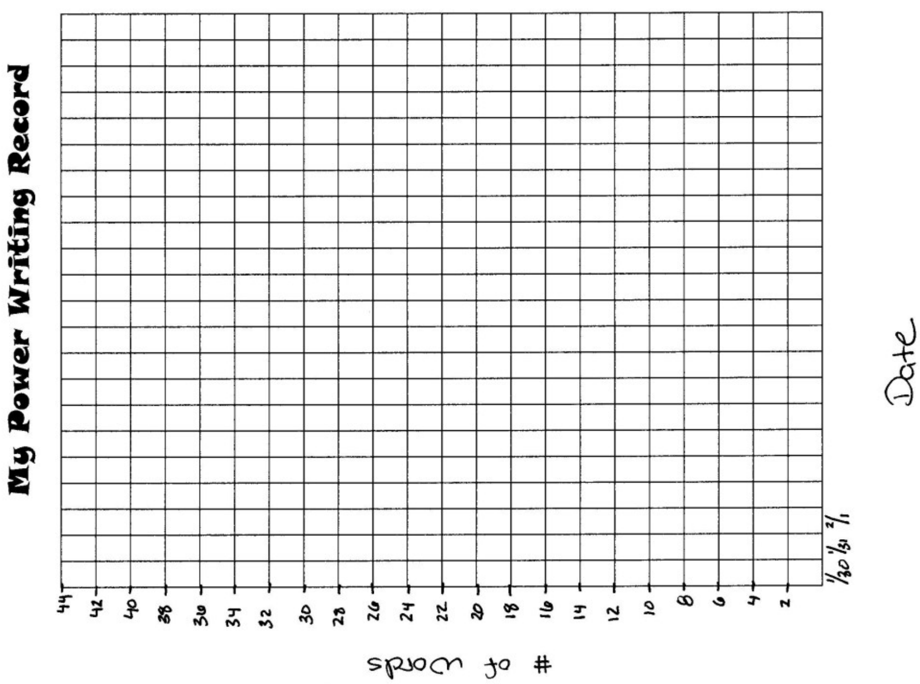
(e) verb: ☐argues, ☐ asserts, ☐states, ☐explores, ☐investigates, ☐discusses, ☐explains

(g) Write the claim your group identified in each of the sections. (g1, g2, g3, g4).

(h) Write the supporting evidence for the claim. (h1, h2, h3, h4)

In the ______________(c) entitled "______________________(a),"
______________(b) ______________(e) that______________
______________________(d).
First, ______________(b) claims that (g1) ______________________
______________________.
S/he supports this claim by (g2) ______________________
______________________ In addition, ____________(b)
states that (g3) ______________________
which is important because ______________________
______________________Lastly, ______________(b)
concludes by stating that (g4) ______________________
______________________.
______________________.
______________________.


My Power Writing Record
# of words
1/30 1/31 2/1
Date


My Power Writing Record
# of words
1/30 1/31 2/1
Date

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