IMPACT OF CLOSE READING STRATEGIES
IN CHEMISTRY

by

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of the requirements for the degree

of

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in

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DEDICATION

To my father, Guy D. Savastano, whose gift to me was a life-long passion for reading, nurtured by weekly trips to the library from my pre-school years until high school. You showed me that a book really is a dream you can hold in your hand. Dad, you were the ultimate inspiration for this work.

To my mother, Antonette P. Savastano, whose enduring love and support gave me the assurance to believe in myself, and modeled for me just what it means to be a loving parent. Mom, I miss you every day.
ACKNOWLEDGEMENT

This project could not have reached fruition were it not for my period seven and period nine college-prep chemistry classes at St. Ignatius High School. In spite of the promise of more school-related work, they demonstrated incredible cooperation and dedication to this project. I thank them for living the school mission to be “open to growth” throughout this school year.

Likewise, this project could not have been completed without the guidance, support and understanding of my advisor, Walt Woolbaugh, and course assistants Patrice Malamis and Megan Hopkins, who graciously leant their expertise throughout the development of this project. Thank you to my science reader, Dave Willey, for leading two incredible field classes and giving of his time to review this work.

This project greatly benefitted from the knowledge of my science & English colleagues at St. Ignatius – Doug Emancipator, Robert Wolf, Terry McCafferty and Dennis Arko. They were there from inception to completion, giving advice on project design, teaching reading, and data analysis and interpretation. I thank you all profusely.

Finally, an undertaking like this could have never been accomplished without the continual love and support of my family – my wife Kelly, and daughters Nina and Elena. Words cannot express how much you mean to me, and how I appreciated your love and understanding all along this two-and-a-half year journey. Now it is my turn to take care of you!
TABLE OF CONTENTS

1. INTRODUCTION AND BACKGROUND .......................................................... 1

2. CONCEPTUAL FRAMEWORK ....................................................................... 4

3. METHODOLOGY .......................................................................................... 10

4. DATA AND ANALYSIS ............................................................................... 18

5. INTERPRETATION AND CONCLUSION .................................................... 46

6. VALUE ......................................................................................................... 51

REFERENCES CITED .................................................................................. 53

APPENDICES ............................................................................................. 56

APPENDIX A Scan It Strategy ........................................................................ 57
APPENDIX B Mark It Up Strategy .................................................................. 60
APPENDIX C Talk It Out Strategy .................................................................. 62
APPENDIX D Put It Together Strategy ............................................................ 64
APPENDIX E QRI-5 Pretreatment Passage .................................................. 69
APPENDIX F QRI-5 Posttreatment Passage .................................................. 72
APPENDIX G QRI-5 Pretreatment Questions and Answers ......................... 75
APPENDIX H QRI-5 Posttreatment Questions and Answers ....................... 78
APPENDIX I Classroom Assessment Techniques – Nontreatment .............. 81
APPENDIX J Classroom Assessment Techniques – Treatment
   Phase One ..................................................................................................... 85
APPENDIX K Classroom Assessment Techniques – Treatment
   Phase Two .................................................................................................... 89
APPENDIX L Classroom Assessment Techniques – Treatment
   Phase Three ................................................................................................. 93
APPENDIX M Classroom Assessment Techniques – Treatment
   Phase Four .................................................................................................... 97
APPENDIX N Survey of Adolescent Reading Attitudes ............................... 101
APPENDIX O Adolescent Motivation to Read Profile .................................. 105
APPENDIX P Student Interview Questions – Pretreatment ......................... 109
APPENDIX Q Student Interview Questions – Posttreatment ....................... 111
APPENDIX R Reading Strategy Usefulness Survey ....................................... 113
APPENDIX S Teacher Journal Guiding Prompts ......................................... 119
APPENDIX T Institutional Review Board Exemption Approval .................. 121
LIST OF TABLES

1. Academic Level and Variability – English Courses ......................................................... 3
2. Academic Level and Variability – Mathematics Courses .................................................... 3
3. Treatment Matrix ............................................................................................................... 12
4. Data Collection Matrix ...................................................................................................... 13
5. Student CAT Scores (MM and OSS) by Treatment Phase ............................................... 23
6. Student Scores for AP Subscale, Pretreatment and Posttreatment Compared to National Norms .......................................................................................................................... 28
7. Coded Responses for Selected SARA Follow Up Questions, Pretreatment and Posttreatment ................................................................................................................................. 31
8. Grouped Student Responses – Read the Chemistry Textbook More Carefully .................. 38
9. Grouped Student Responses – Better Understand the Chemistry Textbook ....................... 39
10. Student Responses – Most Recommended and Least Recommended Strategy ................ 40
11. Student Responses – Usefulness of Reading Strategies for English and Social Studies .......................................................... 41
LIST OF FIGURES

1. QRI Scores without Look-backs, Pretreatment and Posttreatment, Full Inventory.................................................................19

2. QRI Scores with Look-backs, Pretreatment and Posttreatment, Full Inventory........................................................................19

3. Student QRI Reading Levels without Look-backs: Pretreatment and Posttreatment, Full Inventory.................................................20

4. Student QRI Reading Levels with Look-backs: Pretreatment and Posttreatment, Full Inventory..................................................20

5. Box Plot of Pretreatment and Posttreatment QRI scores, Full Inventory, without Look-backs......................................................21

6. Box Plot of Pretreatment and Posttreatment QRI scores, Full Inventory, with Look-backs ..........................................................22

7. Box Plot of Student Average CAT Scores by Treatment Phase .........................24

8. Distribution of Individual Student Scores for the SARA AP Subscale, Pretreatment and Posttreatment .............................................26

9. Class Average Scores for all SARA Subscales, Pretreatment and Posttreatment .................................................................27

10. Percent of Grouped Responses to Selected Questions from the AP and RP Subscales, Pretreatment and Posttreatment .......................29

11. AMRP Scores for the Full Survey, Self-Concept and Value Sub Surveys, Pretreatment and Posttreatment .........................................32

12. Change in AMRP Percent Score for Selected Questions from the Self-Concept and Value Sub Surveys .........................................33
ABSTRACT

Many high school students have difficulty learning content by reading – a key component of scientific literacy – since they often lack the skills, confidence and motivation to read expository text. This study investigated the impact of close reading strategies on reading comprehension, attitude and motivation for textbook-based reading in chemistry, and the perceived utility of reading strategies for chemistry and other subjects. Students were taught three literature-based reading strategies – a text and visuals scanning strategy, an annotation strategy, and a writing and dialogue strategy – that addressed the pre-reading, during-reading and post-reading stages, respectively. During each three-week treatment phase, students learned a new reading strategy, and were given three reading challenges to practice the strategy. In a final treatment phase, students used all three reading strategies in concert. Data collection instruments included the Qualitative Reading Inventory (QRI) and Classroom Assessment Techniques (CAT) to assess comprehension, the Survey of Adolescent Reading Attitudes and Adolescent Motivation to Read Profile (AMRP) for attitude and motivation, a student survey for strategy usefulness, and individual interviews and a teacher reflection journal to appraise student and teacher experiences. This study found that reading comprehension improved significantly posttreatment as measured by the QRI, with an effect size in the large range. Analysis of CAT scores showed that only the post-reading stage writing and dialogue strategy resulted in a significant increase in reading quiz scores. Though student attitude towards reading the textbook was largely unaffected, both facets of motivation measured by the AMRP – student’s self-concept as a reader and student’s value of reading – increased significantly, with a small effect size. Over 90% of students agreed or felt neutral that all of the strategies helped them read the textbook more carefully and understand the chemistry textbook better, and students reported an even preference for reading strategies. A plurality of students agreed that the strategies learned in chemistry could be applied to English and social studies and 60% of students interviewed had already applied a strategy learned in chemistry to another subject. This study confirmed the value of teaching students scientific literacy skills related to reading expository text.
INTRODUCTION AND BACKGROUND

Purpose and Significance

Ezra Pound said, “Properly we should read for power. Man reading should be man intensely alive. The book should be a ball of light in one’s hand” (Ezra Pound, 2016, para. 1). This quote served as an inspiration for my action research project on close reading.

When I think of the many times I have had to read a complex text to learn something new, I realize that reading for comprehension is a key skill that is necessary for mastering the material presented. However, my experience has shown me that my students, especially my college-prep chemistry students, have difficulty learning by reading the textbook. I periodically assign pre-reading for the following day’s topic and have students complete guided reading questions written by me, but they consistently struggle to pick up concepts from the reading. This observation prompted me to ask the following question: How can I improve the reading ability of my students in chemistry?

Additionally, my students’ reluctance to read the textbook results in some students choosing not to complete reading homework. This is evidenced by a review of my gradebook entries for the 2015-2016 school year – for reading assignments, up to 30% of my students chose to not complete the assignment, compared to about 10% for other types of homework (N=53). This observation caused me to ask: Can I improve the motivation of my students toward reading in chemistry?

Based on these observations and questions, I chose to focus my action research project on the impact of teaching content area reading strategies to my students. My goal
was to improve my students’ reading skills and increase their motivation for reading in chemistry. I also hoped, in the process, that they might become better readers in general, so that this critical skill may serve them for the rest of high school, in college, and as life-long learners.

Research Questions

My action research project examined the impact of close reading strategies in chemistry. Boyles (2013, p. 37) stated that “close reading means reading to uncover layers of meaning that lead to deep comprehension.” I adopted Boyles (2013) definition of close reading for my research question and sub questions, as follows:

Research question
What is the impact of close reading techniques on student comprehension in chemistry?

Sub questions
1. What is the impact of close reading on student attitudes and motivation toward reading in the content area?
2. To what extent can students apply close reading techniques to other subjects?
3. In what ways did this experience affect my own teaching practice?

School and Study Demographics

This action research project was conducted at St. Ignatius High School in Cleveland, Ohio. St. Ignatius is a private, all-boys Jesuit school with an enrollment of 1499 students located just west of downtown Cleveland. Our student body matriculates to St. Ignatius from 135 different feeder schools. The majority of students identify as Caucasian; 16% of students identify as Black/African American, Hispanic, Asian, and
American Indian. Ten percent of students receive free or reduced lunches, and 4% receive Title I services. Upon graduation, 98% of students enter a four-year college or university (D. Bradesca, personal communication, October 7, 2016).

For this study, I worked with two classes of college-prep chemistry with a total of 52 students. At St. Ignatius, all students are required to take chemistry, and take the course as sophomores. Exceptions to the sophomore chemistry requirement do occur for transfer students. In this study, 51 of the 52 students were sophomores, and 1 student was a senior.

To gauge the academic level and variability of the students included in the study, I conducted a review of the English and mathematics courses taken concurrently with college-prep chemistry for the 51 sophomore students in the study, and compared these study students to all sophomores and all college-prep chemistry students at St. Ignatius. The results of this review can be seen in Table 1 and Table 2.

Table 1
*Academic Level and Variability – English Courses*

<table>
<thead>
<tr>
<th></th>
<th>All sophomores (N = 360)</th>
<th>All college-prep chemistry (N = 201)</th>
<th>Study subjects (N = 51)</th>
</tr>
</thead>
<tbody>
<tr>
<td>English 2</td>
<td>66.1%</td>
<td>76.6%</td>
<td>80.4%</td>
</tr>
<tr>
<td>Honors English 2</td>
<td>33.9%</td>
<td>23.3%</td>
<td>19.6%</td>
</tr>
</tbody>
</table>

Table 2
*Academic Level and Variability – Mathematics Courses*

<table>
<thead>
<tr>
<th></th>
<th>All sophomores (N = 360)</th>
<th>All college-prep chemistry (N = 201)</th>
<th>Study subjects (N = 51)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below Grade Level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Algebra I</td>
<td>3.1%</td>
<td>5.5%</td>
<td>11.8%</td>
</tr>
<tr>
<td>At Grade Level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geometry/Honors Geometry</td>
<td>80.0%</td>
<td>87.6%</td>
<td>86.3%</td>
</tr>
<tr>
<td>Above Grade Level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Algebra II or higher</td>
<td>16.9%</td>
<td>6.9%</td>
<td>2.0%</td>
</tr>
</tbody>
</table>
Students in this study were more likely to be enrolled in regular English than other sophomores or sophomores taking college-prep chemistry. They were also more likely to be in a below grade level mathematics course and less likely to be in an above grade level mathematics course than other sophomores or sophomores taking college-prep chemistry.

CONCEPTUAL FRAMEWORK

In any study of reading comprehension in adolescents, it is important to look at the current state of reading within this population. In 2007, the National Endowment for the Arts collated information from numerous national studies to assess the status of reading in America. In the executive summary, the report stated, “Americans spend less time reading” and “reading comprehension skills are eroding” (National Endowment for the Arts (NEA), 2007, p. 7). For adolescents, the trends were particularly unsettling. Only 30% of 13 year olds and 22% of 17 year olds reported that they read almost every day for fun (p. 8). The National Assessment of Educational Progress Reading Scale scores for 17 year olds showed a steady decline since 1984, while scores for 13 year olds remained flat over the same timeframe (p. 58). Average Reading Scale scores for both ages were below the proficient level (p. 56). Examining gender differences, the report noted average Reading Scale scores for 12\textsuperscript{th}-grade male students were 4.6% lower than that of female students (p. 13). Though a limited-in-scope follow up report (NEA, 2009) examining reading in 18-24 year olds – corresponding to the adolescent population in the 2007 study – showed an encouraging 9% increase in reading literature for fun (p. 4), the reading habits and reading proficiency in America remain a concern. This is clearly demonstrated in a recent report from the Organization for Economic Co-operation and
Development (2016, p. 5), which found that U.S. fifteen-year olds ranked 25th among 70 countries in reading literacy.

In a practical summary of the findings of the National Reading Panel’s report from 2000, Teaching Children to Read, Shanahan (2005) stated “reading comprehension is the act of understanding and interpreting the information within a text” (p.28). Therefore, reading for comprehension is more than just remembering what one has read, but includes the skill to interpret text and infer meaning. This requires a concerted effort on the part of the reader since for most readers this level of comprehension does not happen automatically just by reading the words of a text. Instead, students can be taught reading comprehension strategies that help them build deeper understandings while reading.

The National Reading Panel was formed by Congress in 1997 to assess the effectiveness of various approaches to teaching children to read (National Institute of Child Health and Human Development (NICHD), 2000, p. 1-1). With respect to reading comprehension, the panel reviewed 205 prior studies of reading comprehension instruction to answer the questions: “Does comprehension strategy instruction improve reading? If so, how is this instruction best provided?” (NICHD, 2000, pp. 1-3).

According to Shanahan (2005), the findings of the National Reading Panel can be practically interpreted for teachers with the following recommendations. First, though all strategies reviewed benefitted students to some degree, the most effective learning happened when several reading comprehension strategies were taught in combination
The most effective process for teaching comprehension strategies used a gradual release of responsibility model in which the teacher first models the strategy for students, guides students to use it successfully while reading, and finally assigns independent practice with the strategy (p. 32). Reading instruction typically occurs with narrative text. Since narrative and expository text are different, students have difficulty applying strategies to read expository text. Therefore, to be most effective, reading comprehension instruction must include instruction with both types of text (p.30). A final recommendation comes from the National Reading Panel report itself. When evaluating the effectiveness of reading strategy instruction in the classroom, the focus must be not on how well students perform the strategies, but on measuring students’ reading achievement, students' attitude or motivation to read, and teacher satisfaction with their instructional methods (NICHD, 2000, page 4-125).

In a review article, Krajcik & Sutherland (2010) considered scientific literacy in total – reading, writing, and oral communication – and detailed five instructional elements they believed were crucial to developing literacy skills. The five instructional principles include the following: (i) linking new knowledge to prior knowledge, especially when the new concepts are abstract, (ii) anchoring learning in motivating questions that learners find meaningful in their own lives, (iii) connecting and integrating text with visual representations to understand complex themes, (iv) providing learners a chance to apply science concepts in new contexts, and (v) allowing learners to engage in discourse by constructing explanations and engaging in argumentation.
Writing is a key component of scientific literacy (Krajcik & Sutherland, 2010), since it can be used as a way to have students construct explanations and engage in discourse. According to Hand, Lawrence and Yore (1999), writing in science has great potential to enhance learning, since writing in science develops reasoning ability, trains students in discourse, engages prior knowledge, consolidates new concepts into prior understanding, and promotes personal sense-making and meaning. Additionally, when students write in science, and respond to the writing of others, it provides opportunity for them to refine their own understanding. More recently, Fisher and Frey (2013) explain that during writing in a content area, students are thinking more deeply about the content; students often self-report that they understand the content better once they have written about it. Finally, the Common Core State Standards for English language arts and literacy in history/social studies, science, and technical subjects has codified the importance of both reading and writing in science (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010, pp. 62-66).

Hand, et al. (1999) and Fisher and Frey (2013) each describe instructional writing routines or strategies that can be employed with students. Two of these strategies are worthy of note. Hand, et al. (1999) describe a process of individual writing for a peer. Each student is asked to read about or investigate a narrow topic, and communicate the information learned first in written form, then orally with a peer. A key part of this exercise is translation of any scientific terminology into language the peer would understand. The peer then reciprocates the oral presentation. Fisher and Frey (2013) describe a routine of writing from a content area text source to inform and explain.
Students practice a close reading strategy, such as an annotation strategy, to identify a limited number of main points and gather supporting evidence. Students write answers to questions posed by the teacher and cite evidence from the text, or select specific main points and write an explanation of what each point means. As a component of reading instruction, these two strategies can be used to enhance scientific literacy and satisfy Common Core State Standards.

One way to evaluate and monitor reading ability as a part of scientific literacy is through the use of informal reading inventories. Informal reading inventories are assessment instruments commonly employed by educational professionals to evaluate students’ reading performance or document reading progress over time (Nilsson, 2008). Typically, an informal reading inventory consists of grade-leveled passages and follow-up questions assessing comprehension and recall. In a critical review of eight different informal reading inventories, Nilsson (2008) considered the Qualitative Reading Inventory (QRI) as valuable for middle and high school readers based on its passages, assessment options and easy to navigate instructions. In a follow-up study of the reliability of 11 informal reading inventories, Nilsson (2013) concluded that the QRI had acceptable levels of interrater, internal consistency and alternate form reliabilities.

Researchers have found a relationship between students’ reading achievement and their attitudes toward reading (Conradi, Jang, Bryant, Craft & McKenna, 2013). Therefore, teacher researchers studying ways to improve reading, or teachers planning instruction that involves reading, should consider assessing their students’ attitudes toward reading. Students have a general attitude toward reading, but this attitude has
several components, for example, reading for school versus reading for fun, or reading print media versus reading online materials. To this end, Conradi, et al. (2013) developed a Survey of Adolescent Reading Attitudes (SARA) to assess student attitudes toward reading. Given the increase in availability and use of technology for reading and writing, SARA was developed as a Likert-style survey with 18 questions to assess student attitudes for 4 subsets of reading content – academic print materials, academic digital materials, recreational print materials and recreational digital materials. In this study, SARA was administered to 4,461 adolescent students reflecting the U.S. national demographic make-up. Reliability for the full scale was 0.96 (Conradi, et al., 2013).

Students’ motivation to read is a “complex construct that influences readers’ choices of reading material, their willingness to engage in reading, and thus their ultimate competence in reading, especially related to academic tasks” (Pitcher et al., 2007, p. 379). Two facets of this complex construct are a student’s self-concept as a reader and a student’s value of reading. Pitcher et al. (2007) developed a 20 question survey instrument, the Adolescent Motivation to Read Profile (AMRP) focused equally on these two facets to allow teachers to assess and monitor their students’ motivation to read in response to different instructional approaches.

In summary, the literature demonstrates the necessity for reading instruction, especially for adolescent males. It provides a basis for the positive impact of teaching reading skills, and presents instruments which to measure progress in reading comprehension and attitudes toward reading. Finally, it presents a foundation for selecting instructional strategies that can help students acquire reading skills.
METHODOLOGY

Treatment Plan

For this study on the impact of close reading strategies, I chose two classes of college-prep chemistry with a combined sample of 52 students. I selected my college-prep classes for this study since they seem to struggle much more with reading than their counterparts in honors chemistry, and hopefully would get greater value.

For my close reading strategy treatment, I taught students a comprehensive process for focused reading that addressed the pre-reading, during-reading and post-reading stages. I taught students three reading strategies – one strategy for each reading stage – but the overall intent was to have students use the three strategies in concert to positively impact their ability to learn by reading expository text.

The pre-reading process prepares the student for effective critical reading; this stage includes scanning the text for cues to the content of the passage. The pre-reading strategy I designed was a combination of two strategies called Working Inside the Text and Connecting Visuals to the Surrounding Text; together I called this the Scan It strategy (Appendix A). This strategy asked students to survey the text, note organizational signals, access familiar vocabulary, make predictions about the content or main idea of the passage, and connect visuals to the text. I chose these strategies since they specifically include a step to connect visuals – graphs, tables, and illustrations – to the text (LeMaster, 2011, pp. 16, 19). According to Krajcik and Sutherland (2010), “connecting and integrating text with visual representations to understand complex themes” is one of the key scientific literacy skills (p. 457).

For the during-reading treatment, I selected an annotation strategy described by
Ball, Ginno and Morgan (2015) from the American Association of Chemistry Teachers, that I called the Mark It Up strategy (Appendix B). According to Fisher and Frey (2015) annotation strategies result in deeper understanding of a text for several reasons. First, they require students to underline main or key ideas, which teach students to note important information. They have students circle unclear words and phrases, allowing them to monitor their understanding. Finally, students are asked to write notes in the margin in their own words, causing them to summarize and synthesize information (pp. 59-60).

For the third treatment phase, I designed a post-reading strategy I called Talk It Out (Appendix C), that combined writing and dialogue strategies described by Hand, et al. (1999) and Fisher and Frey (2013). The Talk It Out strategy asked students to first read the text in a focused manner, then choose three passages from the text that they felt were important or relevant. For each of the three passages, students wrote why they chose each passage as being important and what they learned from each passage. The following class day, students shared what they wrote about the three passages with a dialogue partner – hence the name Talk It Out.

The fourth treatment phase allowed students to address the pre-reading, during-reading and post-reading stages in a combined strategy I called Put It Together (Appendix D). This strategy joined streamlined versions of the Scan It and Mark It Up strategies with the Talk It Out strategy. The Scan It strategy was streamlined by removing the Surveying the Text and Noting Organizational Signals steps in the original strategy while retaining the Predicting the Main Idea and Examine the Visuals steps. The Mark It
Up strategy was changed to eliminate the Summary Statement step since the Talk It Out strategy also asks students to write about what they learned from the text. These modifications made the Put It Together strategy more time efficient for students.

Each phase of the treatment plan lasted three weeks. During the three week time periods I introduced each new strategy using a gradual release of responsibility model. That is, I first modeled the strategy for the entire class, then students performed the strategy during class time while I observed their use of the strategy. Finally, students were expected to use the strategy on their own. During each treatment phase, I assigned at least three reading challenges from the chemistry textbook, and used classroom assessment techniques to assess student comprehension after each challenge. After the three individual reading strategies were taught, students practiced all three reading strategies, used in concert, in the final treatment phase. A summary of this treatment plan is presented in Table 3, Treatment Matrix.

Table 3
*Treatment Matrix*

<table>
<thead>
<tr>
<th>Project Phase</th>
<th>Reading Strategy</th>
<th>Topic</th>
<th>Dates of Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nontreatment</td>
<td>None</td>
<td>Atomic Structure</td>
<td>10/04/16 – 10/21/16</td>
</tr>
<tr>
<td>Treatment 1</td>
<td>Pre-reading: Scan It</td>
<td>Periodic Properties</td>
<td>11/07/16 – 11/23/16</td>
</tr>
<tr>
<td>Treatment 2</td>
<td>During-reading: Mark It Up</td>
<td>Chemical Bonding</td>
<td>01/24/17 – 02/10/17</td>
</tr>
<tr>
<td>Treatment 3</td>
<td>Post-reading: Talk It Out</td>
<td>Chemical Reactions</td>
<td>02/21/17 – 03/10/17</td>
</tr>
<tr>
<td>Treatment 4</td>
<td>Combined: Put It Together</td>
<td>Chemical Quantities</td>
<td>03/20/17 – 04/05/17</td>
</tr>
</tbody>
</table>
Data Collection

The data collection process was designed to provide triangulation of data. An overview of the data collection process is presented in Table 4, Data Collection Matrix.

Table 4
Data Collection Matrix

<table>
<thead>
<tr>
<th>Research Question</th>
<th>Data Collection Method</th>
<th>Timeframe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Question: What is the impact of close reading techniques on student comprehension in chemistry?</td>
<td>Informal reading inventory</td>
<td>Pretreatment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Posttreatment</td>
</tr>
<tr>
<td></td>
<td>Classroom assessment techniques</td>
<td>Pre-strategy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Post-strategy</td>
</tr>
<tr>
<td></td>
<td>Teacher observational records/field notes</td>
<td>During implementation of each reading strategy</td>
</tr>
<tr>
<td>Sub Question: What is the impact of close reading on student attitudes and motivation toward reading in the content area?</td>
<td>Survey of Adolescent Reading Attitudes</td>
<td>Pretreatment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Posttreatment</td>
</tr>
<tr>
<td></td>
<td>Adolescent Motivation to Read Profile</td>
<td>Pretreatment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Posttreatment</td>
</tr>
<tr>
<td></td>
<td>Student individual interviews</td>
<td>Pretreatment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Posttreatment</td>
</tr>
<tr>
<td>Sub Question: To what extent can students apply close reading techniques to other subjects?</td>
<td>Reading strategy usefulness survey</td>
<td>Posttreatment</td>
</tr>
<tr>
<td></td>
<td>Student individual interviews</td>
<td>Posttreatment</td>
</tr>
<tr>
<td>Sub Question: In what ways did this experience affect my own teaching practice?</td>
<td>Teacher self-reflection journal</td>
<td>Throughout action research project</td>
</tr>
<tr>
<td></td>
<td>Student individual interviews</td>
<td>Pretreatment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Posttreatment</td>
</tr>
<tr>
<td></td>
<td>All instruments listed above</td>
<td>Throughout action research project</td>
</tr>
</tbody>
</table>
Informal Reading Inventory

Prior to the first treatment phase, I administered an informal reading inventory, the Qualitative Reading Inventory (QRI) to all students to assess their initial reading comprehension ability (Leslie & Caldwell, 2011).

Various editions of the QRI have been used for 40 years to identify subjects’ reading levels, design and evaluate interventions, and document student growth in reading. The QRI is not a norm-referenced or standardized instrument; instead, the user determines which reading passages and assessment options to employ. For high school science, the QRI-5, the fifth edition, contains three grade-leveled expository reading passages, each paired with 5 explicit and 5 implicit reading comprehension questions for a total of 10 questions, with answer keys.

The QRI-5 provides a number of assessment options. For this study, reading comprehension was first assessed without the opportunity to look back to the text, to gauge students’ ability to answer explicit and implicit questions about the text they just read from memory. Next, students were permitted to use look-backs to locate missing or incorrect information. The use of look-backs provides a more complete picture of a student’s basic reading ability, since “a student who can locate answers and correct errors probably understood the text, at least after rereading it. The initial problem may have been one of memory or purpose” (Leslie & Caldwell, 2011, p. 79).

After scoring the QRI reading comprehension questions, students received a total correct score out of 10 points for the full inventory, and out of 5 points for the explicit and implicit subscales. Students received separate scores without look-backs and with
look-backs. Depending on their score on the full inventory, the students were placed into one of three reading level ranges, independent (9-10), instructional (7-8), and frustration (0-6) (Leslie & Caldwell, 2011).

The QRI was repeated immediately after the last treatment phase. QRI reading passages with the administration instructions used in this study and the QRI questions with answers can be seen in Appendices E – H.

**Classroom Assessment Techniques**

In my data collection scheme, I monitored progress in students’ reading comprehension as they moved through the various treatment phases using classroom assessment techniques (CATs). Their general ease of design, potential for immediate and rich feedback, and familiarity of my student population with CATs were factors in this decision.

I elected to use a limited number of CATs in this study, so my students and I would be used to using the same techniques repeatedly. Additionally, this allowed me to examine the results from the same type of CAT throughout the timeline of the project. The three CATs employed in the study were the Memory Matrix (MM), One Sentence Summary (OSS) (Angelo & Cross, 1993) and the Odd One Out (OOO), or as I renamed it for this study, One of These Things Is Not Like the Others (Keeley, 2008).

During the nontreatment phase and after students learned a new reading strategy in each of the treatment phases, students were assigned three textbook passages to read. On the day following the reading assignments, I administered a CAT of my own design using one of the aforementioned CAT techniques. Each CAT type was used only once
per study phase, and all CATs were designed to have ten possible points to facilitate comparison from one study phase to another (see Appendices I through M). All CATs were scored for the number of correct answers out of ten, and a total correct score was determined.

**Survey Instruments**

During the non-treatment phase, I assessed all students’ attitudes and motivation toward reading in chemistry using two survey instruments, the Survey of Adolescent Reading Attitudes (Conradi, et al., 2013; Appendix N), and the Adolescent Motivation to Read Profile (Pitcher, et al., 2007; Appendix O). I set up the two surveys on our school’s learning management system so students were able to take them electronically, streamlining the data collection and analysis process. The two surveys were repeated immediately after the end of the last treatment phase to detect any change in students’ attitude and motivation to read.

**Student Interviews**

I conducted pretreatment and posttreatment individual student interviews about the reading process to assist with triangulation for the study’s three research sub questions on attitude and motivation, utility of reading strategies, and impact on my practice. I selected students via a stratified random sampling technique from three strata – high achieving, average achieving, and low achieving – on the pretreatment QRI full inventory with look-backs, and I identified five students randomly from within those strata. Pretreatment interview questions (Appendix P) focused on students’ prior experiences with reading and reading strategies. Posttreatment interview questions
focused on students’ experience with using the reading strategies taught in the study, and how these strategies may have impacted their reading practice.

**Reading Strategy Usefulness Survey**

After the last treatment phase, I administered a survey of my own design, the Reading Strategy Usefulness Survey (Appendix R), to all students in the study. The survey was designed as Likert-type survey with open-ended follow up questions. The intent of the survey was to evaluate students’ experience with each of the reading strategies, and to solicit students’ opinions on the applicability of the reading strategies for chemistry, English and social studies.

**Teacher Journal**

Throughout the action research project, I maintained a journal as a combined observational record of classroom activities and self-reflection journal. I made journal entries each day that class work was focused on the project. I used guiding prompts to keep a log of classroom activities, interactions and notable student quotes from each work day (Appendix S). I also used the journal entries to record my thoughts, impressions and reflections about the progress of the action research experience.

The research methodology for this project received an exemption by Montana State University's Institutional Review Board and compliance for working with human subjects was maintained. See Appendix T.
DATA AND ANALYSIS

My main research question addressed the impact of close reading techniques on student comprehension in chemistry. Analysis of pretreatment and posttreatment QRI results and CAT scores from each treatment phase provided evidence to answer my question concerning comprehension. Additionally, CAT scores for each treatment phase were used to evaluate the relative effectiveness of each reading strategy.

After scoring the pretreatment and posttreatment QRI tests, students received a total correct score out of 10 possible points. Separate scores were determined without look-backs – without the opportunity to refer back to the text when answering questions – and with look-backs – with the chance to refer back to the text to locate missing or incorrect information.

Histogram plots of student scores pretreatment and posttreatment, without look-backs and with look-backs are shown in Figures 1 and 2, respectively. Overall student scores without look-backs (Figure 1) showed a marked upward shift from pretreatment to posttreatment, while scores with look-backs (Figure 2) did not seem to shift from pretreatment and posttreatment. A review of individual student scores without look-backs showed that 40 students (77%) scored higher, 7 students (13%) scored the same and 5 students (10%) scored lower on the posttreatment QRI; 4 of the 5 students who scored lower dropped by only 1 point. For individual student scores with look-backs, 30 students (58%) scored higher or the same, and 22 students (42%) scored lower posttreatment; 11 of the 22 students who scored lower dropped by only 1 point.
Based on their QRI full inventory score, students were also assigned one of three reading levels, independent (9-10), instructional (7-8), and frustration (0-6). Student reading levels pretreatment and posttreatment, without and with look-backs can be seen in Figures 3 and 4. Overall, students experienced an upward movement in their reading
level without look-backs, most moving up from frustration level to instructional level. Pretreatment, 45 students (87\%) read at a frustration level, with this number dropping to 33 (63\%) students posttreatment. Student reading levels with look-backs remained flat.

**Figure 3.** Student QRI reading levels without look-backs, pretreatment and posttreatment, full inventory, \((N=52)\).

**Figure 4.** Student QRI Reading Levels with look-backs, pretreatment and posttreatment, full inventory, \((N=52)\).
A Wilcoxon matched-pairs signed rank test was performed to determine whether student average pretreatment and posttreatment QRI scores, without look-backs and with look-backs, were significantly different. For student QRI scores without look-backs, this analysis indicated that the study treatment produced a significant difference in student QRI scores ($z = 5.26$, $p = 0.0000001$), with an effect size of 0.90. This effect size value is considered large (Madsen, Sayre & McKagan, 2016), indicating the study treatment caused a marked improvement in QRI scores without look-backs. For student QRI scores with look-backs, this analysis showed that the difference in student QRI scores was not significant ($z = 0.23$, $p = 0.81$). This analysis is shown as box plots in Figures 5 and 6. The boxes in Figures 5 and 6 show quartile two, the median and quartile three; the whiskers show the minimum and maximum values.

![QRI Scores - Full Inventory - Without Look-Backs](image)

*Figure 5.* Box plot of pretreatment and posttreatment QRI scores, full inventory, without look-backs, $(N=52)$. Pretreatment mean = $3.69 \pm 2.20$ (SD); Posttreatment mean = $5.58 \pm 1.98$ (SD).
While administering the posttreatment QRI assessment, I noted in my teacher field notes that students seemed particularly focused on the task. This prompted me to look for evidence to support this impression. I retrospectively reviewed the pretreatment and posttreatment QRI reading passage handouts for evidence of active reading – underlining, circling, or the making of margin notes – and conducted an analysis of the length of time students took to read the pretreatment and posttreatment QRI passages. During the pretreatment QRI administration, only 4 students (8%) displayed evidence of active reading, while on the posttreatment administration 15 students (29%) showed evidence of active reading. This was a positive result, since the instructions for both test administrations said to “read the text passage…as you would normally read textbook material.” Finally, students took an average of 3.4 ± 1.4 (SD) minutes to read the pretreatment QRI passage and 4.6 ± 1.9 (SD) minutes to read the posttreatment QRI
passage. A Mann Whitney U test applied to reading time length showed these means were significantly different \((z = 4.25, p = 0.00002)\), therefore this provided strong evidence that students spent more time reading the posttreatment QRI passage than the pretreatment passage.

Three textbook reading passages were assigned in the nontreatment phase and in each treatment phase, followed the next school day by the administration of a CAT – a Memory Matrix (MM), One Sentence Summary (OSS) or Odd One Out. Due to a data collection error, scores for the nontreatment Odd One Out CAT were not available for all 52 students in the study, therefore analysis of CAT scores included only the MM and OSS CAT scores from each study phase.

Student average CAT scores for each of the five study phases were determined, and a paired t-test was performed between nontreatment CAT scores and each treatment phase CAT scores to determine whether student performance was significantly different for the reading strategy employed in that treatment phase. Also, nontreatment CAT scores were compared to all treatment phase CAT scores to look for a difference over all reading strategies. The results of this comparison and statistical analyses are summarized in Table 5, and are presented visually in Figure 7.

<table>
<thead>
<tr>
<th>Study Phase</th>
<th>Reading Strategy</th>
<th>Mean ± Std. Dev.</th>
<th>Significant (p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nontreatment</td>
<td>---</td>
<td>4.48 ± 1.80</td>
<td>---</td>
</tr>
<tr>
<td>Treatment 1</td>
<td>Scan It</td>
<td>3.69 ± 2.26</td>
<td>no; ( p = 0.09 )</td>
</tr>
<tr>
<td>Treatment 2</td>
<td>Mark It Up</td>
<td>4.59 ± 1.85</td>
<td>no; ( p = 0.64 )</td>
</tr>
<tr>
<td>Treatment 3</td>
<td>Talk It Out</td>
<td>5.25 ± 2.34</td>
<td>yes; ( p = 0.013 )</td>
</tr>
<tr>
<td>Treatment 4</td>
<td>Put It Together</td>
<td>4.88 ± 2.22</td>
<td>no; ( p = 0.17 )</td>
</tr>
<tr>
<td>All Treatments</td>
<td>---</td>
<td>4.67 ± 1.79</td>
<td>no; ( p = 0.39 )</td>
</tr>
</tbody>
</table>

\( (N=52) \).
Only the Talk It Out strategy showed a significant difference \((t = 2.56, p = 0.013)\) in student reading comprehension as measured by CAT scores. This difference had an effect size of 0.36, which is considered between a small and medium effect.

![Figure 7](image-url). Box plot of student average CAT scores by treatment phase, \((N=52)\).

Although the analysis of the Scan It, Mark It Up, and Put It Together strategies did not show a significant effect on reading comprehension (i.e., as measured by CAT scores), this result does not necessarily confirm the strategies did not have value to individual students. In posttreatment student interviews, 12 of 15 students interviewed felt they were better equipped with the tools or skills necessary to read the textbook effectively after learning the reading strategies in the study. All of the strategies taught in this study garnered a mention as the reading strategy that helped that student the most. One student stated, “I love the Scan It strategy, and I probably use it the most now in other subjects. It helps with pictures and diagrams, and has made my reading skills a lot stronger.” Another commented, “The strategy that was most effective for me was the
Mark It Up. It has helped me get in the habit of highlighting and taking more notes when I read.” Promoting the Talk It Out strategy, a student offered “it worked best as you had to really think about what you wrote, and when you talked to a partner, you learned what he learned as well.” Finally, a student said, “The method that helped me most was the Put It Together method. It made me read more deeply and really understand the subject. Chemistry textbooks are hard to read, and this made it easier.”

The second research question asked about the impact of learning close reading techniques on student attitude and motivation toward reading in chemistry. Analysis of pretreatment and posttreatment survey instruments – the SARA and AMRP – along with student interviews were used to explore this research question.

The SARA has respondents answer questions on four subsets of reading content – academic print materials (AP), academic digital materials (AD), recreational print materials (RP), and recreational digital materials (RD). The survey authors recommend tracking scores on these individual subscales rather than on the survey total score (Conradi, et al., 2013, p. 570). Since this study focused on reading chemistry content in textbook form, most of the analysis centered on the AP subscale.

Figure 8 shows the distribution of SARA scores for the AP subscale pretreatment and posttreatment. The AP subscale consists of 5 questions, each with a Likert choice range of 1 to 6, so the minimum score on the subscale is 6 and the maximum score is 30.
Figure 8. Distribution of individual student scores for the SARA AP subscale, pretreatment and posttreatment; maximum score = 30, (N=52).

In this histogram plot, it appears that there was a slight upward shift in student attitude toward reading academic print materials, however, additional analysis showed that the difference in AP subscale scores was not significant.

Conradi, et al. (2013) suggest two ways to interpret the results of the SARA subscales. First, one can interpret the average score for a subscale using the anchor phrases of the Likert items in the survey – an average score of 6 would correspond to feeling very good, whereas an average score of 1 would correspond to feeling very bad about the type of reading content addressed in the subscale. As the midpoint, a score of 3.5 suggests neutrality. The more an average score for the subscale exceeds 3.5, the more positive the attitude toward the type of reading content (p. 570).

The results for pretreatment and posttreatment surveys for all SARA subscales are seen in Figure 9. The average scores for the AP subscale (pretreatment 3.5 ± 0.9 and
posttreatment 3.6 ± 1.0) hovered in the range of having a neutral attitude toward reading, as did the RP subscale (pretreatment 3.6 ± 1.0 and posttreatment 3.9 ± 1.2). The average scores for the AD subscale (pretreatment 4.2 ± 0.8 and posttreatment 4.2 ± 0.8) showed attitudes toward reading recreational print materials were slightly better, though not approaching the level of feeling good or very good about reading. The only subscale that did approach these attitude levels was the RD scale (pretreatment 5.4 ± 0.8 and posttreatment 5.3 ± 0.8). The RD scale asked students about reading text messages and social media posts, so this result may not be surprising.

![Average Score by SARA Subscale](image)

*Figure 9. Class average scores for all SARA subscales, pretreatment and posttreatment. Error bars represent 1 S.D., (N=52).*

Focusing on the results for the AP subscale, a paired t-test was performed on the pretreatment and posttreatment average AP subscale scores. These mean scores, 3.5 and 3.6, respectively, were not significantly different (t = 1.15, p = 0.256).

The survey authors also suggest comparing the score of each subscale to national norms computed from a nationwide SARA survey given to 4,491 students in 2012.
This comparison was done for the AP subscale only, determining the number and percent of students scoring in each percentile range. This data is shown in Table 6.

Table 6
Student Scores for AP Subscale, Pretreatment and Posttreatment, Compared to National Norms

<table>
<thead>
<tr>
<th>Percentile Range</th>
<th>SARA Score Range</th>
<th>Pretreatment (%)</th>
<th>Posttreatment (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-25</td>
<td>8-12</td>
<td>6 (11.8)</td>
<td>7 (13.5)</td>
</tr>
<tr>
<td>26-50</td>
<td>13-16</td>
<td>17 (33.3)</td>
<td>10 (19.2)</td>
</tr>
<tr>
<td>51-75</td>
<td>17-19</td>
<td>12 (23.5)</td>
<td>16 (30.7)</td>
</tr>
<tr>
<td>76-90</td>
<td>20-23</td>
<td>11 (21.6)</td>
<td>12 (23.1)</td>
</tr>
<tr>
<td>90-100</td>
<td>24-30</td>
<td>5 (9.8)</td>
<td>7 (13.5)</td>
</tr>
</tbody>
</table>

(N=52).

Though there appeared to be movement of a small number of students from the 26-50 percentile range to the 51-75 percentile range, the number of students in each range did not change appreciably pretreatment to posttreatment. An examination of the identities of the students scoring in the lowest percentile range and highest percentile range pretreatment versus posttreatment showed near agreement in these students’ identities. Therefore, students with the poorest attitudes toward reading pretreatment did not appear to change their attitude toward reading academic print material posttreatment, and students with the most positive attitudes encouragingly remained positive.

Next, pretreatment and posttreatment responses for three selected SARA questions were compared. Two questions were part of the AP subscale and one was from the RP subscale. The SARA questions selected for this comparison were: question 6, How do you feel about reading a textbook?; question 18, How do you feel about reading
a novel for class?; and question 2, How do you feel about reading a book in your spare time? For this analysis, the possible Likert responses were grouped as 1 – 2, 3 – 4, and 5 – 6, representing the attitudes feeling bad about, feeling neutral about, and feeling good about reading, respectively. The percent of students selecting each grouped response in the pretreatment and posttreatment surveys are presented in Figure 10.

Figure 10. Percent of grouped responses to selected questions from the AP and RP subscales, pretreatment and posttreatment, (N=52).

Students’ attitude toward reading a textbook did not change pretreatment to posttreatment, with nearly identical percentages for each grouped response. The percent of students selecting that they felt bad about reading a textbook remained at 15% both pretreatment and posttreatment, and the percent of students selecting that they felt good about reading a textbook was similar at 27% pretreatment and 25% posttreatment. However, there did appear to be a positive change in attitude about reading a novel for
class or a book in a student’s free time. Posttreatment, the percent of students selecting that they felt bad about reading a novel for class dropped from 29% to 15%, and the percent of students selecting that they felt bad about reading a book in their free time dropped from 25% to 19%. Posttreatment, the percent of students selecting that they felt good about reading a novel for class increased from 27% to 42%, and the percent of students selecting that they felt good about a book in their free time increased from 25% to 39%.

The next stage of analysis for the SARA focused on qualitative data gleaned from the open-ended follow up questions added to the original SARA survey. For this analysis, I examined the responses for two of the seven follow up questions. Specifically, this examination looked at the follow up question to SARA question 2, How do you feel about reading a book in your free time?, which had the follow up question, What type of books would you normally read?, and SARA question 6, How do you feel about reading a textbook? with the follow up question, Why did you answer the way you did? Common or similar answers were grouped and coded, and each response was tallied. The frequency of coded student responses for these two follow up questions are summarized in Table 7.

Students were more likely to state that they do not like reading textbooks than reading books in their free time. Looking specifically at the pretreatment data in Table 7, 25.0% of students offered that they are “not a fan/not interested” in reading a textbook, compared to 15.3% for reading a book in general. These values did not change considerably after the treatment period, with 21.2% of students continuing to say that
they are “not a fan/not interested” in reading a textbook and 13.5% for reading a book in general.

Overall, the student responses for these follow up questions did not differ pretreatment to posttreatment. For the question 6 follow up, 17 students out of 52 gave a negative answer pretreatment compared to 15 students posttreatment, and 14 out of 52 students gave a positive response pretreatment compared to 16 students posttreatment.

Table 7

<table>
<thead>
<tr>
<th>Question 2 Follow Up</th>
<th>Coded Response</th>
<th>Numbers of Students (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>None/Not a fan of reading/Don’t like to read</td>
<td>8 (15.4) 7 (13.5)</td>
</tr>
<tr>
<td></td>
<td>Not a fan/Not interested/It’s boring</td>
<td>13 (25.0) 11 (21.2)</td>
</tr>
<tr>
<td></td>
<td>Textbooks are vague/Don’t help with learning</td>
<td>4 (7.7) 4 (7.7)</td>
</tr>
<tr>
<td></td>
<td>I’m comfortable with it/Don’t mind it</td>
<td>4 (7.7) 5 (9.6)</td>
</tr>
<tr>
<td></td>
<td>I learn well from it/It helps me comprehend</td>
<td>10 (19.2) 11 (21.2)</td>
</tr>
</tbody>
</table>

(N=52).

The AMRP assesses two facets of reading – a student’s self-concept as a reader and a student’s value of reading. Student responses may be analyzed for the full profile, which includes both facets, or for each facet individually. Student raw scores for the survey were converted to percentage scores by dividing the raw scores by the total score possible (Conradi, et al., 2013).

The results for pretreatment and posttreatment surveys for the AMRP Full survey and the Self-Concept and Value sub surveys are shown in Figure 11. The percent scores for all three surveys showed an increase in value from pretreatment to posttreatment.
Figure 11. AMRP scores for the Full survey, Self-Concept and Value sub surveys, pretreatment and posttreatment. Error bars represent 1 S.D., (N=52).

The average student Full survey percent score increased from 69.6% to 72.4%; a paired t-test performed on the pretreatment and posttreatment scores showed this difference was significant ($t = 3.41$, $p = 0.001$) with an effect size of 0.30. The Self-Concept sub survey percent score increased from 75.3% to 77.7%; a paired t-test showed this difference was significant ($t = 3.00$, $p = 0.004$) with an effect size of 0.18. The Value sub survey percent score increased from 63.9% to 67.1%; a paired t-test also showed this difference was significant ($t = 2.57$, $p = 0.013$) with an effect size of 0.32. All three effect sizes were in the small range.

A review of the way in which individual percent scores for the 20 AMRP question prompts changed from pretreatment to posttreatment showed that individual scores increased for 15 out of 20 prompts, with a range of increase from 0.5 to 10.1%. Percent scores for 3 out of 20 prompts remained the same, and scores for 2 question prompts decreased, both by 1.0%. The two prompts that showed a decrease were question
prompt 11, I worry less about what other students think about my reading, and question prompt 18, I would like for my teachers to read out loud in my classes more often.

Figure 12 details changes in students’ responses to six selected question prompts from the AMRP, three from each sub survey. The prompts chosen for review from the student Self-Concept as a reader sub survey were: prompt 9, I feel I am a good reader; prompt 15, Reading is easy, and prompt 17, When I am in a group talking about what we are reading I feel comfortable. The prompts chosen for review from the student Value of reading sub survey were: question 2, Reading a book is something I like to do; question 12, Knowing how to read well is important, and question 14, I think reading is a good way to spend time.

![Change in AMRP Scores for Selected Questions](image)

*Figure 12.* Change in AMRP percent score for selected questions from the Self-Concept and Value sub surveys, \((N=52)\).
The scores for these selected questions were subjected to a Wilcoxon matched-pairs signed rank test to evaluate if they were significantly different from pretreatment to posttreatment. Only the scores for question prompt 17, When I am in a group talking about what we are reading I feel comfortable, \((z = 4.57, p = 0.0037)\), and question prompt 14, I think reading is a good way to spend time, \((z = 3.98, p = 0.012)\), were found to be significantly different. The effect size for prompt 17 was 0.45, in the medium range, and the effect size for prompt 14 was 0.38, between small and medium effect.

Any exploration of how student attitudes and motivation toward reading might change needs to begin by investigating students’ prior experience with reading tasks. The pretreatment student interview questions for this study focused on students’ approach to reading and their experience with reading strategies.

Prior to this school year, the 15 students interviewed – selected by stratified random sampling as described under Methodology – had limited experience using reading strategies, especially at the high school level. Only 5 of 15 interviewees reported being taught a reading strategy, either Cornell notes or an annotation strategy, by a teacher at St. Ignatius High School. Five students reported learning a highlighting/underlining strategy in middle school, mostly to prepare for State of Ohio achievement testing. Five students said they had not learned a reading strategy before this study.

This prior experience is echoed in these students’ approach to assigned reading for class, since only four students reported that they regularly employed an active reading strategy when they are assigned reading – two of these students used an annotation strategy and two students said they actively took notes while reading. The remaining 11
students gave their approach to reading as skimming the text, skimming the text then re-reading more slowly, or just reading the assigned text start to finish. From a follow up question that asked about students’ approach to reading a textbook and how this might differ from other assigned reading, common themes emerged that are exemplified by the following quotes, “I feel in a textbook there is too much information, and I normally can’t figure out what to focus on”, “I read the textbook because I have to, but they are just filled with information and there is no fast way to find what is important”, and, “If I see I have to read, say, five pages in a textbook, I may look at it and decide not to do it.”

Even students who had a more positive attitude toward reading the textbook lamented, “It’s not as laid back as reading a story for English. I need to try to focus much harder if reading a textbook.”

Finally, during the pretreatment interviews, students were asked “What do you think you need to do or have to learn to become a better reader?” which spoke to students’ self-concept as a readers. Twelve of 15 students felt they needed to take more time or focus more when reading, as illustrated by several responses, “I need to slow down. Usually I start reading faster and faster because I just want to get through it. I need to take my time.”, “I think I have to be more patient and not always rush through, taking more time to digest the material presented”, and “I need to be more attentive and really take my time. I need to highlight more or summarize the main points to become a better reader.” Two students felt they needed to read more outside of school, and one student felt he needed to read faster to become a better reader.
Posttreatment interview questions focused on students’ experience learning reading strategies and how this impacted their reading practice. Student responses to these questions seemed to support the results seen from the SARA and AMRP surveys.

When interviewees were asked, “Have your attitudes about reading the chemistry textbook changed after learning different reading strategies?”, 5 of 15 students acknowledged that their attitude toward reading the textbook improved, while the remaining 10 students said their attitude was the same or worse. Two students who felt their attitude improved stated, “I felt it was impossible to understand before learning strategies. It is now easier to understand the reading”, and “I’ve changed from ‘I’m just getting through this’ to ‘I want to learn this’.” Several of the students whose attitudes remained flat or became worse opined, “I still look at reading the textbook with neutrality. It is just a means to an end to get information for the class.”, “I still get frustrated with reading, though I am spending more time doing it.”, and, “I didn’t like reading the textbook before, and I like it less now since it is much more like work.”

Two questions from the posttreatment interview elicited responses that spoke to students’ self-concept and value. The first question asked “After practicing reading strategies in chemistry this year, do you feel you have better skills/tools to read and understand your chemistry textbook more effectively?” Overwhelmingly, 12 of 15 students agreed they felt better equipped to read the textbook after participating in the study. The remaining three students said their skills were the same, explaining that they were already good readers. It is noteworthy that all three of these students were selected to be interviewed as part of the stratified random sampling strategy by being in the high
achieving category on the pretreatment QRI. The second question asked “Does reading the chemistry textbook seem easier or harder for you now that you have learned several reading strategies?” Notably, 11 of 15 students thought reading the textbook was easier, while 4 students said it was harder. Two of the four students who said it was harder explained that it was harder “because it was more work” but both acknowledged that it helped them understand better. Both of these students were from the low achieving category on the pretreatment QRI. The following sentiments came from two students who thought reading was easier, “I now know it is important to read the text, and it is easier to dissect what I am reading.”, and “I know how to determine what is relevant or not in the reading.”

This study’s third research question asked about how students might apply the close reading techniques they learned in chemistry to other subjects. Relevant to this question is the premise that if students did not think a reading strategy was helpful in chemistry, they would probably not be as likely to try it in another subject. The Reading Strategy Usefulness Survey (RSUS) and the posttreatment student interviews were used to explicate the answer to this research question.

The RSUS was designed to evaluate students’ experience with each reading strategy, and to ask students about the applicability of these strategies to chemistry, English and social studies texts.

For each reading strategy, the RSUS asked students to rate their agreement with the same two statements, “The (insert strategy name) helped me read the chemistry textbook more carefully.” and “The (insert strategy name) helped me better understand
what I read in the chemistry textbook.” Ratings used a Likert choice range of 1 to 6, with 1 corresponding to strongly disagree and 6 corresponding to strongly agree. A summary of student responses to these two statements can be seen in Tables 8 and 9. For this analysis, the possible Likert responses were grouped as 1 – 2, 3 – 4, and 5 – 6, representing the opinions disagree with, feel neutral about, and agree with, respectively.

Referring to the results in Table 8, for all strategies, over 90% of students felt neutral about or agreed that each strategy helped them to read the textbook more carefully. The Scan It strategy scored the lowest in the agree category with only 46% of students agreeing with the statement. This can be illustrated by a student’s follow up comment, “Looking ahead and looking at the visuals was helpful, but the Scan It didn’t really have you reading into depth of the text. It was more of a brief glance at it.” The Put It Together strategy scored the highest in the agree category with 63% of students agreeing that it helped them read more carefully, typified by one student’s follow up quote, “The strategy works for me because all of the strategies coming together is more useful than just one. Each strategy had us pick out different information.”

Table 8

<table>
<thead>
<tr>
<th>Reading Strategy</th>
<th>1 – 2 (disagree)</th>
<th>3 – 4 (neutral)</th>
<th>5 – 6 (agree)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scan It</td>
<td>3 (6%)</td>
<td>25 (48%)</td>
<td>24 (46%)</td>
</tr>
<tr>
<td>Mark It Up</td>
<td>0 (0%)</td>
<td>22 (42%)</td>
<td>30 (58%)</td>
</tr>
<tr>
<td>Talk It Out</td>
<td>5 (9%)</td>
<td>19 (37%)</td>
<td>28 (54%)</td>
</tr>
<tr>
<td>Put It Together</td>
<td>3 (6%)</td>
<td>16 (31%)</td>
<td>33 (63%)</td>
</tr>
</tbody>
</table>

(N=52).
Table 9

*Grouped Student Responses – Better Understand the Chemistry Textbook*

<table>
<thead>
<tr>
<th>Reading Strategy</th>
<th>Numbers of Students (%)</th>
<th>1 – 2 (disagree)</th>
<th>3 – 4 (neutral)</th>
<th>5 – 6 (agree)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scan It</td>
<td></td>
<td>4 (8%)</td>
<td>27 (52%)</td>
<td>21 (40%)</td>
</tr>
<tr>
<td>Mark It Up</td>
<td></td>
<td>1 (2%)</td>
<td>23 (44%)</td>
<td>28 (54%)</td>
</tr>
<tr>
<td>Talk It Out</td>
<td></td>
<td>5 (9%)</td>
<td>18 (35%)</td>
<td>29 (56%)</td>
</tr>
<tr>
<td>Put It Together</td>
<td></td>
<td>5 (9%)</td>
<td>12 (24%)</td>
<td>35 (67%)</td>
</tr>
</tbody>
</table>

(N=52).

The outcomes in Table 9 mirrored the results from Table 8. More than 90% of students felt neutral about or agreed that each strategy helped them understand the chemistry textbook better. The Scan It strategy scored the lowest in the agree category with only 40% of students agreeing with the statement. One student commented, “I think it helped a little, but it didn’t make a huge effect because it is just a pre-scanning method.” The Put It Together strategy scored the highest in the agree category with 67% of students agreeing that it helped them read more carefully, represented by the comment, “Doing all the strategies in one reading helped me retain information from the whole passage better.”

The survey also asked students two open ended questions about which reading strategy they would most recommend and least recommend to a friend who was struggling with understanding the science textbook. A summary of responses is presented in Table 10.
Students did not overwhelmingly endorse one strategy over another, with responses for the most recommended strategy being distributed between 19% and 31%. The Scan It was clearly the strategy least recommended with 44% responding with that choice. Follow up comments to the most recommend and least recommend questions revealed that students perceived that each strategy had its strengths and weaknesses. For example, the Put It Together strategy was thought by students to help them understand the textbook better, but they also recognized its drawback as the amount of time it takes to use that strategy. Students appreciated that the Mark It Up strategy could be used with any type of reading, and does not require a partner as the Talk It Out strategy does. The Scan It strategy was recognized by students for its intent – to set the framework for the reading – but they felt it did not provide as deep an interaction with the text as other strategies. The results of this analysis are summed up by two student quotes from the posttreatment interviews, “I feel all of the strategies helped. Each showed an effective way to better understand the content”, and “I liked all of the strategies because I like to have several ways to approach my learning.”

<table>
<thead>
<tr>
<th>Reading Strategy</th>
<th>Most Recommend</th>
<th>Least Recommend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scan It</td>
<td>11 (21%)</td>
<td>23 (44%)</td>
</tr>
<tr>
<td>Mark It Up</td>
<td>16 (31%)</td>
<td>7 (13%)</td>
</tr>
<tr>
<td>Talk It Out</td>
<td>15 (29%)</td>
<td>10 (19%)</td>
</tr>
<tr>
<td>Put It Together</td>
<td>10 (19%)</td>
<td>12 (24%)</td>
</tr>
</tbody>
</table>

(N=52).
The RSUS and posttreatment interviews also explored how students might apply reading strategies to other subjects, namely English and social studies. For each reading strategy, the RSUS asked students to rate their agreement with two statements, “The (insert strategy name) would also be a useful strategy to use in English class.” and “The (insert strategy name) would also be a useful strategy to use in social studies class.” Again, ratings used a Likert choice range of 1 to 6, with 1 corresponding to strongly disagree and 6 corresponding to strongly agree. A summary of student responses to these two statements are seen in Table 11. This table shows only students choosing Likert responses 5 and 6, representing the opinions agree and strongly agree, respectively.

<table>
<thead>
<tr>
<th>Reading Strategy</th>
<th>Numbers of Students Selecting Agree or Strongly Agree (%)</th>
<th>English</th>
<th>Social Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scan It</td>
<td>21 (40%)</td>
<td>32 (62%)</td>
<td></td>
</tr>
<tr>
<td>Mark It Up</td>
<td>29 (56%)</td>
<td>39 (75%)</td>
<td></td>
</tr>
<tr>
<td>Talk It Out</td>
<td>28 (54%)</td>
<td>31 (60%)</td>
<td></td>
</tr>
<tr>
<td>Put It Together</td>
<td>24 (46%)</td>
<td>31 (60%)</td>
<td></td>
</tr>
</tbody>
</table>

(N=52).

Students were more likely to agree or strongly agree that the reading strategies learned in this study would be useful in social studies (60 – 75%) rather than in English (40 – 56%). The Mark It Up strategy was chosen by students as the most useful in both subjects, with 29/25 (56%) saying the Mark It Up strategy would be useful in English, and 39/52 (75%) agreeing it would be useful in social studies. Though not shown in Table 11, it is notable that all strategies had less than 9/52 (17%) of students choosing a 1
or 2 on the Likert scale, representing the positions strongly disagree or disagree, for the applicability of these strategies to English and social studies.

While the RSUS asked all students in the study about the potential usefulness of reading strategies to English and social studies, the posttreatment interview specifically asked the 15 interviewees, “Have you used any of the reading strategies you learned in this class in another class this year?” with follow up questions, “If yes, which strategy and which class? If no, why not?” Responses showed that 9 of 15 students had already applied at least one of the reading strategies to another class. Four of the nine students chose to use a strategy in social studies, three of nine applied a strategy in English, and two of nine used a strategy in both classes. One student said, “Ever since I was taught the Mark It Up strategy, I’ve been using it in history, English, and when I’m doing bible study.” As for this student, the strategy of choice for these nine students was the Mark It Up strategy, with six of the nine students using that strategy in other classes. Probing the six students who had not used a strategy in another class, four of the six students said they had not thought to apply the strategies in other classes.

To evaluate my final research question on how this study has affected my own teaching practice I used my own notes and reflections collected throughout the study, but also relied on any student interactions, interviews and assessments from the last six months. After reviewing and reflecting upon these sources of data, I would like to expand on three themes.

First, although reading is something I have been passionate about my whole life, and as a teacher I recognize that students who read more effectively are better positioned
to be successful lifelong learners, I had never seen myself as a teacher of reading. I think this is true for many content area teachers, and it is true of most content teachers at St. Ignatius. While planning this study I found that, except for English classes, our students are not instructed in reading techniques in the content areas. Only 2 of 13 history teachers and 2 of 14 science teachers at Saint Ignatius High School formally teach reading strategies.

After participating in this study I have come to appreciate that teaching reading is not dramatically different that teaching other skills. When I begin the school year, I explain to students that we will not only be learning chemistry subject matter, but we will be learning correct laboratory skills like lighting a Bunsen burner or using an electronic balance. As I taught students proper filtration technique in October 2016, using what I now know is called the gradual release of responsibility model, and concomitantly teaching students the Scan It strategy, I noted in my journal that teaching the Scan It strategy was really no different than teaching filtration or using the Bunsen burner. I initially noted, though, that teaching a reading strategy takes longer and more persistent practice. Then my students did a lab where we needed to use the Bunsen burner again, and I noted that many students needed a refresher, that is, more persistent practice, on how to use the burner. After realizing this in October, I used this mindset not only for teaching the final three reading strategies, but also for any lab skill I taught my students. I transformed from a teacher of laboratory practices or a teacher of reading strategies to simply a teacher of skills – reading or otherwise. This especially hit home after analyzing
the posttreatment interviews, when I found that 9 of 15 students had been applying the reading strategies learned in chemistry class to other subjects.

Next I would like to expound on the theme of working with students toward a common goal, in this case, to make them better readers now and looking ahead toward college. As I embarked on this study in the fall of 2016, I was concerned about the cooperation and participation students would be willing to commit to the project, given that it would entail additional work for them. I had noted in the past that up to 30% of my students chose to not complete reading assignments for homework, compared to about 10% for other types of homework.

As noted above in the section on school demographics, 98% of our students enter a four-year college upon graduation, so when I first introduced the project to students – what I recorded in my journal as “a pep talk about buying into learning how to read, on how to slow down and address the text” – I began an honest conversation with my classes on my own experiences in college being compelled to learn on my own by reading a textbook. One student blurted out, “Oh, this sounds like it is going to be tedious”. I noted in my journal that I spontaneously pulled my textbook from the biochemistry class I took through Montana State from my classroom bookshelf and showed students how I had highlighted, underlined and made copious margin notes. I wrote, “There was a noticeable change in the mood of the class. They realized that I wasn’t asking them to do something that I hadn’t done myself or didn’t think was critical to college success.” This was just the first of several pep talks throughout the project; it appeared that I repeated a similarly themed talk as I introduced and described the goal of each new reading strategy.
As I noted again and again in my journal throughout the project, I was humbled and gratified by the level of buy in and cooperation by all students. As evidence of our working together toward a common goal, all of the 52 students in my 2 college-prep chemistry classes elected to be a part of the study, and all 52 remained in the study until its conclusion. Also, during the study, I noted how many students failed to complete the assigned reading and corresponding reading strategy work. This number hovered around 5 students per assignment, or approximately 10%. This was better than the 30% of the prior year’s students who chose to not complete reading assignments for homework, and in line with this year’s level of 10% for other homework.

Finally, throughout the project I consistently observed juxtaposition between students’ awareness of the time it takes to be a more effective reader and the amount of time they feel they can devote to this end. In pretreatment interviews, 12 of 15 students showed the awareness that reading more effectively takes time. In their responses to the open-ended response questions on the SARA, AMRP and in posttreatment interviews, students recognized this conflict, as noted in the quotes used throughout the data and analysis section above. It is also evident from the results of the RSUS, where 67% of students agreed that the Put It Together method helped them understand the chemistry book better, but only 10/52 students (19%) would most recommend and 12/52 (24%) would least recommend it to a friend. In 9 out of these 12 cases, the reason given for not recommending it was the length of time the strategy took to complete. The chief lesson I learned from observing this conflict is the importance of my role as coach to support
students balancing academic short cuts versus those practices that can lead to deeper learning.

INTERPRETATION AND CONCLUSION

The purpose of this action research project was to ascertain if teaching content area reading strategies to my students could improve their reading comprehension skills and improve their attitude and motivation for reading in chemistry. I also hoped that students might become better readers in general, so that this critical skill may serve them in the future. This purpose arose from a personal passion for reading, and the observations that my college-prep chemistry students have difficulty learning by reading the textbook and are often not motivated to read the textbook.

My primary research question asked, “What is the impact of close reading techniques on student comprehension in chemistry?” The results from the Qualitative Reading Inventory (QRI) support the conclusion that student comprehension increased as a result of the treatment. Class scores on the QRI without look-backs, that is, without referring back to the text when answering questions, increased from a pretreatment mean of 3.69 to a posttreatment mean of 5.58. This difference was statistically significant ($p = 0.0000001$), and had a calculated effect size of 0.90, in the large range. Also, a review of individual student QRI scores without look-backs showed that 48 students (92%) scored higher or the same on the posttreatment QRI, and only 4 students (8%) scored lower. Class QRI scores with look-backs were not significantly different, with a pretreatment mean of 7.42 and a posttreatment mean of 7.54. The QRI without look-backs tests the ability of students to answer explicit and implicit questions from memory on what they
have just read in an unfamiliar text, while the QRI with look-backs is a gauge of students’ basic reading ability (Leslie & Caldwell, 2011, p. 79). These results indicate that college-prep chemistry students at St. Ignatius have an acceptable reading ability, but were able to improve their ability to learn when reading unfamiliar text.

Additional evidence from the QRI showed the treatment had a positive effect on students actively engaging the text when reading. The average time students spent reading the QRI passage increased from 3.4 minutes pretreatment to 4.6 minutes. This reading time difference was significantly different (p = 0.00002), confirming that students spent more time reading the QRI passage posttreatment. Also, during the QRI administration the number of students demonstrating evidence of active reading – underlining, circling, or the making of margin notes – increased from 8% to 29%.

The effect of each reading strategy on student comprehension as measured by classroom assessment techniques (CATs) did not show as dramatic a result as that for the QRI. However, one reading strategy, the Talk It Out strategy, showed a significant increase in reading comprehension as measured by CATs. The students’ mean CAT scores increased from 4.48 for the nontreatment phase to 5.25 during the Talk It Out treatment phase. This difference was significantly different (p = 0.013) and the strategy showed an effect size of 0.36, in the small to medium range. The other three reading strategies, the Scan It, Mark It Up and Put It Together, did not produce mean CAT scores that were significantly different than the nontreatment phase. However, this does not invalidate the use of a mix of reading strategies when teaching close reading skills. Students showed an evenly distributed preference for which of the four strategies they
thought would help them read the textbook more carefully, help them understand the
textbook better, and would most recommend to another student. This is underscored by
the following quote, “I feel all of the strategies helped. Each showed an effective way to
better understand the content.”

My first research sub question asked, “What is the impact of close reading on
student attitudes and motivation toward reading in the content area?” Student attitudes
toward reading did not appear to change based on the results of the Survey of Adolescent
Reading Attitudes (SARA) survey. Class average scores for the survey’s academic print
(AP) subscale pretreatment started at 3.5, the neutral point of the survey’s Likert scale,
and ended at 3.6 posttreatment. These scores were not statistically different. Ranges of
student scores on the AP subscale were compared to national norms for the SARA, and
this, too, showed minimal change from pretreatment to posttreatment. In this analysis,
students in the lowest percentile range pretreatment remained in the lowest percentile
range posttreatment. A comparison of pretreatment and posttreatment student responses
to the AP subscale question, “How do you feel about reading a textbook?” with follow up
question “Why did you answer the way you did?”, showed nearly identical answers. The
percent of students who indicated they felt bad about reading a textbook remained at 15%
pretreatment to posttreatment, and the percent of students saying that they felt good about
reading a textbook remained similar at 27% and 25%, respectively. This was confirmed
by a review of answers to the follow up, for which 25.0 % of students offered that they
are “not a fan/not interested” in reading a textbook pretreatment compared to 21.2 %
posttreatment. Not all results were neutral for student attitudes, since in posttreatment
interviews 5/15 students did report that their attitude toward reading the textbook improved, demonstrating that a subset of the 52 students in the study could have had a positive change in attitude towards reading the textbook.

The results for student motivation, measured by the Adolescent Motivation to Read Profile (AMRP), fared better than student attitudes. Student motivation to read improved slightly for the AMRP Full survey and its two sub surveys focused on Self-Concept and Value. The Full survey score increased by 2.8%, the Self-Concept sub survey score increased by 2.4%, and the Value sub survey score increased 3.2%. All three surveys showed a statistically significant increase, though the effect size was small for all three surveys.

Relevant to students’ use of the Talk It Out strategy, one AMRP Self-Concept prompt showed a significant difference with a medium effect size. The scores for question prompt 17, “When I am in a group talking about what we are reading I feel comfortable” showed an increase of 10.1% from pretreatment to posttreatment.

The results for this research question seem to be summed up perfectly by one student’s quote, speaking to both value of reading and attitude, “I now know it is important to read the textbook, but my attitude hasn’t changed.”

My second research sub question asked, “To what extent can students apply close reading techniques to other subjects?” The Reading Strategy Usefulness Survey and posttreatment interviews provided insight to answer this question.

Students responded more receptively to the using of reading strategies in chemistry, English and social studies than I anticipated prior to the study. This has to be
considered a positive result of implementing reading strategies in chemistry. Depending on the reading strategy, 46 – 63% of students agreed or strongly agreed that strategies helped them read the chemistry textbook more carefully, and 40 – 67% agreed or strongly agreed strategies helped them better understand the chemistry textbook. Student agreement that these reading strategies would be useful to social studies (60 – 75%) and English (40 – 56%) are just as encouraging as the results for chemistry. Students appear to prefer the Mark It Up strategy as the strategy of choice for chemistry, English and social studies. This perceived willingness to apply reading strategies learned in chemistry to other subjects was confirmed by 9/15 (60%) of interviewees who said they have already been using these strategies in English and social studies, where 6/9 (67%) have applied the Mark It Up strategy.

In conclusion, I believe that this action research project achieved most of what I set out to accomplish. Student reading comprehension improved significantly as measured by the QRI without look-backs. Although student attitudes toward reading did not change appreciably, student motivation, their self-concept as readers, and their value of reading improved modestly. Students appeared to be willing to apply reading strategies not only to chemistry, but to English and social studies as well. I have identified two reading strategies that know I will continue to use for the future. I will use the Talk It Out strategy, since it caused a significant change in reading comprehension as measured by CATs, and may have contributed to a significant improvement to a facet of students’ self-concept as a reader. I will also use the Mark It Up strategy for its ease of use, and because students seem to prefer it as practical for all subjects. Finally, I have
grown into my role as a teacher of skills, reading or otherwise. I have successfully worked together with students to accomplish a significant goal, beneficial to them and to me. While doing so, I have become more aware of the academic time demands on students, and this will make me a better mentor for my students.

VALUE

The most immediate impact of this action research project has been on my own students. As the results of the QRI and other instruments have become available, I have shared the positive results with my students. This has given rise to a palpable sense of pride among these two classes of college-prep chemistry. These students realized they have become better readers because of the effort they have put into reading, and I believe this will have a continued constructive effect on them in the future.

As I have shared progress on the project with other science faculty at St. Ignatius, I have noticed a definite interest in my work this year. I plan to give my capstone presentation for a science department inservice at the start of next school year. St. Ignatius’ new academic accreditation goal focuses on college-readiness, and the school’s accreditation planning committee has already asked me to present my project to department chairs.

Looking beyond, I see how this project confirms the work of the many teachers of reading who have come before, to wit, if you want to improve students’ reading ability, both the teacher and students need to actively work at it. By actively working to make a difference, you can assemble a toolkit of literature-based reading strategies that fit with your classroom and your students. I have the start of this toolkit with the Talk It Out and
Mark It Up strategies, and will continue the search to discover relevant but manageable strategies to employ for my students.

Finally, when planning this action research project last year, for a time I considered basing my research questions and design on the use of online textbooks. However, the lack of information on the efficacy of online reading caused me to decide upon a more traditional study using hard copy text, allowing my treatments to be based in the literature. After I administered the pretreatment SARA, and began to collate responses, I noticed that 16 students used the open-ended follow up to SARA question 6 to indicate an unsolicited preference for hard copy text versus online text. Ten of 16 students (63%) said that they preferred a hard copy, leaving 6 to indicate a preference for online text. This result was interesting to me given the move in education toward electronic textbooks. If students do not like to read textbooks, and especially do not like online texts, this could present a greater challenge to educators seeking to enhance students’ reading experience. To explore this further, I added a question to the RSUS which asked, ‘If you had to choose reading an online textbook or a print copy of a textbook, which would you prefer?’ so all students in the study could indicate their preference. The results echoed the smaller sample of 16 students, since 35/52 (67%) indicated a preference for hard copy text. This finding has opened up a new research avenue for me to investigate in the future.
REFERENCES CITED


APPENDICES
APPENDIX A

SCAN IT STRATEGY
Use the questions or instructions to guide your prereading. Record your responses in the right column. When you finish scanning, read the text normally from start to finish.

Surveying the Text
1. What is the title of the text or section?

2. Provide some comments on the text (length, number of paragraphs, layout, visuals, etc.).

3. Briefly describe the visuals in the section (see page 2 for detailed review of visuals).

Noting Organizational Signals
4. Briefly describe the layout of the text, headings, subheadings, sections and page breaks.

Predicting the Main Idea
5. After reading the title of the text, and observing text headings, make predictions about the main idea. What will this text be about?

6. Now, read the first and last paragraphs. What do you know about the text that you didn’t know before?
### Examine the Visuals

7. For each visual (graph, chart, or table) in the section, complete the following.

#### Visual 1

<table>
<thead>
<tr>
<th>Describe or draw the visual in the space below:</th>
<th>Read the labels and the caption. What is the visual illustrating?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Write a sentence or two that identifies the purpose of the visual, and how the visual connects to the surrounding text.</td>
</tr>
</tbody>
</table>

#### Visual 2

<table>
<thead>
<tr>
<th>Describe or draw the visual in the space below:</th>
<th>Read the labels and the caption. What is the visual illustrating?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Write a sentence or two that identifies the purpose of the visual, and how the visual connects to the surrounding text.</td>
</tr>
</tbody>
</table>

#### Visual 3

<table>
<thead>
<tr>
<th>Describe or draw the visual in the space below:</th>
<th>Read the labels and the caption. What is the visual illustrating?</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Write a sentence or two that identifies the purpose of the visual, and how the visual connects to the surrounding text.</td>
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</tbody>
</table>
APPENDIX B

MARK IT UP STRATEGY
Procedure:
1. Read the Text – with a pencil/highlighter in hand, mark the text as described below.
   a. Underline or highlight key words and phrases—anything that strikes you as surprising or important, or that raises questions.
   b. Write your thoughts and reactions in the margins next to what you have highlighted or underlined. These need to be rich comments. Rich comments might begin with the highlighted word, “what” or “why”.
   c. Circle any words you don’t know the meaning of, and look them up – either in the text or using an online resource. Write out the definition in the margins next to the word.

2. Summary Statement – write a summary statement for the text you read; include the following in your summary statement:
   a. the title of the section read
   b. a summary verb (see list of summary verbs below)
   c. the sentence, with the main idea of the article

   Your summary statement should be 25 words or less; the title counts as 1 word. At the end of your statement, write the number of words in your statement and circle it.

   Summary Verbs

<table>
<thead>
<tr>
<th>Beginning Verbs</th>
<th>Advanced Verbs</th>
</tr>
</thead>
<tbody>
<tr>
<td>compares</td>
<td>acknowledges</td>
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<tr>
<td>defines</td>
<td>advises</td>
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<tr>
<td>describes</td>
<td>answers</td>
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<td>explains</td>
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<td>simplifies</td>
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<tr>
<td></td>
<td>supports</td>
</tr>
<tr>
<td></td>
<td>teaches</td>
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<td>traces</td>
</tr>
</tbody>
</table>

3. Reflection Statement – use one of the following sentence starters and write a brief 1-2 sentence reflection statement for the article.

   Sentence Starters

| I noticed… | I’d like to know… |
| I wonder… | I realized… |
| I was reminded of… | I am unsure of… |
APPENDIX C

TALK IT OUT STRATEGY
Close reading may involve a post-reading stage where one writes down the most important points one has read in a section of text, and reflects on why these points are important. When this written reflection is shared with a dialogue partner, this can positively affect reading comprehension.

This strategy, called Talk It Out, has been reported to increase students’ depth of understanding after reading complex text, like that encountered in a chemistry class.

1. Read the section of assigned text.
   Read the text in a focused manner; you may use choose to use a pencil/highlighter to help you focus on the text at hand.

2. Prepare a Three Point Response
   a. Choose three passages (statements, sentences, short sections) from the text you read that you feel were most important or relevant to the topic you read about.
   b. Write out each of the three passages verbatim (on loose leaf paper or type out).
   c. For each passage, write why you chose that passage. That is, write why you thought that passage was important or relevant.
   d. For each passage, write a statement explaining what you learned about the topic from the passage.

3. Dialogue, or “Talk It Out”
   a. In class, pair up with another student to act as your dialogue partner.
   b. Take turns sharing each of your three point responses with your dialogue partner.
      When your role is that of the speaker: read out the passage to your dialogue partner, tell why you thought the passage was important, and explain what you learned from the passage.

      When your role is that of the listener: listen actively and carefully to your dialogue partner. If you need clarification on what your partner has told you about the passage, ask your partner for further explanation.
APPENDIX D

PUT IT TOGETHER STRATEGY
Put It Together: Combined Reading Strategy

Close reading often involves careful attention to all three stages of reading – pre-reading, during-reading and post-reading. This strategy, called Put-It-Together, incorporates techniques from three different reading strategies to increase students’ depth of understanding after reading complex text, like that encountered in a chemistry class.

**Text Selection:**

**Pre reading – Scan It:** Use the prompts below to guide your pre-reading. Record your responses in the spaces below. When you finish the Scan-It strategy, continue with the next strategy, Mark-It-Up.

Surveying & Predicting the Main Idea: scan the title and section headings
1. What is the title of the text or section?

2. After reading the title of the text, and observing text headings, make predictions about the main idea. What will this text be about?

Examine the Visuals: for each visual (graph, chart, table, or problem solution example) in the section, complete the following:

<table>
<thead>
<tr>
<th>Visual 1</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Describe or draw a sketch of the visual in the space below:</strong></td>
<td><strong>Read the labels and the caption. What is the visual illustrating?</strong></td>
</tr>
<tr>
<td></td>
<td>Write a sentence or two that identifies the purpose of the visual, and how the visual connects to the surrounding text.</td>
</tr>
</tbody>
</table>
Visual 2

Describe or draw a sketch of the visual in the space below:

Read the labels and the caption. What is the visual illustrating?

Write a sentence or two that identifies the purpose of the visual, and how the visual connects to the surrounding text.

**During reading – Mark It Up:** Read the text using the modified Mark-It-Up strategy described below. Write your Reflection Statement in the space designated below.

1. Read – Read the text *actively* with a pencil/highlighter in hand; mark the text as described below.
   a. Underline or highlight key words and phrases – anything that strikes you as important, surprising, or that raises questions.
   b. Write your thoughts and reactions in the margins next to what you have highlighted or underlined. These need to be rich comments; these might begin with: the highlighted word, “what” or “why”.
   c. Circle any words you don’t know the meaning of, and look them up – either in the text’s Lesson Vocabulary or using an online resource. Write out the definition in the margins next to the word.

2. Reflection Statement – use one of the following sentence starters and write a brief 1-2 sentence reflection statement for the section; write your reflection statement below.

<table>
<thead>
<tr>
<th>Sentence Starters</th>
<th>I noticed…</th>
<th>I’d like to know…</th>
</tr>
</thead>
<tbody>
<tr>
<td>I noticed…</td>
<td>I wonder…</td>
<td>I realized…</td>
</tr>
<tr>
<td>I was reminded of…</td>
<td>I am unsure of…</td>
<td></td>
</tr>
<tr>
<td>I am surprised that…</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Reflection Statement:
Post reading – Talk It Out: After completing the Mark It Up strategy, prepare a Three-Point Response using the instructions below. Write the three responses in the space designated below. We will follow up by sharing your three points with your dialogue partner, as usual.

1. Prepare a Three Point Response
   a. Choose three passages (statements, sentences, short sections) from the text you read that you feel were most important or relevant to the topic you read about.
   b. Write out each of the three passages verbatim, using an ellipsis if the passage is lengthy.
   c. For each passage, write why you chose that passage. That is, write why you thought that passage was important or relevant.
   d. For each passage, write a statement explaining what you learned about the topic from the passage.

Response 1:

Why you chose:

What you learned:

Response 2:

Why you chose:

What you learned:

Response 3:

Why you chose:
What you learned:

2. Follow-up Dialogue, or “Talk It Out”
   
a. In class, pair up with another student to act as your dialogue partner.

b. Take turns sharing each of your three point responses with your dialogue partner.
   
   When your role is that of the speaker: read out the passage to your dialogue partner, tell why you thought the passage was important, and explain what you learned from the passage.

   When your role is that of the listener: listen actively and carefully to your dialogue partner. If you need clarification on what your partner has told you about the passage, ask your partner for further explanation.
APPENDIX E

QRI-5 PRETREATMENT PASSAGE
Characteristics of Viruses—Part 1

Similarities and Differences between Viruses and Cells

If you ever had a cold or the flu, you probably housed viruses. A virus is an infectious agent made up of a core of nucleic acid and a protein coat. Viruses are not cells. Unlike plant and animal cells, a virus package does not have a nucleus, a membrane, or cellular organelles such as ribosomes, mitochondria, or chloroplasts. Although viruses are not cells, they do have organized structural parts.

Compared to even the smallest cell, a virus is tiny. The virus that causes polio, for example, measures only 20 nanometers in diameter. One nanometer is one billionth of a meter. At that size, 3000 polioviruses could line up across the period at the end of this sentence.

All viruses have at least two parts: a protective protein coat and a core of nucleic acid. The protein coat around the core of the nucleic acid is called a capsid. Depending on the virus, the capsid may consist of one or several kinds of protein. The capsid protects the viral nucleic acid core from its environment.

In cells, DNA is the hereditary material. Some viruses also contain DNA, while other viruses contain only RNA. In viruses containing RNA, the RNA functions as the hereditary material.

Compared to a cell, a virus has a relatively simple existence. Viruses do not eat, respire, or respond to environmental changes as cells do. It should not surprise you, therefore, to learn that viruses have fewer genes than cells have. While a human cell may contain about 100,000 genes and a bacterial cell about 1000, a virus may contain only 5 genes.
In the figure on the previous page, you can see the parts of an influenza virus: a core of RNA, a surrounding capsid, and an outer covering called an envelope. An envelope is an additional protective coating usually made up of lipids, proteins, and carbohydrates. Envelopes are found only in viruses that infect animal cells. An envelope has spike-like projections that recognize and bind to complementary sites on the membrane of the cell being infected. Think about how a prickly burr sticks to objects.

APPENDIX F

QRI-5 POSTTREATMENT PASSAGE
Characteristics of Viruses—Part 2

Viral Replication: Ticking Time Bombs

Viruses do not reproduce; they replicate. Reproduction, which is characteristic of living things, involves cell division. Replication does not involve cell division. Viruses cannot replicate on their own. In order to replicate, viruses require a host. A host is an organism that shelters and nourishes something. Living cells host viruses. These host cells provide all the materials that viruses need to copy themselves.

When it enters a host cell, a virus may immediately begin to replicate, or it may remain relatively inactive. The viral replication process that rapidly kills a host cell is called the lytic cycle. You can follow the lytic cycle in the figure below. The lytic cycle begins when a virus invades a host cell and begins to replicate immediately, producing many new viruses. Eventually, the host cell lyses, or breaks apart, releasing the newly made viruses. The new viruses may then enter other cells and repeat the cycle.

As a child you may have had chicken pox, which is caused by a virus. While you were ill, most of the viruses were in the lytic cycle. Because your cells were being destroyed by the chicken pox virus, you showed symptoms of the disease.

Sometimes a virus does not start the lytic cycle immediately. Instead the virus enters the lysogenic cycle. The lysogenic cycle is a type of replication in which a virus does not immediately tell a host cell. The lysogenic cycle in a bacteria cell is shown on the right side of the figure on the next page.

During the lysogenic cycle, viral DNA inserts itself into a host cell’s chromosome. A viral DNA segment that is inserted in a bacterial chromosome is called a prophage. A host cell carrying a prophage may divide many times. The prophage is replicated every time the host cells chromosome replicates.
Some prophages remain in the lysogenic cycle indefinitely. Usually, however, some type of environmental stimulus eventually results in the separation of a prophage from the chromosome of its host cell. The viral DNA then enters the lytic cycle. The virus that causes cold sores in humans can go through the lysogenic cycle, for example. Cold sores erupt when these viruses enter the lytic cycle.
APPENDIX G

QRI-5 PRETREATMENT QUESTIONS AND ANSWERS
Instructions: You have just completed reading the text passage Characteristics of Viruses Part 1 – Similarities and Differences between Viruses and Cells. Your task is to answer the following questions about the passage.

1. First, you will be asked to answer as many questions as you can from memory, without referring back to the text; answer these questions in GREEN pen. Record the time you started answering questions: ____________

2. When you have completed Step 1, raise your hand, and the teacher will give you a copy of the passage.

3. Next, you will be asked to finish answering the questions, but you may refer back to the text; answer these questions in BLUE pen. Record the time you finished answering all ten questions: ____________

4. When you complete Step 3, raise your hand and the teacher will collect the passage and answer sheet.

Characteristics of Viruses – Similarities and Differences between Viruses and Cells

1. What is this section mainly about?
   Implicit: It describes what a virus is and how it is different from a cell.

2. What are the two parts of a virus?
   Explicit: A core of (nucleic not required) acid and a protein (or protective) coat.

3. What is the function of the protein coat?
   Explicit: It protects the core of the acid.

4. Why isn’t a virus a cell?
   Implicit: It does not have a nucleus or a membrane or organelles (ribosomes, mitochondria, chloroplasts not required.)

5. If a virus contains both DNA and RNA, which functions as the hereditary material?
   Explicit: RNA.

6. What determines the proteins in a capsid?
   Explicit, from figure: Genes in the virus.

7. How is the envelope of the influenza virus different from the capsid?
   Implicit: It is an additional protective coating outside of the virus.
8. What types of viruses have envelopes?

*Explicit:* Viruses that infect animal cells.

9. How does the envelope of a virus help the virus infect a cell?

*Implicit:* Its projections bind to complementary sites on the cell membrane.

10. How does the text suggest that the existence of a virus is less complex than that of a cell?

*Implicit:* Viruses have fewer genes, their genetic make-up is less complex; or, they don’t do as many processes as cells do.
APPENDIX H

QRI-5 POSTTREATMENT QUESTIONS AND ANSWERS
Instructions: You have just completed reading the text passage Characteristics of Viruses Part 2—Viral Replication: Ticking Time Bombs. Your task is to answer the following questions about the passage.

1. First, you will be asked to answer as many questions as you can from memory, without referring back to the text; answer these questions in GREEN pen. Record the time you started answering questions: __________

2. When you have completed Step 1, raise your hand, and the teacher will give you a copy of the passage.

3. Next, you will be asked to finish answering the questions, but you may refer back to the text; answer these questions in BLUE pen. Record the time you finished answering all ten questions: ________

4. When you complete Step 3, raise your hand and the teacher will collect the passage and answer sheet.

Characteristics of Viruses – Viral Replication: Ticking Time Bombs

1. What is this section mainly about?
   
   Implicit: The two cycles of viral replication

2. How does a virus increase in number?

   Explicit: It replicates.

3. What does a virus need to replicate?

   Explicit: A host.

4. How does replication different from reproduction?

   Explicit: Reproduction requires cell division and replication does not.

5. What is the major difference between the lytic and lysogenic cycle?

   Implicit: In the lytic cycle, the virus immediately begins to replicate and kill the host cell, whereas in the lysogenic cycle it doesn’t kill the host cell.

6. If a virus enters your body but you show no symptoms of disease, what cycle is the virus in?

   Implicit: The lysogenic cycle.
7. In the lytic cycle, what role does DNA play in replication?

*Implicit:* It tells the cell to replicate or make new viruses; *or,* it carries the information necessary for replication.

8. If a cell’s viral DNA separates from the cell’s chromosome, what can we conclude?

*Implicit:* A stimulus has prompted it; *or,* the lytic cycle will soon begin.

9. How does the envelope of a virus help the virus infect a cell?

*Explicit:* Its projections bind to complementary sites on the cell membrane.

10. What happens to a prophage when the host cell divides?

*Explicit:* The prophage is replicated each time.
APPENDIX I

CLASSROOM ASSESSMENT TECHNIQUES –

NONTREATMENT PHASE
Memory Matrix: Ch. 4.2 & 5.2, Intro to Atomic Structure

<table>
<thead>
<tr>
<th>Particles</th>
<th>Mass Number</th>
<th>Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proton</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neutron</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electron</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Isotope Symbol</th>
<th>Number of Neutrons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium-40</td>
<td>$^{107}_{47}\text{Ag}$</td>
<td></td>
</tr>
</tbody>
</table>
CHEMISTRY

One Sentence Summary: Ch. 5.1, Development of Modern Atomic Theory

Instructions:

Write a One Sentence Summary to summarize the contribution of the scientists whose experiments lead to the development of the current theory of atomic structure. For this atomic model OSS, we will modify the usual OSS pattern of “Who / did What / to Whom / When / Where / How / and Why” to the following sentence scheme:

Who / used What experiment / to do What / When / to propose What model

Since this scheme is new, I will demonstrate this OSS format using John Dalton as an example:

John Dalton / used the experimental results of Lavoisier, Proust and other scientists from the late 1700's / to propose the first comprehensive atomic theory / in 1803 / which stated matter is made up of atoms that are indivisible, like tiny billiard balls.

Assignment:

Choose two of the three scientists below – your choice. Write a One Sentence Summary for each scientist you choose using the scheme outlined above.

☐ J.J. Thomson  ☐ Ernest Rutherford  ☐ Niels Bohr
One of These Things is not Like the Others: Ch. 5.3, Light and Energy

Instructions: Circle item in the list that does not fit with the others in the list. Explain why you choose this odd one out in the space below.

1. momentum frequency wavelength amplitude
   Why?

2. radio waves gamma rays microwaves infrared
   Why?

3. Faraday Maxwell Schrödinger Hertz
   Why?

4. meters/second (m/s) meters (m) Hertz (Hz) grams (g)
   Why?

5. violet red indigo blue
   Why?
One Sentence Summary: History of the Periodic Table

Instructions: Write a One Sentence Summary about the chief contributions of the scientists who played a part in the development of the modern periodic table.

Who / proposed or noticed What order or pattern or arrangement for the elements / When

Choose five of the seven scientists below – your choice. Write a One Sentence Summary for each scientist you choose using the scheme outlined above.

- Johann Dobereiner (1817)
- Alexandre DeChancourtois (1860)
- Julius Lothar Meyer (1864)
- John Newlands (1864)
- Dmitri Mendeleev (1869)
- Henry Moseley (1913)
- Glenn Seaborg (1940.s)
<table>
<thead>
<tr>
<th>Definition</th>
<th>Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>A positively charged ion</td>
<td></td>
</tr>
<tr>
<td>The energy required to remove an electron from an atom</td>
<td></td>
</tr>
<tr>
<td>When the attractive force of the protons in the nucleus for the outer electrons is blocked by inner electrons</td>
<td></td>
</tr>
<tr>
<td>The distance from an atom’s nucleus to the electrons in its outermost orbit</td>
<td></td>
</tr>
<tr>
<td>The property in an atom that determines how strong the pull on outer electrons is as you move across a period</td>
<td></td>
</tr>
<tr>
<td>The element symbol for one of the elements that has a noble gas electron configuration</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Trend</th>
<th>Group Trend (show with an arrow)</th>
<th>Period Trend (show with an arrow)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atomic Radius</td>
<td><img src="image1" alt="Atomic Radius Group Trend" /></td>
<td><img src="image2" alt="Atomic Radius Period Trend" /></td>
</tr>
<tr>
<td>Ionization Energy</td>
<td><img src="image3" alt="Ionization Energy Group Trend" /></td>
<td><img src="image4" alt="Ionization Energy Period Trend" /></td>
</tr>
</tbody>
</table>
One of These Things is not Like the Others: Ch. 6.3. Part 2, Periodic Trends

Instructions: Circle element in the list that does not fit with the others in the list using your knowledge of the periodic table and periodic trends. Explain why you choose this odd one out in the space below.

1. Li  Cs  Ba  Rb  Fr  K
   Why?: ____________________________________________

2. Ne  Rn  Ar  O  Xe  He
   Why?: ____________________________________________

3. Ti  Ag  Cu  K  Au  Hg
   Why?: ____________________________________________

4. Mg  Pr  Ba  Be  Sr  Ca
   Why?: ____________________________________________

5. Li  Mg  N  U  Cr  Pb
   Why?: ____________________________________________
APPENDIX K

CLASSROOM ASSESSMENT TECHNIQUES –

TREATMENT PHASE TWO
Memory Matrix: Ch. 9.2, Molecular Geometry

<table>
<thead>
<tr>
<th>Number of Shared Electron Clouds</th>
<th>Number of Unshared Electron Clouds</th>
<th>Molecular Geometry/Shape</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td></td>
<td>Tetrahedral</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>Linear</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>Bent</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>Trigonal Planar</td>
</tr>
</tbody>
</table>

The shape of a molecule if only 2 atoms are present in the molecule, example HF:

Valence shell electron pair __________________________ theory, abbreviated _____________.

is a theory that says a molecule will adjust its shape so that regions of high electron density
(shared and unshared electron clouds) stay ________________________________.
One of These Things is not Like the Others: Ch. 9.3, Part 1, Molecular Polarity

Instructions: Circle item in the list that does not fit with the others in the list. Explain why you choose this odd one out in the space below.

1. Bond Polarity of:

C – H  C – N  Br – Cl  P – S

Why?

2. Molecular Shape of:

CCl₄  NH₃  SiH₄  CBr₄

Why?

3. Bond Polarity of:

O – Cl  P – H  C – S  P – O

Why?

4. Molecular Polarity of:

Why?

5. Molecular Polarity of:

Why?
Chemistry

One Sentence Summary: Ch. 9.3, Part 2, Intermolecular Forces

Instructions: Write a One Sentence Summary about the following terms below by completing the starter phrase with the prompt guidance given.

1. Intermolecular forces (What are intermolecular forces)
   
   Intermolecular Forces are…

2. Dipole-Dipole forces (What is it / What kinds of molecules exhibit this force)
   
   The Dipole-Dipole Force…

3. Hydrogen bond (What is it / What kinds of molecules exhibit this force)
   
   The Hydrogen Bond…

4. Dispersion Force (What is it / What kinds of molecules exhibit this force)
   
   The Dispersion Force…

5. Ion-Dipole Force (What is it / What kinds of molecules exhibit this force)
   
   The Ion-Dipole Force…
APPENDIX L

CLASSROOM ASSESSMENT TECHNIQUES –
TREATMENT PHASE THREE
Memory Matrix: Ch. 11.1, Chemical Equations

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description or Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>(s)</td>
<td>participant state of matter = gas</td>
</tr>
<tr>
<td>arrow</td>
<td>participant state of matter = dissolved in water</td>
</tr>
<tr>
<td>Pt</td>
<td></td>
</tr>
</tbody>
</table>

**Definition** | **Term**
--- | ---
A whole number placed in front of a formula in a chemical equation in order to balance it | |

Consider the following balanced reaction: \( \text{Fe}_2\text{O}_3 \,(s) \, + \, 3 \text{CO} \,(g) \rightarrow 2 \text{Fe} \,(s) \, + \, 3 \text{CO}_2 \,(g) \)

Write the formula of one of the *reactants* in this equation: ________________________

How many atoms of oxygen are involved in this reaction? ________________________

Balance the following equation (2 pts.):

\[
\_\_ \text{Mn} \, + \, \_\_ \text{ZnO} \, \rightarrow \, \_\_ \text{Mn}_2\text{O}_3 \, + \, \_\_ \text{Zn}
\]
One of These Things is not Like the Others: Ch. 11.2, Part 1, Types of Reactions

Instructions: Circle item in the list that does not fit with the others in the list. Explain why you choose this odd one out in the space below.

1. Reaction type
   a. $2 \text{Na} + \text{Cl}_2 \rightarrow 2 \text{NaCl}$
   b. $\text{H}_2\text{O} + \text{CaO} \rightarrow \text{Ca(OH)}_2$
   c. $\text{CH}_4 + 2 \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$

   Why? 

2. Reaction type
   a. $\text{C}_2\text{H}_4\text{O}_2 + 2 \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$
   b. $2 \text{Mg} + \text{O}_2 \rightarrow 2 \text{MgO}$
   c. $\text{CH}_4 + 2 \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$

   Why? 

3. Reaction type
   a. $2 \text{NaHCO}_3 \rightarrow \text{Na}_2\text{CO}_3 + \text{CO}_2 + \text{H}_2\text{O}$
   b. $2 \text{KClO}_3 \rightarrow 2 \text{KCl} + 3 \text{O}_2$
   c. $\text{C}_2\text{H}_4 + 3 \text{O}_2 \rightarrow 2 \text{CO}_2 + 2 \text{H}_2\text{O}$

   Why? 

4. Reaction type
   a. $\text{C}_3\text{H}_8 + 5 \text{O}_2 \rightarrow 3 \text{CO}_2 + 4 \text{H}_2\text{O}$
   b. $\text{C}_6\text{H}_{12}\text{O}_6 + 6 \text{O}_2 \rightarrow 6 \text{CO}_2 + 6 \text{H}_2\text{O}$
   c. $2 \text{Ca(HCO}_3)_2 \rightarrow 2 \text{CaCO}_3 + 2 \text{CO}_2 + \text{H}_2\text{O}$

   Why? 

5. Reaction type
   a. $3 \text{A} + \text{B} \rightarrow \text{A}_3\text{B}$
   b. $\text{XY}_2 \rightarrow \text{X} + 2 \text{Y}$
   c. $\text{M} + \text{G} + 2 \text{H} \rightarrow \text{MG}_2\text{H}$

   Why? 

2016-2017 T3-2
One Sentence Summary: Ch. 11.2, Part 2, Types of Reactions

Instructions: Write a One Sentence Summary about the following terms below by completing the starter phrase with the guidance given.

1. Activity Series (What is an Activity Series)
   An Activity Series is…

2. Using an Activity Series (How is an Activity Series used / What type of reaction does an Activity Series apply to)
   An Activity Series can be used…

3. Double Displacement (Replacement) Reactions (What is it / How can you recognize a double displacement reaction)
   A Double Displacement Reaction is…

4. Combustion Reactions (What is it / How can you recognize a combustion reaction)
   A Combustion Reaction is…

5. Single Displacement (Replacement) Reactions (What is it / How can you recognize a single displacement reaction)
   A Single Displacement Reaction is…
APPENDIX M

CLASSROOM ASSESSMENT TECHNIQUES – TREATMENT PHASE FOUR
One of These Things is not Like the Others: Ch. 10.1, The Mole Concept

Instructions: Circle the item in the list that does not fit with the others using your knowledge of the mole concept. Explain why you choose this odd one out in the space below.

1. weight  counting  volume  atom

   Why?:

2. Avogadro’s number  mass  6.022E23  representative particle

   Why?:

3. molecules  atoms  grams  ions

   Why?:

4. average atomic mass  grams/mole  mole  molar mass

   Why?:

5. Li: 6.9  Mg: 24.3  N: 3.0  U: 238.0

   Why?:
Memory Matrix: Ch. 10.2 & 3, Moles, Mass & Percent Composition

<table>
<thead>
<tr>
<th>Description</th>
<th>Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>The number grams in 1 mole of a substance</td>
<td>Avogadro’s Number</td>
</tr>
<tr>
<td>The counting unit that is equivalent to $6.022 \times 10^{23}$ particles</td>
<td>Representative particle</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Definition</th>
<th>Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>The percent, by mass, of each element in a compound</td>
<td></td>
</tr>
<tr>
<td>This formula that represents the lowest whole-number ratio of the elements in a compound</td>
<td></td>
</tr>
</tbody>
</table>

To convert mass of a substance to moles, use ________________________________.

To convert moles of a substance to particles, use ________________________________.

Since number of particles is not a practical way to measure matter, chemists typically use ________________________________ or ________________________________ to quantify the amount of a substance.
One Sentence Summary: Ch. 10.3, Chemical Formulas

Instructions: Write a One Sentence Summary about the following terms below using the guidance given.

1. Empirical Formula (what is it/what does it show) (3 pts.)

2. Molecular Formulas (what is it/what does it show) (3 pts.)

3. Using Empirical Formulas (what can it be used to find or calculate) (2 pts.)

4. Using a Chemical Formula (what can it be used to find or calculate) (2 pts.)
APPENDIX N

SURVEY OF ADOLESCENT READING ATTITUDES
Survey of Adolescent Reading Attitudes

Student Name: ___________________________ Student ID: ________ Date: ____________

Note: Participation in this research is voluntary. Participation or non-participation will not affect your grades or eligibility to participate in any other class activities.

1. How do you feel about reading news online for class?

   Very Good: 6
   5 4 3 2 1

   Why did you answer the way you did in the above question?

2. How do you feel about reading a book in your free time?

   Very Good: 6
   5 4 3 2 1

   What type of books would you normally read?

3. How do you feel about doing research using books or printed resources for a class?

   Very Good: 6
   5 4 3 2 1

   Have you ever done this before and in what class?

4. How do you feel about texting or e-mailing friends in your free time?

   Very Good: 6
   5 4 3 2 1

5. How do you feel about reading online for class?

   Very Good: 6
   5 4 3 2 1

   Have you ever done this before?
6. How do you feel about reading a textbook?

   Very Good     Very Bad
   6  5  4  3  2  1

   Why did you answer the way you did in the above question?

7. How do you feel about reading a book online for class?

   Very Good     Very Bad
   6  5  4  3  2  1

8. How do you feel about talking with friends about something you’ve been reading in your free time?

   Very Good     Very Bad
   6  5  4  3  2  1

9. How do you feel about getting a book or a magazine for a present?

   Very Good     Very Bad
   6  5  4  3  2  1

10. How do you feel about texting friends in your free time?

    Very Good     Very Bad
    6  5  4  3  2  1

11. How do you feel about reading a book for fun on a rainy day?

    Very Good     Very Bad
    6  5  4  3  2  1

12. How do you feel about working in an Internet project with classmates?

    Very Good     Very Bad
    6  5  4  3  2  1

Why did you answer the way you did in the above question?
13. How do you feel about reading anything printed (book, magazine, comic book, etc… in your free time?

Very Good
6 5 4 3 2 1

14. How do you feel about using a dictionary for class?

Very Good
6 5 4 3 2 1

15. How do you feel about using social media like Twitter, Instagram, etc… in your free time?

Very Good
6 5 4 3 2 1

16. How do you feel about looking up information online for a class?

Very Good
6 5 4 3 2 1

In what ways has that been helpful?

17. How do you feel about reading a newspaper or a magazine for a class?

Very Good
6 5 4 3 2 1

18. How do you feel about reading a novel for class?

Very Good
6 5 4 3 2 1
APPENDIX O

ADOLESCENT MOTIVATION TO READ PROFILE
Adolescent Motivation to Read Profile

Note: Participation in this research is voluntary. Participation or non-participation will not affect your grades or eligibility to participate in any other class activities.

1. My friends think I am __________.
   - a very good reader
   - a good reader
   - an OK reader
   - a poor reader

2. Reading a book is something I like to do.
   - never
   - not very often
   - sometimes
   - often

3. I read __________.
   - not as well as my friends
   - about the same as my friends
   - a little better than my friends
   - a lot better than my friends

4. My best friends think reading is __________.
   - really fun
   - fun
   - OK to do
   - no fun at all

5. When I come to a word I don’t know, I can __________.
   - almost always figure it out
   - sometimes figure it out
   - almost never figure it out
   - never figure it out

6. I tell my friends about good books I read.
   - I never do this
   - I almost never do this
   - I do this some of the time
   - I do this a lot

7. When I am reading by myself, I understand __________.
   - almost everything I read
   - some of what I read
8. People who read a lot are ____________.
   ☐ very interesting
   ☐ interesting
   ☐ not very interesting
   ☐ boring

   Why did you answer the way you did in the above question?

9. I feel I am ____________.
   ☐ a poor reader
   ☐ an OK reader
   ☐ a good reader
   ☐ a very good reader

10. I think libraries are ____________.
    ☐ a great place to spend time
    ☐ an interesting place to spend time
    ☐ an OK place to spend time
    ☐ a boring place to spend time

11. I worry about what other students think about my reading ____________.
    ☐ every day
    ☐ almost every day
    ☐ once in a while
    ☐ never

12. Knowing how to read well is ____________.
    ☐ not very important
    ☐ sort of important
    ☐ important
    ☐ very important

    Why did you answer the way you did in the above question?

13. When my teacher asks me a question about what I have read, I ____________.
    ☐ can never think of an answer
    ☐ have trouble thinking of an answer
    ☐ sometimes think of an answer
    ☐ always think of an answer

14. I think reading is ____________.
a boring way to spend time
an OK way to spend time
an interesting way to spend time
a great way to spend time

15. Reading is __________.
very easy for me
kind of easy for me
kind of hard for me
very hard for me

16. As an adult, I will spend __________.
none of my time reading
very little time reading
some of my time reading
a lot of my time reading

17. When I am in a group talking about what we are reading, I __________.
almost never talk about my ideas
sometimes talk about my ideas
almost always talk about my ideas
always talk about my ideas

18. I would like for my teachers to read out loud in my classes __________.
every day
almost every day
once in a while
never

Why did you answer the way you did in the above question?

19. When I read out loud I am a __________.
poor reader
OK reader
good reader
very good reader

20. When someone gives me a book for a present, I feel __________.
very happy
sort of happy
sort of unhappy
unhappy
APPENDIX P

STUDENT INTERVIEW QUESTIONS – PRETREATMENT
Student Name:______________________ Student ID:_______ Date:_____________

Pretreatment Interview

1. Think about something you learned recently, not from a teacher or from television, but from something you read. What did you read about?
   Follow-up: Tell me more about what you learned.

2. In what class do you most like to read? Why?

3. In what class do you feel reading is the most difficult? Why?

4. When you are assigned reading for a class, how do you normally approach this task?
   Follow-up: Is your approach different if the reading is from a textbook? Explain how it is different.

5. What do you do if you have completed reading for a class, and you don’t feel you’ve understood what you’ve just read?

6. What do you think you need to do or have to learn in order to become a better reader?

7. Have any of your teachers taught you techniques or strategies to use when reading? If yes, describe the process you were taught.
   Follow-up: Have any of your teachers done something with reading that you really enjoyed? Please explain what your teacher did.

8. Do you have any other ideas or experiences that involve reading?

Notes:

QRI Score: _______________
APPENDIX Q

STUDENT INTERVIEW QUESTIONS – POSTTREATMENT
Posttreatment Interview

1. When reading is assigned for a class, how frequently do you do the assigned reading?
   
   Follow-up: If frequently, what motivates you to do the reading?
   If infrequently, why do you choose to not do the reading?
   If sometimes, what determines whether you do the reading or not?

   Follow-up: With the reading strategies we learned in Chemistry, did you do the reading more or less frequently than you usually would? Why or why not?

2. If you were the teacher, how would you encourage students to read more frequently?

3. Do you think reading a science textbook is important? Why or why not?

4. As you read a textbook, do you ever think about how what is being presented relates to something you already know? Explain (with an example if you can think of one).

5. After practicing reading strategies in Chemistry this year, do you feel you have better skills/tools to read and understand your Chemistry textbook more effectively? If yes, what strategy helped you the most and why do you think it was most effective? If no, why do you feel this way?

6. Does reading the Chemistry textbook seem easier or harder for you now that you have learned several reading strategies? Explain.

   Follow-up: Do you feel you can pick out the important ideas/concepts as you read? How do you know they are important?

   Follow-up: Was there a specific strategy that helped you pick out the important ideas?

7. Have your attitudes about reading the Chemistry textbook changed after learning different reading strategies? If yes, how have they changed? If no, what was your attitude before learning these strategies?

8. Have you used any of the reading strategies you learned in this class in another class this year? If yes, which class and which strategy(ies)? If no, why not?

9. Do you have any other comments or ideas about reading – especially reading in science – after learning reading strategies this year?
APPENDIX R

READING STRATEGY USEFULNESS SURVEY
Student Name: ___________________________ Student ID: ____________ Date: ______________

Reading Strategy Usefulness Survey

Note: Participation in this research is voluntary. Participation or non-participation will not affect your grades or eligibility to participate in any other class activities.

Instructions: Bring to mind what you think would help you become a better reader in Science or other subjects, such as English or Social Studies. With this in mind, answer the following questions or statements about the reading strategies you learned this year.

Think specifically about the Scan It strategy to answer the following questions:

1. In your own words, what was the purpose of the Scan It strategy?

2. I feel I had enough instruction and practice to use the Scan It strategy.

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3. The Scan It strategy helped me read the Chemistry textbook more carefully.

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Why did you answer the way you did for the above statement?

4. The Scan It strategy helped me better understand what I read in the Chemistry textbook.

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Why did you answer the way you did for the above statement?

5. The Scan It strategy would also be a useful strategy to use in English class.

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6. The Scan It strategy would also be a useful strategy to use in Social Studies class.

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Why did you answer the way you did for the above two statements?

Think specifically about the *Mark It Up* strategy to answer the following questions:

7. In your own words, what was the purpose of the Mark It Up strategy?

8. I feel I had enough instruction and practice to use the Mark It Up strategy.

9. The Mark It Up strategy helped me read the Chemistry textbook more carefully.

Why did you answer the way you did for the above statement?

10. The Mark It Up strategy helped me better understand what I read in the Chemistry textbook.

Why did you answer the way you did for the above statement?

11. The Mark It Up strategy would also be a useful strategy to use in English class.

12. The Mark It Up strategy would also be a useful strategy to use in Social Studies class.

Why did you answer the way you did for the above two statements?

Think specifically about the *Talk It Out* strategy to answer the following questions:
13. In your own words, what was the purpose of the Talk It Out strategy?

14. I feel I had enough instruction and practice to use the Talk It Out strategy.
   
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15. The Talk It Out strategy helped me read the Chemistry textbook more carefully.

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   Why did you answer the way you did for the above statement?

16. The Talk It Out strategy helped me better understand what I read in the Chemistry textbook.

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   Why did you answer the way you did for the above statement?

17. The Talk It Out strategy would also be a useful strategy to use in English class.

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18. The Talk It Out strategy would also be a useful strategy to use in Social Studies class.

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   Why did you answer the way you did for the above two statements?

Think specifically about the *Put It Together* strategy to answer the following questions:

19. In your own words, what was the purpose of the Put It Together strategy?

20. I feel I had enough instruction and practice to use the Put It Together strategy.
21. The Put It Together strategy helped me read the Chemistry textbook more carefully.

Strongly Agree

6

5

4

3

2

1

Disagree

Strongly

Why did you answer the way you did for the above statement?

22. The Put It Together strategy helped me better understand what I read in the Chemistry textbook.

Strongly Agree

6

5

4

3

2

1

Disagree

Strongly

Why did you answer the way you did for the above statement?

23. The Put It Together strategy would also be a useful strategy to use in English class.

Strongly Agree

6

5

4

3

2

1

Disagree

Strongly

24. The Put It Together strategy would also be a useful strategy to use in Social Studies class.

Strongly Agree

6

5

4

3

2

1

Disagree

Strongly

Why did you answer the way you did for the above two statements?

Now think about all of the reading strategies to answer the following questions:

25. Which reading strategy took the most time to complete (choose only one)?

☐ Scan It

☐ Mark It Up

☐ Talk It Out

☐ Put It Together

26. Which reading strategy would you be MOST likely to recommend to a friend who was having trouble reading or understanding his science textbook (choose only one)?

☐ Scan It

☐ Mark It Up

☐ Talk It Out

☐ Put It Together
Explain why you would MOST recommend this strategy.

27. Which reading strategy would you be LEAST likely to recommend to a friend who was having trouble reading or understanding his science textbook (choose only one)?

☐ Scan It  ☐ Mark It Up  ☐ Talk It Out  ☐ Put It Together

Explain why you would LEAST recommend this strategy.

Three final questions…almost there!

28. Learning and practicing reading strategies this year helped me become a more confident reader.

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Why do you think so?

29. Learning and practicing reading strategies this year helped me become a better reader.

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Why do you think so?

30. Lastly: If you had to choose reading an online textbook or a print copy of a textbook, which would you prefer?

☐ Online  ☐ Print

Why do you prefer that type of textbook?

Thank you again for your participation in learning reading strategies this year, and cooperating with the surveys and classroom assessments. I truly hope it will make a difference in your reading ability for the future.
APPENDIX S

TEACHER JOURNAL GUIDING PROMPTS
Date:

Today’s Topic or Activity:

My Role:

Student’s Role:

What Happened Today?:

Notable Students Actions or Quotes:

Strengths and Weaknesses of Today’s Activity:

Additional Reflections:
APPENDIX T

INSTITUTIONAL REVIEW BOARD EXEMPTION APPROVAL
INSTITUTIONAL REVIEW BOARD
For the Protection of Human Subjects
FWA 00080165

MEMORANDUM

TO: Guy Savastano and Walter Woolbaugh
FROM: Mark Quinn
DATE: September 13, 2016
RE: "Impact of Close Reading Strategies in Chemistry" [GS091316-EX]

The above research, described in your submission of September 13, 2016, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101. The specific paragraph which applies to your research is:

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

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

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

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

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

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

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