Literacy and Science: Why Literacy is Important and Literacy Strategies for the Science Classroom

Debra Ortenzi

St. John Fisher College

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Dedication

I would like to dedicate this manuscript to my family; Len, Danny and Julia Ortenzi. You have been incredibly patient as I spent countless evenings locked up in the office off the kitchen reading, planning, and typing. The night classes that pulled me away from home on weeknights, the weekend courses in the summer, and the Sunday afternoons doing school work are behind us now.
Acknowledgements

Larry Neal gave me the book that this manuscript is based on. He solidified my gut feelings that I would not get far with teaching science if my students do not know how to read. He gave me the reassurance that an experienced teacher can take one day each week to teach reading strategies and still have time to cover the content.

Cecille Shorter is my roommate and fellow seventh grade science teacher at East High. She has been a constant supporter, encourager, and teacher to me this year. I would like to acknowledge her and thank her for all her help. Her observations of my classes and telling me what can be improved, constantly meeting my supply needs, and even bringing in the sheep’s respiratory and digestive tracts were all priceless gifts.
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The world of education is abuzz with literacy concerns, strategies, goals, and content-specific suggestions to help students comprehend what they read. There are conferences, workshops, newsletters, websites, e-mails, professional development opportunities, and discussions in the break room regarding teachers’ concerns that our students do not know how to read for understanding. No matter what subject, which classroom, what district, or how experienced the teacher is, literacy concerns are at the front of everyone’s thoughts.

Since literacy is a global concern, it is time for all teachers to acknowledge and accept their role in teaching students to read, write, speak, and listen for understanding. There is a wide range of strategies available to try and adapt to almost any curriculum. In response to this the following literature review will explore the importance of science content literacy and offer many pre-, during-, and post-reading strategies.

This research focused on literacy in the content area of science. One class period per week was devoted to specific literacy practice. Using Reading in the Content Areas: Science (2005), as a tool, students were led through a series of reading exercises followed by six questions each week. Students were supplied with a graph to chart their progress as they learned new reading strategies. This weekly practice, along with the implementation of various reading strategies throughout the week, was continued throughout the school year to expose students to science literature and teach them techniques to better comprehend what they have read.
Research on the subject of literacy was selected because after one year of teaching in the Rochester City School District, it was apparent that the majority of students struggled with basic literacy skills. Teacher requests of students to read a short passage on a science topic, or to write a paragraph on what was learned that day, were consistently met with groans and frustration. To be an effective teacher of any subject, literacy skills need to be modeled and taught by the teacher and ultimately required from the students.

Upon completion of this research, the teacher hoped to gather information on the effectiveness of incorporating literacy practice on a regular basis in the science classroom.
Review of Literature

Although literacy includes reading, writing, speaking, and listening (Their, 2002), the scope and purpose of this review will focus on content literacy, which is “the ability to use reading and writing to learn subject matter in a given discipline” (Vacca & Vacca, 1999, p. 8). This is where primary and secondary grade teachers differ greatly on their literacy focuses; primary grades the focus is learning to read, secondary is reading to learn (Jacobs, 2002). Content area literacy includes how students interact with the text, and not coming to the text as blank slates. Secondary students are expected to bring background knowledge to the text and be able to think about what they are reading.

According to Street (2002), middle school students are often shocked by the reading expectations of their content area teachers. It becomes apparent in many middle schools that their students have failed to learn how to read expository texts previously. Many students are not learning how to handle this genre in elementary school. Students often try to read textbooks the same way they read narratives, rather than thinking of textbooks as information sources from which they can learn. It is not surprising that attitudes toward reading tend to grow negative in middle school. This is precisely the time many teachers begin to expect students to read dense, expository text (Street). However, the middle school science classroom is the ideal setting for the relationships between science, reading, and writing to be developed and strengthened. Scientific literacy cannot be attained without fundamental literacy, the ability to read and comprehend textual information. Science teachers are school’s resident experts in digesting expository text.
laden with factual details, processes, and complex vocabulary. Science teachers must take seriously their role in instructing students in the fundamental literacy skills that support scientific literacy, most importantly reading comprehension (Miller, 2006).

The choice of textbook plays a huge part in students' reading comprehension. Many teachers rely on textbooks as the major instructional resource for their classes. This results in a huge disparity between many students' reading ability and the required reading materials in middle and high school. It is imperative to ensure that the text meets the students' reading level, but additionally the organization of the text is crucial. Poorly written textbooks fail to use precise language or make clear the relations between concepts, ideas, and sentences or clarify the main idea. Science textbooks typically provide extensive coverage of content with little opportunity for in-depth practice of important concepts (Dickson, Simmons, & Kameenui, 2006). Content textbooks contain densely worded paragraphs that include an overwhelming number of concepts, facts, and details with insufficient explanation. The amount of new vocabulary words in any one paragraph of a high school science textbook is awe-inspiring. The shear volume of new information presented is overwhelming, as many books contain 800 pages or more. Additionally, teachers tend to move at a faster pace than the students can keep up with, sometimes moving past a concept before the students have grasped it, leading to problems later on because most curriculums build on themselves as the year goes on (Mastropero, Scruggs, & Graetz, 2003).

This review will include two main areas of focus. The first section will introduce the reader to the importance of literacy in middle and high school classrooms with a focus on content-area literacy with a science perspective. The second section will share
strategies to implement in the science classroom to help students succeed in the area of literacy.

Importance of Literacy

Many students can read the words on a page in front of them, but cannot understand what they are reading. Teaching students how to comprehend written information is very important, from the very beginning of reading instruction and right through all the years in school, in all curriculum areas (Snowball, 2006). Reading is an essential skill in our culture. Educators must rely on students' abilities to learn through reading. “Textbooks, articles, literature, online resources, primary documents, lab manuals- all of these and many other resources serve as the foundation for powerful teaching and learning” (Strong, Perini, Silver, & Tuculescu, 2002, p. viii).

Teachers do not need to know everything about science and literacy to be effective at teaching either. According to the literature, student achievement can be raised by simply knowing a few things well (Miller, 2006). The amount of strategies available to teachers to improve student literacy can be overwhelming. It is doubtful that a teacher will implement all the ideas in this review into their classroom repertoire, but if a few strategies are chosen, used appropriately and consistently, students will benefit and their reading comprehension should improve.

It seems elementary teachers struggle to incorporate more science into their curriculum while middle school teachers struggle to incorporate more literacy into theirs.
Reading, identified as the backbone of education in the United States, receives more instructional time than any other area during the elementary years. Science, however, is often short-changed during the elementary years. There are resources to help bridge the gap and build bridges across these domains. *Science and Children*, a journal published by the National Science Teachers Association (NSTA), publishes the “Outstanding Trade Books for Children” list each year. This descriptive list is also available online via the NSTA website (http://www.nsta.org) (El-Hindi, 2003). The use of trade books, picture books, fiction and nonfiction books all are tools to compliment the subject matter.

Despite the difficulties with many science textbooks, as mentioned earlier, science classrooms are at an advantage for increasing student reading motivation and comprehension. According to Guthrie, Wigfield, Humenick, Perencevich, Taboada and Barbosa (2006), there exists a relationship between hands-on activities and students’ engagement in reading. Motivation plays a huge role in reading comprehension, and what better subject than science to provide hands-on activities to increase student motivation? An expanding body of research has shed light on instructional practices that increase students’ motivation to read. The top six of these practices, according to Guthrie, et al., are:

1. Using content goals for reading instruction that expands students’ interest and motivation, instead of goals that only include doing well on tests.
2. Offering student choices in the classroom. When students can choose what texts they read, the tasks they can perform, and their partners during instruction, their intrinsic motivation for reading increases.
3. Properties of texts increase interest. When the topic is interesting, appealing, and relevant student interest and motivation increase.

4. Social goals or cooperative-learning structures in reading activities improve students' motivation.

5. Teacher involvement, or if students perceive that the teacher understands them and cares about them, is associated with intrinsic motivation levels.

6. Emphasizing mastery goals. Teachers should stress that students read for mastery, not just to glean a fact or two.

The use of stimulating tasks to arouse interest is another motivation-enhancing instructional practice that is gaining in popularity. The literature suggests that the challenge science teachers face is to identify classroom practices or activities that will evoke situational interest related to reading. It is important to find activities that challenge the students to think in new ways. Middle school students are best motivated to learn by being asked to create concrete products. These tasks must be connected conceptually to further knowledge for them to have any lasting effects on motivation and comprehension. The hands-on activity can be followed by reading related text while the students are curious or excited about the topic because of the interest generated by the task. As mentioned previously, teachers must be sure to provide books that are accessible, topically-related and at an appropriate reading level for this to occur (Guthrie, et al., 2006).
Strategies to Improve Student Literacy in the Science Classroom

Reading comprehension research has increased our knowledge of best practices for instructing students to better comprehend written text (Mastropieri, et al., 2003). This review will share many specific instructional procedures that have proven to increase student comprehension.

The National Reading Panel (2000) acknowledged seven categories of instruction that have a definite influence on the comprehension of readers. The development of a science literate classroom should consider each of these categories. First, strategic readers should monitor their comprehension as they read. Second, cooperative learning offers students an opportunity to teach others, which has been proven to improve retention rates. Third, the use of graphic and semantic organizers allows the reader to see relationships in the content. Fourth, the strategy of student-generated questions while reading has scientific evidence backing its effectiveness. Fifth, answering oral and written questions while reading is another effective means of improving comprehension. Sixth, instructing students to provide a brief summary of the main ideas of a reading passage increases comprehension. Lastly, the use of multiple strategies develops comprehension and cognitive skills.

The literature suggested that science teachers should never ask their students to sit down and silently read a chunk of science text without preparing them first. Instead, they should encourage their students to interact with their reading material by trying different strategies. Some specific strategies are shared below that could be effective in a science classroom of any grade level. It is important to remember that not all strategies can be used effectively by all students. If, after receiving careful instruction and modeling,
students find a strategy difficult or impossible to use, then the strategy may involve a
level of complexity and demands that are too difficult for them. The teacher can provide
a simplified version of the strategy or use others that are not as complex (Slater &
Horstman, 2002).

George Martin (2002) routinely had his students do the following with each
reading assignment to comprehend the text; take notes to clarify ideas, challenge and
question the text, stop reading occasionally to evaluate if the text is understood, reread to
revise understanding, and predict what will come next. The challenge faced by science
teachers is to make sure students are implementing these strategies. There are many
before-, during- and after-reading methods that stimulate students to become better
readers.

According to Street (2002), the Structured Reading Lesson (SRL) is a simple and
effective way to structure a lesson involving expository reading. The three components
of the SRL include before-, during, and after-reading activities that will be discussed
below. Any one of the activities included below can be used, as long as at least one is
implemented before, during and after the reading assignment.

Pre-reading Strategies
Students who are able to activate their prior knowledge of the concepts about
which they are reading remember more than do students with little or no prior
knowledge. It serves students well if the teacher takes the time to help their students
trigger their prior knowledge before reading so that they can concentrate their reading
effort towards merging their knowledge with the new information and ideas they
encounter (Mitchell, 2006; Beers, 2003). When students link new information with what they already know, their curiosity is heightened. Students are motivated to finish reading if they are looking for answers to their own questions.

Before reading text, students should not only activate prior knowledge, but also establish a purpose for reading. Any unfamiliar vocabulary should be presented ahead of time. Anything the teacher can do to instill curiosity and motivation is also helpful prior to reading (Street, 2002).

Prediction Guides and Anticipation Guides are common and effective tools to get students actively engaged in text. In the first strategy, the teacher provides approximately five true or false statements based on the facts from the text. After the students record their responses, they read the text and then revisit their answers. This is followed with a discussion led by the teacher. The second strategy, the Anticipation Guide, stimulates a class discussion before reading. Students are challenged to agree or disagree with approximately five statements and justify their answers in writing. After students share their opinions, they are engaged to read the text (Martin, 2002). These are most effective when students have some preconceived notions relating to the concepts in the reading. The statements in the Anticipation Guide are created to support and contrast an author's ideas with students' belief systems. These guides serve to connect a student to the reading selection, not to force them to resolve all their uncertainties about the topic (Mitchell, 2006).

The literature suggested a very common-sense approach to preparing students to read a section of text. Simply walk students through the text first, before they have been asked to read. Using this technique, the teacher can prepare students to read by asking
them to look the chapter over while the section titles are pointed out and the pictures, graphs, tables, and charts are observed. The teacher should demonstrate that effective readers take the time to scan the chapter and read the subtitles and captions under the graphics first, all the while making predictions about what will be learned from reading this material. To meet the needs of diverse students at different reading abilities, it is imperative that teachers model and demonstrate inquiry thought during reading to their students before asking them to read independently. This builds a toolkit of comprehension strategies for students to use during independent reading (Walker & Huber, 2002; Misulis, 1997; Miller, 2006).

After asking students to scan the chapter, Misulis (1997) stated that it is worth the time investment to require students to read the introductory paragraph and draw connections between the information in the introduction and the information obtained while scanning the chapter. Spending a few minutes on the introduction as a class helps to provide focus and motivation for the rest of the chapter. The introduction may also draw upon students' prior knowledge, which is an essential key to comprehension as they read.

According to Misulis (1997), the reading of the introductory paragraph should be followed by reading the conclusion of the chapter. This step should be followed by a brief discussion of the important information or ideas expressed in the text. Lastly, the main idea should be gleaned from the information read and the class should reach a consensus on what that is. A student should record the main idea clearly on poster paper and this should be displayed where the whole class can see it. Finally, the class should be ready to read the chapter of a textbook word for word. These steps allow students to be
more focused because they already have a sense of the organization of the information presented in the chapter. Students are then freed to focus more on concepts and information within the series of categories and relationships, ultimately enhancing their comprehension.

A unique pre-reading strategy that involves students moving through the classroom and actively participating with the text is called the Tea Party, and is explained by Beers (2003). In this approach, students are given index cards with short passages from the reading and told to walk around the room sharing what is on their card and discussing their predictions and inferences while comparing and contrasting what is on other students' cards. This technique allows students a chance to see casual relationships, practice sequencing, and draw on their prior experiences.

The more educators frontload students' knowledge of a text and help them become actively involved in constructing meaning prior to reading, the more engaged they are likely to be as they read the text (Beers, 2003).

During-Reading and Post-Reading Strategies

Effective readers monitor their comprehension by using context clues to figure out unknown words and by discussing, imagining, inferencing, and predicting, all while engaging in reading. The ultimate goal during reading is to integrate new concepts with existing knowledge (Street, 2002).

There are many options besides the traditional question-and-answer responses following a chapter of reading. Learning logs, response journals, double-entry journals,
and triple-entry journals allow students to record what they gained from reading text, however teachers must be careful to make these routine and check student responses because students may procrastinate if they think their answers will not be read (Martin, 2002).

Knowing that many science teachers need class time for labs and other learning activities, it is important to find during-reading strategies that could be used independently, perhaps as homework. Misulis (1997) provides three strategies that require some work by the teacher ahead of time, but allow the students to work through the reading on their own through the use of writing. There is a distinct and concrete connection between reading and writing. The following strategies require writing, which strengthens and reinforces the reading.

Writing tasks can be short compositions, longer reports, reader-response journals, scientist notebook entries, or traditional laboratory reports – the key is that the writing assignments must contain specific requirements structured to obtain a new product necessitating the transformation of student knowledge gained from readings, rather than simply a reiteration of facts. Writing in this manner promotes the reinforcement of reading, capitalizing on the well-known reading and writing connection. (Miller, 2006, p. 33)

The first strategy shared by Misulis (1997) is called a Hierarchical Summary. In this approach, the teacher prepares a skeletal outline of the chapter, leaving many lines of space below each subsection for students to fill in their summaries. These summaries should be in the students' own words. Students should also formulate a topic sentence for the entire section of the text. An added feature of these outlines could be asking
students to jot down key words or phrases that connect the subsections in the left hand margin. This assignment could be followed by providing students with a chance to share what they have written with a partner. While one student recalls ideas orally, the other student can review their hierarchical summary and provide feedback. This technique helps student comprehension by focusing on the structure or organization of information in a textbook chapter. Their writing as they fill in the outline contributes to this as well.

The second strategy offered by Misulis (1997) is called a Patterns Guide. This is a teacher-developed reading guide that will enhance students' understanding of the structure of information and ideas presented in a textbook. Most expository texts have a consistent pattern of organization, which may include enumeration, cause-effect, comparison-contrast, and sequence or time order. Once the teacher has identified which organizational pattern is present in the text, they then develop a two-part guide to aid the students in their reading. Part one reflects the organizational pattern in the text. For example, if the text presents information in a cause and effect style, then the guide would have a list of words separated by a slash that students would have to elaborate on (ex. photosynthesis/plant growth). Part two of these patterns guides would include a list of statements developed by the teacher that relate to the content. Students respond to each statement by finding supporting or refuting information from the text.

The third strategy shared by Misulis (1997) is called a Structured Overview. This technique allows students to perceive the information in the text as a set of relationships. These overviews are a type of graphic organizer that portrays relationships among information, ideas, and vocabulary words. Students display key concepts and vocabulary in a structured, hierarchical arrangement by placing the main idea at the top
and the related subtopics underneath. Students place the main topic, subtopics, and specific vocabulary words into a structured framework that explicitly presents relationships between concepts and words. These guides are completed as the class moves through the unit, both on their own and as a class.

Other during-reading strategies are suggested in the literature. One strategy, called Reciprocal Reading, does not involve writing and is explained by Street (2002). In this during-reading technique, students pair up and take turns reading a paragraph (or page) of text and asking each other questions about what was just read. Again, it is important for the teacher to model good questions so students learn to make connections with the material and clarify their thoughts.

A similar during-reading activity is explained by Walker and Huber (2002). Teacher assigned stopping points, often at the end of a page or section, allow students a chance to share something with the rest of the group. They can explain a concept, share connections they are making to other learning, ask a question, or make a prediction about further reading.

A quieter during-reading activity requires the use of sticky notes. After student interest is heightened about a piece of text by using any of the above pre-reading activities, the teacher can supply each student with a few sticky notes and instruct them to place them in places where they struggled with the information in the reading. Later, as discussion of the chapter begins, several students can share with the class the trouble they experienced and strategies they used to solve the problems. Students benefit from hearing how their peers create meaning as they read (Walker & Huber, 2002).
An after-reading strategy offered by Street (2002) is the Fish Bowl Discussion. This would work best in a high school classroom. This activity engages a small group of students in a discussion while the rest of the class observes. First, the whole class reads a selection of text and responds in writing to several guiding questions for the discussion. After written responses have been completed, the teacher selects a fishbowl group, identifies a conversation leader, and helps to facilitate the discussion. Observers record the main points of the conversation and share their responses or comments afterwards.

Freeman and Taylor (2006) offered many after-reading strategies that help with vocabulary acquisition. They stated "Students often will continue reading an entire text without questioning or self-monitoring to determine their level of comprehension" (p. 77). A few strategies to help students with comprehension of new vocabulary encountered in the reading include graphic organizers, alpha boxes, riddles, and fill-in-the-blank activities.

There are also a wide variety of tools that can be used in all three stages of reading. One strategy that integrates pre-, during-, and post-reading steps is the SQ3R which stands for Survey, Question, Read, Recite, and Review. This is one tool that requires the reader to think about what they are reading. Another is the KWL method; this determines what the reader knows, wants to know, and what they learned. This can be used as a whole class activity or used individually by each student privately at their own seat (Martin, 2002).

Reciprocal Teaching is another strategy that can be used to cover all three stages of reading. Reciprocal Teaching incorporates the use of small groups of students who are instructed to predict what they will earn by scanning the text, form questions as they read,
clarify the meaning of unknown words, terms, phrases and sections of the text, and summarize the main ideas by restating them. Reciprocal Teaching is best taught by modeling it for the students first. According to Slater and Horstman (2002), a primary purpose of reciprocal teaching is to convince all students to become actively engaged in using the strategies themselves. Eventually, the students should do the questioning, clarifying, summarizing, and predicting themselves. The teacher should increasingly hand over the responsibility to the students so it is less teacher-centered and more and more student-centered. In this gradual release of responsibility, the students take total or nearly total responsibility for the instructional task. According to Snowball (2006), after twenty sessions of properly conducted reciprocal teaching, student comprehension will improve dramatically. Slater & Horstman are convinced that reciprocal teaching is the cognitive strategy best suited to assist struggling readers because the four steps provide important scaffolding needed to grow as a reader.

Vocabulary is a large part of understanding science literature. According to Janet Allen (2006), a columnist writer for Voices from the Middle, we already know that students who know more words are better readers, increasing the volume of reading helps readers learn new words, we can only teach a small fraction of words that adolescents need to know, knowing a word means more than knowing the definition, word learning is often based on a background knowledge of the concept, instruction in definitions probably won't increase comprehension of a passage containing the word, and learners need vocabulary instruction that is generative so they are learning how to learn new words they encounter during independent literacy experiences. One technique to master
authentic, science related material. Creech and Hale provided steps for the students to follow to help them grasp the big idea of the reading they chose. For example, they required students to highlight the research methods used with one color and to highlight the results with another color. These authors also suggested a nonfiction reading project that accompanies a children’s science book writing project. They also explained a third literacy project option that asked students to read a biography of a scientist and present Interactive Historical Vignettes which involved students dressing up and acting out their historical scientist to the class. Lastly, Creech and Hale required their students to read a fiction book with good science content and participate in a book club. These inquiry-based projects were designed “to improve student's attitudes toward science reading and give students the tools to become lifelong science readers” (p. 27).

Summary

Many teachers may worry that taking the time to teach reading strategies means less time to teach content. However, if time is not invested to teach these strategies, students will not become better readers and the chant of these kids can’t read will only continue. The extra time spent early in the school year working on these strategies pays off later in the school year when students are more strategic readers (Beers, 2003).

Educators have a responsibility to incorporate reading and writing into their daily lesson plans. Many pre-service and first year teachers do not recognize the extent to which content area subjects and literacy are correlated. Their loyalty is to their specialization fields, with little attention paid to the role that reading and writing play in
those fields. Once students are in middle school, no one teacher is solely responsible for student learning, and students can get lost in the shuffle. If an educator’s goal is high literacy in reading for all students, we are definitely falling short, especially when we consider the large numbers of middle and high school students performing at or below the basic level: 66% and 53% respectively in reading (Slater & Horstman, 2002). In many urban schools, the numbers reflect an even darker picture, with sometimes 85% of students below their grade-appropriate reading level. These large percentages include formidable numbers of struggling readers. Teachers of all subjects need to incorporate literacy strategies whenever possible to help students develop an ability to read and understand written text.

The ability to read and comprehend is an essential skill for students. If educators understand the process and take the time to demonstrate and practice effective strategies, they can support students in their growth as readers while also helping to develop their ability to know and understand science (Walker & Huber, 2002).
Methodology

As a necessity to fulfill the requirements of the Master of Science in Mathematics/Science/Technology Education program at St. John Fisher College, action research was conducted at East High School in the Rochester City School District in the State of New York. The research occurred in the fall of 2006 through the spring of 2007. This research focused on ways to improve student comprehension of written text, with an emphasis on science content.

The book used in this study was entitled Reading in the Content Areas: Science. The text included 75 reading passages related to science. Within the science content area, the book included several subcategories, for example, biology, weather, and chemistry. Each passage met two criteria: high interest level and appropriate readability level. The high interest level was assured by choosing passages of mature content that would appeal to a wide range of readers. The readability level for each passage was concluded by applying Dr. Edward B Fry's Formula for Estimating Readability. The passages were arranged in order of increasing difficulty in the book. This allowed the teacher to select appropriate reading passages based on content and on reading level.

Six essential questions followed each reading passage. The most important of these was the main idea, which was presented to the student in a set of three statements. Students were instructed to choose and label the statement that represented the main idea of the passage, they were then asked to label the other statements as too broad and too narrow. Additionally, there were five other questions. These questions were always
within the framework of the following five categories: subject matter, supporting details, conclusion, clarifying devices, and vocabulary in context. Refer to Appendix A.

The diagnostic chart provided the students with feedback on their weaknesses (Appendix B). This chart was filled out after they completed the six questions. Students were instructed to only fill in the second column if their answer was different than the correct answer provided by the teacher. As the answers for more passages were recorded, the chart showed the types of questions missed consistently. This made seeing patterns in student strengths and weaknesses easy.

Once a weakness was identified, students were reminded to make an extra effort to correctly answer the questions in that category in the future. If time allowed, students were encouraged to go back and reread the passage and see if they could identify how the writer developed the correct answer to that particular question.

The last step was to total the scores and graph their results (Appendix C). It was hoped that the graphs would display an upward trend as the students became more familiar with science reading passages and the format of the six essential questions.

Participants

The ethnic makeup of the Rochester City School District student population was 64 percent African American, 20 percent Hispanic, 14 percent white, and 2 percent Native American, Asian, and other minorities. There were 35 different languages spoken within the District’s student population.
While the District was ranked 73rd in the nation in size, the city of Rochester was 11th in the nation in child poverty. Eighty percent of District students were eligible for free or reduced-price lunch based on family income and that percentage was even higher at East High School.

The subjects of this research were approximately 76 7th graders seen daily in four 43 minute periods. Class sizes ranged from 18 students to 28 students, depending on the period. The seventh grade students were between 12 and 14 years of age. Additionally, one class of Chemistry students were included in this study. These students ranged in age from 17 to 20 years of age.

The seventh grade classroom environment was a controlled setting with students not allowed to get out of their seats without permission. The teacher had to encourage students to stay on task and stop talking often. Some students were motivated and could focus on any task given to them until it had been completed. Other students, however, could not seem to focus and tried to distract others from completing their work.

The Chemistry classroom environment was not as controlled, as students frequently got up to sharpen pencils, get something from their locker, or simply change their seats. This was a chatty group but they knew when it was time to get to work and could quiet down to complete their work.

Materials

The book used as tool in this research was entitled Reading in the Content Areas: Science (2005). Each student was provided with a folder that was kept in the classroom. Inside each folder was a colored piece of card stock with a diagnostic chart printed on it.
(Appendix B) and another piece of card stock with a graph printed on it (Appendix C).

Each week a new reading passage and accompanying six questions were selected from the book and photocopied for each student and placed in their folder (Appendix A).

Every Monday, students were asked to get their reading folders as they entered the classroom and read that week's passage and answer the questions. The repeated procedure of reading a chunk of science literature and trying to answer questions about it is a valid practice because students learn through repetition. It teaches students to always look for the main idea in what they are reading. Practice allows them a chance to find supporting details of the main idea provided by the author, which is an important technique in deciphering science literature. Repeating these steps each week with different selections of science text provided students with an opportunity to practice reading strategies learned throughout the week in science and other classes. For example, a teacher of another content area may teach students to figure out unknown vocabulary words by using the surrounding text to decipher its meaning. That is one reading strategy that was reinforced with weekly exercise.

Data Collection

The formal data collected in this research was simply the student’s score on the six questions that accompanied each week’s reading passage. This score was placed on a diagnostic chart and a graph each week so the students could chart their overall progress and the teacher could see how they were improving.

Students were reminded each week that there was no point in cheating or changing their score as the correct answers were provided by the teacher because they
were not graded on this assignment. Their score was simply to show the students and their teacher how they progressed over time.

Additionally, informal data was collected on students' comprehension through class discussions after the reading exercises were completed.

**Procedure**

One day each week was devoted exclusively to literacy practice. Using science content reading samples, students were asked to read the text and answer six questions about what they just read to check for comprehension (Appendix A). After students had completed the questions, they scored themselves as the correct answers were provided by the teacher. Any questions that had a different answer than their own were recorded on the diagnostic chart (Appendix B). The diagnostic charts were used so students could identify areas of weakness and strive to improve in these areas. The diagnostic charts revealed the type of questions answered correctly or incorrectly. As the answers to more questions were recorded, the chart showed the types of questions that were missed consistently. For example, if a student answers question two (identifying subject matter) incorrectly four out of five passages, the student's weakness in this area shows up automatically. The students were provided with a graph to chart their weekly progress (Appendix C). Each week a different sample of written text was used. This exercise was followed by a question and answer discussion period which provided the teacher with additional information on student comprehension. By closely noting the students' approximate reading abilities and comprehension at the beginning of the school year and
comparing that with their abilities to understand written text later in the year, an improvement was expected to be witnessed after implementing various reading strategies. The graphs included in *Reading in the Content Areas* (2005) provided a visual representation of individual student growth for both student and teacher.

Additionally, the teacher implemented various reading strategies throughout the week as appropriate. As the school year progressed, new literacy tools and techniques were incorporated into the curriculum. These included various pre-, during-, and post-reading strategies, such as modeling, anticipation guides, graphic organizers, and shared reading activities.
Results

A specific weekly literacy practice was given on Mondays, during each of five class periods. The first period was a small General Chemistry class of juniors and seniors, ranging in age from seventeen to twenty years of age. The remaining four periods consisted of seventh graders ranging in age from twelve to fourteen years of age.

Most classes included in this research completed eight reading passages. After each passage was read, the students answered six questions that accompanied each passage, filled in a diagnostic chart, and plotted their scores on a graph (Appendices A-C). This routine did not change from week to week, which provided the students with a chance to practice finding the main idea and supporting details provided by the author.

For the validity of the results, it was decided to include in Table 1 and 2 data from students who had successfully completed at least five literacy exercises. Table 1 shows the total number of students in each class who completed at least five of the reading exercises. It also includes a breakdown of how many students showed an improvement in their scores, how many students displayed a decrease in their scores, and how many had scores that stayed about the same. Table 1 shows a considerable amount of students who’s scores stayed the same as the classes progressed through numerous literacy practices. The data shows half or more of the student body in each class making no improvement in their score, despite the weekly practice.
Table 1: Literacy Score Results by Period

<table>
<thead>
<tr>
<th></th>
<th>Period 1</th>
<th>Period 2</th>
<th>Period 4</th>
<th>Period 6</th>
<th>Period 8</th>
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</thead>
<tbody>
<tr>
<td>Total number of students who completed 5 or more literacy exercises</td>
<td>6</td>
<td>18</td>
<td>15</td>
<td>14</td>
<td>12</td>
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<tr>
<td>Number of students whose score increased over time</td>
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<td>7</td>
<td>3</td>
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<tr>
<td>Number of students whose score decreased over time</td>
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<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<tr>
<td>Number of students whose score stayed the same</td>
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<td>9</td>
<td>11</td>
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</table>
Table 2 shows the combined results from all five classes and breaks down the data into the total number of students who completed at least five exercises, the total number of students who’s scored improved, the total number of students who’s scores decreased, and the total number of students who’s score remained the same. It shows 65 students completed five or more literacy exercises. Out of those 65 students, 39 students’ scores remained about the same week after week. 21 students had scores that improved with the weekly literacy practice. Only five students had scores that decreased over time.

Knowing the few students who showed an actual decrease in their overall scores, it should be noted that most are poorly motivated students who make no effort in school. Due to family circumstances, one of them slept through many classes and would not even try to complete the literacy exercises. Others have issues in their lives that prevent them from viewing school as a priority. Some face neighborhood gangs and domestic violence almost daily and see school as simply a safe place to spend the day.

After the first observation of Literacy Monday, it was obvious that one adjustment was required immediately, especially for the seventh graders. These students were not receptive to being instructed to read something, with no former discussion about it or introduction. Student interest needed to be heightened before they would cooperate and complete the literacy exercise.
Table 2: Literacy Score Results Overall

<table>
<thead>
<tr>
<th>Total number of students who completed 5 or more literacy exercises</th>
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<tr>
<td>Total number of students whose score increased over time</td>
<td>21</td>
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<tr>
<td>Total number of students whose score decreased over time</td>
<td>5</td>
</tr>
<tr>
<td>Total number of students whose score stayed the same</td>
<td>39</td>
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</tbody>
</table>
Table 3 displays how many students’ scores were not included in Table 1 and Table 2 due to frequent absences by class period. As displayed in Table 3, the most scores were excluded from Period 1, General Chemistry. This class of students seemed to find it very difficult to get up in the morning and come to class and their grades reflected this. Many of these students had given up on graduation and only came to school occasionally. These students came to school on a few Mondays and completed less than five literacy exercises. It was decided not to include their overall scores in Tables 1 and 2.

Poor attendance resulted in approximately 29 student scores being eliminated out of 94 students, or 31% overall, since these scores were from students who completed less than five exercises. Attendance is an important concern in the Rochester City School District. Period One class, General Chemistry, was the biggest contributor to the large number of students who did not complete at least five exercises, as shown in the data. As mentioned previously, this is the class of seniors who frequently do not make it to class. Out of 18 students, 12 did not come on Literacy Monday at least five times since the beginning of the school year.

However, of the six students who reported to this Chemistry class regularly, each showed interest and their scores either stayed the same or improved. No one in this class had scores that decreased over time. It was observed that these few students took each week’s reading exercise seriously and did not require the same motivational techniques as the seventh graders needed.
Table 3: Students not included in this study due to poor attendance by class

<table>
<thead>
<tr>
<th>Period</th>
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<th>Number of students who did not complete at least 5 exercises</th>
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<tbody>
<tr>
<td>1</td>
<td>18</td>
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<td>8</td>
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Discussion and Conclusion

The text *Reading in the Content Areas: Science* (2005) was chosen because it met many of the techniques to improve student comprehension recommended by the National Reading Panel (2000), as listed in the review of literature. The requirement of students to answer written questions about what they have read is an effective means of improving comprehension. Another strategy used by this text instructed students to identify the main idea of a reading passage and this too was proven to increase comprehension, according to the National Reading Panel's (2000) evidence-based research.

Additionally, as stated by Dickson, et al., it is imperative that the text meets the student's reading level. The book chosen as a tool in this study provided science literature at three different reading levels in order to ensure that varied reading levels could be met. Dickson et al. went on to state that the organization of the text is crucial. *Reading in the Content Area: Science* (2005) kept the same six essential questions in the same order after every reading assignment. This was hoped to provide the students with practice so that they could develop an active searching attitude about what they read. The six types of questions used in this text were expected to help students become aware of what they were reading at the same time they were actually seeing the words and phrases on a page. This thinking-while-reading was hoped to prepare students for higher comprehension and better retention.

Apart from the strategies offered in the *Reading in the Content Area: Science* (2005) text, this study had improved success when the teacher took the time to activate the students' prior knowledge. In agreement with Street (2002), students should activate
prior knowledge with a short discussion and establish a purpose for reading. Street
continued to state that anything the teacher can do to instill curiosity and motivation is
also helpful prior to reading. The students involved in this study demonstrated increased
cooperation and interest when they saw a correlation to classroom subject matter and the
chosen subject of the reading passage.

It was suggested that the teacher could also improve student motivation by
informing the students of a related activity that would follow the literacy exercise, a
project that required knowledge of what was just read. After reading a selection on
Volcanoes (Appendix A), each student was given play dough and instructed to make a
model of each of the different types of volcanoes as discussed in the reading.

In the beginning, it was helpful to some seventh grade classes if the passage was
read out loud and students were instructed to read along. The students were asked to read
it silently to themselves the second time. This technique got students involved with the
text before having to figure out its meaning on their own. This practice provided them
with a chance to hear any unfamiliar words and made the exercise less intimidating for
those who struggled with reading.

Students also showed more interest when instructed to read the title of the passage
and think about it for a full minute before reading. They were instructed to ask
themselves what they already knew about the subject before beginning the reading. A
short class discussion sometimes followed, before anyone had read the passage. This
demonstrated Beers (2003) belief that the more educators frontload students’ knowledge
of a text and help them become actively involved in constructing meaning prior to
reading, the more engaged they are likely to be as they read the text. If a question was
posed by the teacher that students could answer by reading, a greater number of students were found to be more engaged during the assignment. This acted like a hook to get their attention focused on the assignment.

It was very hard to convey to seventh graders that their scores on the literacy practice would not count against them. Despite constant reassurances that their score would not count towards their science grade, students were often seen erasing wrong answers and fixing them with the correct ones as the answers were shared by the teacher. Many students simply did not believe that they would be asked to do something in class that would not affect their overall science grade. This, of course, impacted the results of this study and therefore they are not 100% accurate. For example, a handful of students’ scores remained constant week after week, at a surprising 100% correct. Knowing these same students’ literacy skills in other classroom activities, these scores do not seem correct. This could have explained why there were so many students who showed no improvement despite the weekly practices. This mistrust may have also explained why a few students showed a decrease in their score over time (Table 1 and 2). One student in period four admitted that after cheating the first four weeks by giving himself a 100% and seeing that it had no effect on his grade, he finally decided to grade himself honestly. This would explain why his grades plummeted to an average low of 45% after having a straight run of 100%’s.

Much energy was devoted to reassuring the seventh grade students that learning literacy skills is important for their success. Convincing the younger students to simply read a half page of written text and try their best to answer the six questions that followed each reading was a daunting task. If they did not see the fun in it, they often gave up. It
was repeatedly stated by the teacher that the class would not continue until everyone had completed the six questions. This made students accountable to their classmates who were waiting for everyone to finish. An increase in effort was observed when students were reminded that the whole class would wait for everyone. This was not required by the seniors in the first period class. These older students showed a desire to practice manageable reading passages and improve their reading abilities. The older students seemed to recognize and agree with the fact that they struggle with understanding written science text and seemed to appreciate a chance to practice without negative consequences on their grade. The teacher mistrust was not displayed by this class when the time came for students to grade themselves.

It was observed that if the literacy piece chosen each week did not engage the students' interest, it was an uphill battle to get them to read the three or four paragraphs and answer the six questions that followed. The highest student interest was displayed when a reading selection was used that was directly related to the topic just talked about in class the week before. Selecting appropriate readings became easier as the school year progressed and more science content was covered. The first month of teaching covered such subjects as lab safety, the scientific method, and measurement. These topics were not covered in the *Literacy in the Content Areas: Science* (2005) text used in this study. This resulted in the first few readings being irrelevant to what had been taught in class and therefore less student interest and engagement. However, as the classes progressed more than halfway through the science curriculum it became easier to find readings on the very same things the class was studying. The literacy selections provided
reinforcement and allowed the students to use their prior knowledge to help them answer the six questions at the end of the reading passages.

The literacy exercise was further enhanced when picture books on the topic were scattered at their tables so as students finished the reading and answered the questions, they could then pick up a related book and see pictures about what they just read. An example of this was the reading on different types of volcanoes (Appendix A), followed by looking at picture books about volcanoes, and further enforced by making the different types of volcanoes out of play dough. This literacy exercise was incorporated into a three day long science lesson and student engagement was higher as a result.

Most seventh grade students seemed to want to move on immediately after the literacy exercises were completed and were frustrated with having to wait. In the future, a puzzle or coloring page ready for those who finish early would be advisable, especially if it related to the reading. Additionally, putting a maximum time limit on the literacy exercise was needed for the seventh graders as well. A fifteen minute block of time was usually sufficient to allow all students to read the passage twice over and answer the questions.

It is important to note that at the beginning of the school year it was announced that Mondays would be Literacy Days. Therefore, wanting to stay true to the promise and keep consistent with the students’ expectations, Literacy Monday was kept constant throughout the study period. However, this turned out to be the worst school day to devote to literacy because of repeated days off. Martin Luther King Day, New Year’s Day, school assemblies, and snow days all affected the schedule. Student attendance school wide was also consistently lowest on this day. However, students seemed to find
comfort in knowing that Mondays were always Literacy Days and they could expect that consistently week after week.

According to Guthrie, et al. (2006), it is important to offer students choices within the classroom to increase their motivation to read. One way this could be implemented with this weekly literacy practice is to allow students to choose one partner and do some form of shared reading. This was not tried in this research study, but it may be worth implementing in the future. It may provide the students additional accountability as they grade themselves on the six questions when they share the same answers as their partner. This would make it harder to cheat on their score as students grade themselves while the correct answers were provided by the teacher. Additionally, according to the National Reading panel (2000), cooperative learning offers students with an opportunity to teach others which has been proven to improve retention rates.

In future research, it may be useful to supplement the weekly reading passages by taking advantage of the Democrat and Chronicle’s free offer for teachers to receive a class set of newspapers once per week and use the newspaper in place of a selected reading passage. Students may have been more engaged if varied reading sources were used. With the Chemistry class, a section of their Chemistry textbook was used in place of a reading passage from Reading in the Content Areas: Science text and students were asked to complete the same six essential questions afterwards (Appendix E), this time with questions designed by the teacher. Another suggestion for future research could include handing out magazines or short stories and asking the students to choose a reading passage, read it over, and then create their own six essential questions about the main idea, the subject matter, the supporting details, conclusion, clarifying devices, and
vocabulary in context. According to the National Reading Panel (2000), the use of student-generated questions has scientific evidence backing its success in student comprehension and retention of what they have read.

Another reading strategy offered by the National Reading Panel (2000) is the use of graphic and semantic organizers, which allows the reader to see relationships in the content. This technique may complement the weekly literacy exercises, especially as the reading passages get more difficult. The teacher could design and pass out a concept map with some bubbles left blank, asking the students to fill it in as they read.

In summary, of the 94 total students who participated in this research, 29 students missed so much school that they have not been in class on Mondays for literacy practice at least five times. Their scores were not included as a result. Of the 65 remaining students, 39 students' scores remained fairly constant week after week. This might have been due, at least in part, to student dishonesty as they graded themselves. Twenty one students showed a general increase in their literacy scores over time. Of the 65 students who completed at least five literacy exercises, only five students showed a general decline in their scores.

It is important to stress that this weekly literacy practice should not stand alone. The more literacy practice offered in the classroom, the better. This research would be most effective if incorporated into a classroom rich in literacy opportunities. The strategies mentioned in the review of literature can be incorporated into almost any lesson. If teachers of all subjects would implement an assortment of literacy strategies on a frequent basis, students would be given a greater chance of becoming successful readers.
References


32 Recognizing Volcanoes

Volcanoes may assume a variety of shapes. These are determined by the composition of the magma, or hot melted rock, that lies within them. The shapes are also determined by their past eruptions. The four main volcano forms are identified by the shape of their cones. These include cinder cones, shield volcanoes, composite cones, and domes.

Cinder cones are the simplest type of volcano. They form when an eruption throws out rocks and ash but little flowing lava. Cinder cones usually consist of small volcanic fragments that are as fine as ash or as large as a pebble. The cinder cone of Paricutín in Mexico began in a flat cornfield in 1943. It reached a height of 1,300 feet before becoming dormant.

Nonexplosive eruptions with easy flowing lava produce shield volcanoes. The flow pours out in all directions, building a broad, gently sloping cone. The lava flows from shield volcanoes are usually only 3 to 33 feet thick, but they may spread out for long distances. The name shield comes from their resemblance to the shields of early Germanic warriors. The volcanoes of Hawaii and Iceland are shield volcanoes.

Alternating eruptions of ash and rocks followed by quiet lava flows form strong, steep-sided volcanic cones called composite cones. Most of the tallest volcanoes on the continents are composite volcanoes. Mount St. Helens in Washington is an example of such a volcano.

Domes are built by a lava so thick that it barely flows. When a dome plugs the vent of a volcano, pressure builds up under the dome. This may result in a future eruption. Domes often form in the craters of composite volcanoes, such as the one that has recently developed in the crater of Mount St. Helens.

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Main Idea 1

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<th>Answer</th>
<th>Score</th>
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<td>M</td>
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<td>B</td>
<td>5</td>
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- The tallest volcanoes on the continents are composite volcanoes.  
- Volcanic forms are identified by the shape of their cones.  
- Volcanoes have a variety of shapes.
Score 15 points for each correct answer.

Subject Matter 2 Which fictional Internet Web site would most likely produce the information found in this passage?
- a. volcano_dwellers@botany.gov
- b. reachingskyward@astronomy.net
- c. rocks-lava-ashes@geology.com
- d. old.old.stuff@paleontology.edu

Supporting Details 3 Paricutín is an example of a
- a. shield volcano.
- b. dome.
- c. cinder cone.
- d. composite cone.

Conclusion 4 This passage leads the reader to conclude that
- a. all volcanoes have cinder cones.
- b. volcanoes can be grouped by their similarities.
- c. like snowflakes, no two volcanoes are alike.
- d. all volcanoes explode regularly.

Clarifying Devices 5 The words in italic type are
- a. supporting details.
- b. names of important places.
- c. key words.
- d. definitions.

Vocabulary in Context 6 In this passage, dormant means
- a. inactive.
- b. tired.
- c. lively.
- d. noticeable.

Add your scores for questions 1–6. Enter the total here and on the graph on page 159. Score 65
Appendix B
Sample Diagnostic Chart

**Diagnostic Chart: Passages 1-25**

**Directions:** For each passage, write your answers to the left of the dotted line in the blocks for each skill category. Then, correct your answers using the Answer Key on page 152. If your answer is correct, do not make any more marks in the block. If your answer is incorrect, write the letter of the correct answer to the right of the dotted line.

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<td></td>
<td>Main Idea</td>
<td>Statement a</td>
<td>Statement b</td>
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Appendix C
Sample Graph

**Progress Graph: Passages 1–25**

*Directions:* Write your total score for each passage in the comprehension score box under the number of the passage. Then plot your score on the graph itself by putting a small x on the line directly above the number of the passage, across from the score you got for that passage. As you mark your score for each passage, graph your progress by drawing a line to connect the x's.
Appendix D
Sample Lesson Study Observation Protocol

Lesson Study Observation Protocol

Pre-Lesson

Background Information:

Teacher

Observer

Date of Observation

Lesson title

Subject/Grade

Demographics:

# of students _____ # of male students _____ # of female students _____

Lesson Focus (circle one):

Engage  Explore  Explain  Extend  Evaluate

Lesson Emphasis (check all that applies):

Engage

○ Providing "hook" for lesson introduction
○ Demonstrating a discrepant event
○ Uncovering misconceptions
○ Assessing prior knowledge
○ Demonstrating a principle or phenomenon

Explore

○ Providing an opened-ended investigation
○ Designing student investigations
- Recording data/collection evidence
- Following prescribed steps of a laboratory

**Explain**
- Introducing new concepts
- Learning new vocabulary/facts
- Presenting background content information

**Elaborate**
- Providing problem-solving activity
- Completing an extended investigation
- Following prescribed steps of a laboratory
- Applying exploration to real-world situation

**Evaluate**
- Answering textbook short and/or open-ended questions
- Reflecting on readings and problems
- Writing reflections in a journal or notebook
- Preparing a oral or written presentation of evidence
- Completing homework sheets
- Completing performance assessments
- Making entries to a portfolio

**Classroom Instruction (Check all that applies):**

**Indicate major materials resources used during the lesson**
- Print materials - commercial textbook
- Print materials - teacher-made
- Print materials - trade books, magazines, etc.
- Hands-on materials - commercial kits
- Hands-on materials - district-produced kits
- Hands-on materials - general laboratory supplies
- Hands-on materials - models
- Technology resources - computers
- Technology resources - calculators
- Technology resources - maps, charts, etc.

**Structure of student work:**
- Whole group
- Small group
- Pairs
- Individual

**Student Engagement:**
- Entire class is engaged in the same activity at the same time
- Groups of students are engaged in different activities at the same time
Class Discussion:
  o Whole group lead by teacher
  o Whole group lead by student(s)
  o Small groups

Room Layout:

Illustrate the classroom layout. Include doors, windows, teacher desk, student desks, lab tables, shelves, etc. During the lesson record the names and gender of students, the path the teacher takes, location of supplies or materials (if appropriate), areas of congestion,

During the Lesson

Comments: Record the time and observation throughout the lesson. Capture the salient interactions between the teacher and the students and among students as they work in groups.

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<thead>
<tr>
<th>TIME</th>
<th>OBSERVATION</th>
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Politics and Chemistry—Elemental Differences

In the time of Antoine Lavoisier (1743-1794), many scientists were still trying to explain matter as combinations of the elements air, earth, fire, and water. Lavoisier’s work changed the way chemistry was done, and today he is recognized as the first modern chemist. However, like other scientists of the 18th century, Lavoisier could not earn a living as a chemist, so he invested in a private firm that collected taxes for the king.

Remaking chemistry. Lavoisier set out to reorganize chemistry.

Lavoisier’s habit of carefully weighing reactants and products in experiments led him to discover that the mass of materials before a chemical change equals the mass of the products after it, which is the basis of the law of conservation of matter. He also discovered that combustion is the result of reaction with oxygen.

International recognition. Many scientists held Lavoisier in high esteem. Benjamin Franklin made a point to observe experiments by Lavoisier when he was in France soliciting support for the cause of the American Revolution. Lavoisier’s experiments were also followed closely by Thomas Jefferson.

In 1774, the British chemist Joseph Priestley discussed one particular experiment with Lavoisier. Priestley explained that after heating “calx of mercury” (which we know today as mercury(II) oxide), metallic mercury remained and a gas was given off. When he placed a candle in the gas, it burned more brightly. He also found that if a mouse is placed in a closed jar with the gas, the mouse can breathe it and live. Priestley’s gas was oxygen, but because he believed in an older theory of matter called the phlogiston theory, Priestley did not recognize it as an element. Lavoisier repeated Priestley’s experiment and came to the history-making conclusion that air is not a simple substance but a mixture of two different gases. One of these gases, oxygen, supports combustion, promotes breathing, and rusts metals. Lavoisier gave oxygen its name.

Political price. Lavoisier was not a member of the aristocracy. He belonged to the professional class from which many of the leaders of the French Revolution came. In spite of his class and the high regard for Lavoisier in the scientific world, his connection with the tax-collecting firm made him a target of suspicion. During the Reign of Terror that followed the French Revolution, Lavoisier was arrested and condemned to death in a trial that lasted less than a day. That same day, he was guillotined and his body thrown into a common grave—a victim of ignorance and mob rule.

Connecting to Chemistry

1. Analyzing: Why was Lavoisier’s role in the discovery of oxygen important even though he merely repeated Priestley’s experiment?

2. Applying: Lavoisier showed that a person uses more oxygen when working than when resting. Explain the reasoning behind Lavoisier’s findings.
A. Politics and Chemistry = Elemental Differences

<table>
<thead>
<tr>
<th>Main Idea</th>
<th>Answer</th>
<th>Score</th>
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<tbody>
<tr>
<td>1</td>
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<tr>
<td>Mark the main idea</td>
<td>M</td>
<td>15</td>
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<td>Mark the statement that is too broad</td>
<td>B</td>
<td>5</td>
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<td>Mark the statement that is too narrow</td>
<td>N</td>
<td>5</td>
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- a. Antoine Lavoisier was an early chemist in the 1700s. (B 0)
- b. Antoine Lavoisier gave oxygen its name. (B 0)
- c. Lavoisier made many important discoveries as an early chemist, but his life had political overtones as well. (B 0)

Subject Matter 2
- This passage is mainly about
  a. the French Revolution
  b. the life and work of Antoine Lavoisier
  c. how oxygen was discovered
  d. Lavoisier’s death on the guillotine. (C 0)

Supporting Details 3
- Lavoisier repeated Priestley’s experiment and proved
  a. the phlogiston theory
  b. the law of conservation of mass
  c. that oxygen is an element and part of a mixture we call air.
  d. you could make a living as a chemist (C 15)
<table>
<thead>
<tr>
<th>Conclusion</th>
<th>4</th>
<th>Lavoisier's life and work</th>
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<tbody>
<tr>
<td>a. Have been ignored.</td>
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<td>b. Are important and recognized in spite of his tragic and untimely death.</td>
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<td>c. Are unimportant.</td>
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<td>d. Were unknown to American scientists.</td>
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<tr>
<th>Clarifying Devices</th>
<th>5</th>
<th>The author presents the information about Lavoisier's life more clearly by</th>
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<tbody>
<tr>
<td>a. Using titled paragraphs</td>
<td></td>
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<td>b. Using a diagram</td>
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<td>c. Presenting a drawing</td>
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<td>d. The results of an experiment</td>
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<tr>
<th>Vocabulary In Context</th>
<th>6</th>
<th>The Law of Conservation of Matter states</th>
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<tbody>
<tr>
<td>a. You must replant trees you cut down.</td>
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<td>b. Oxygen is used in combustion</td>
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<td>c. Matter has mass.</td>
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<td>d. The mass of the chemicals before a chemical change must equal the mass of the products.</td>
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