READING STRATEGIES IN A HIGH SCHOOL SCIENCE CLASSROOM

by

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A professional paper submitted in partial fulfillment
of the requirements for the degree

of

Master of Science

in

Science Education

MONTANA STATE UNIVERSITY
Bozeman, Montana

July 2012

STATEMENT OF PERMISSION TO USE

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July 2012

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ABSTRACT

Are teachers enabling students to be poor readers of science text by not routinely making reading assignments because students usually do not complete them? If students become more effective readers of science text will their attitudes and values towards reading change? In this study reading strategies were implemented with the purpose of helping students read more effectively. Students were instructed in the use of six different strategies. As students used the strategies, their reading skills, values and attitudes were measured using standardized tests, surveys and formative assessments. The results indicated that students improved their reading skills and would complete reading assignments. It was also found that when students are aware of effective reading strategies, they would be likely to use them independently in the future.

INTRODUCTION AND BACKGROUND

The purpose of my Action Research (AR) study was to look at reading strategies that my students could apply to reading science text making them more effective readers and learners, taking them to a higher level of science literacy. A secondary purpose looked at whether students would find strategies that are effective and useful for future independent use.

As a teacher at a high school that was designated as a “persistently low-achieving school”(PLAS) in the area of reading, I began to question what kind of contribution I could make towards improving that situation in my own science classroom. This led me to several discussions with my fellow science teachers, students, school administrators and the reading specialist who was hired to support the teaching staff. I discovered that many teachers, myself included, choose to avoid making reading assignments because typically students will not do them. I began to feel that we might be enabling students to become poor readers who do not have the processing and comprehension skills of effective readers. While the importance of differentiated instruction in the classroom is broadly accepted, I feel that the ability to be an effective reader is an important skill that *all* students should possess.

My inquiries were met with positive responses at most levels. Surprisingly, some of my peers did not readily accept reading instruction as a part of their responsibility in their science curriculum. Questions began forming in my mind as to whether it was my job to teach reading skills? Further research and firsthand experience reinforced what I believe about the value and relevance of reading skills.

Science literacy involves being able to read, write, think critically, perform science and observe how it relates to how our natural world and universe function. Being able to read about science in a meaningful way is an important part of being science literate. The first steps to building the skills needed have a natural beginning in the science classroom. Many of the standardized tests students take focus on science and are strongly based on good reading and comprehension skills. There also seems to be a trend towards more online coursework that demands a high level of reading literacy to participate effectively.

After speaking with students and questioning why they often choose not to complete reading assignments, many of them indicated that science text is “too hard to understand,” “takes too long,” is ”boring,” and is “easier to understand when the teacher explains it.” At this point I began to wonder if students had good reading strategies, would science-reading assignments be more manageable for them and consequently more likely to be completed? A good strategy might not only result in better comprehension, but also allow students to use their time more effectively. Many strategies build on previous knowledge and perhaps bring more relevance that could address the issues of science being “boring.” I was also aware that there are times when a teacher is not readily available and being self-reliant and able to understand an informational text would be extremely beneficial to a student. Science is not the only area where informational text is used. I could visualize strategies that work for science literacy could be applied in other areas, also.

If my students could gain more skill in being able to read science texts, my job as a science teacher could also be impacted. If I had to spend less time lecturing, there would be more time available for doing labs, which is definitely more attractive to my students. My role as the “sage on the stage” would shift toward more of being the “guide on the side,” which is often perceived as more effective pedagogy. As a teacher, I welcome any process that would make my students more self-sufficient, independent learners.

Focus Question and Sub-Questions

How will reading strategies implemented in the secondary science classroom impact students towards becoming more effective readers and learners taking them to a higher level of science literacy?

- How will reading strategies affect students’ reading comprehension of science content?
- Which strategies will students find effective and useful for future use?
- How will students’ attitudes towards reading science text change if they are comfortable with strategies that focus upon reading science text?
- What bearing will the results from the main question have upon my classroom and me as a teacher?

The students involved in the study were my physical science students at Hastings (NE) High School. There were 91 ninth grade students with 4 sophomores and 1 junior. There were two sub-groups, one of 81 honors physical science (HPS) students and another of 15 conceptual physical science (CPS) students.

CONCEPTUAL FRAMEWORK

Reading is a fundamental skill that is vital to functioning within a society. It is a skill of communication that can develop the mind and make the quality of life better. As Confucius once said, “No matter how busy you may think you are, you must find time for reading, or surrender yourself to self-chosen ignorance”(p.1). Reading is an essential skill that must be taught, developed and cultivated. Research from Curtis and Long, points out that “100% of our adolescent students are in need of direct instruction in study skills and organizational tools for wide reading”(Oropallo Consulting, 2006, p. 3). A large part of science literacy lies in the skills necessary to read and comprehend science text. These skills are more advanced reading skills that must be taught and modeled by the teachers who teach them.

The National Endowment for the Arts (2007) looked at a range of data sources to get a comprehensive overview of the status of American reading today. A general decline in time spent in reading and reading ability was abundantly obvious. Data was taken from a “ variety of reliable sources, including large, nationally representative studies conducted by other federal sources” (p.7). It was reported that 62% of all 17 year olds read 15 or fewer pages daily. It was also noted “15-24 year olds spend only 7-10 minutes daily on voluntary reading- about 60% less than the average American” (p.9). This is in contrast to the same age group spending 2-2 1/2 hours watching TV as well as 58% of 7^{th} -12^{th} graders reporting using other media while reading. In looking at the reading abilities of 17 year olds, a slow downward trend has been recorded in the years after 1990 until 2004. It was shown that there was progress in reading ability at the elementary level. What was happening when students entered their teenage years has been very different. "Little more than 1/3 of high school seniors now read proficiently"(p.13). The study linked this decline in reading skills to lower levels of academic achievement that in turn lead to less opportunity in the job market. Sixty-three percent of employers rate reading comprehension as a very important skill for high school graduates and 38% of employers regard high school graduates as deficient in reading skills. A direct correlation was established between poor reading skills and lack of employment, lower wages and fewer opportunities for advancement. Only 3% of adult prisoners in 2003 could read at a proficient level. Poor readers were also shown to be less likely to be active in civic and cultural life looking at volunteerism and voting rates. Final conclusions from this study would indicate that efforts must be made to improve the reading skills of American students because the implications of not paying attention to the warning signs could have serious civic, cultural, and economic effects.

As students move through elementary and middle school years, instruction in disciplinary subject reading decreases as they are being challenged by more sophisticated texts such as those found in science texts. These texts present to be more difficult because they involve more abstract and technical concepts that can be counterintuitive or even foreign to a student's previous life experience. Science texts can also be more challenging because they often have a higher degree of *lexical density*, or a greater number of embedded content words where the word not only has meaning of its own but also possibly requires an understanding of a process that involves the word. Research done by Shanahan and Shanahan (2008) showed how reading comprehension strategies can vary from discipline to discipline, making discipline-specific approaches more effective for different courses. In showing that there were discipline-specific reading skills, the need to teach the specific skills in the appropriate classroom became obvious. Their study began by identifying how the different disciplines of math, social studies and chemistry used literacy. One of the factors that was shown to be important in reading literacy in chemistry was to be able to understand any pictures, graphs and charts that frequently appear in science text. They also determined critical thinking while reading for a history text was different than reading a chemistry text. While historians encourage questioning of some of the truths offered in their text, chemists assumed the facts to be true, but what was more important were the implications and applications of the information read. It becomes evident that reading a science text does involve discipline-specific skills that extend beyond basic literacy skills. As students enter high school, they are being introduced to higher level science concepts and being able to read and understand science text becomes a vital tool.

Scientific literacy with an emphasis on being able to read science text is important for students to be able to learn and achieve in a science classroom and their daily lives. It is also a component of being able to work and contribute to the global community of which we are all a part. Krajcik, and Sutherland (2011) listed five outcomes of scientific reading literacy for students. When students can effectively read science they can link new concepts to previous knowledge and experience, anchor learning to relevance in their lives, use visual factors (such as charts and diagrams) in text help to make relationships within the text, be able to understand new ideas well enough to connect to different context, and be able to apply the new knowledge to other scientific articles and support or explain them using appropriate scientific vocabulary (Krajcik & Sutherland, 2011).

In her doctoral dissertation, Jennifer Patrick (2009) states that the importance of science literacy extends beyond knowing science content solely and must also encompass being able to read and write in science. Patrick presents and supports the idea that science teachers must directly instruct students in the skills needed to learn the language of science. She establishes a strong relationship between being able to read science text and being able to "do" science. She quotes Wellington and Osborne (2001),

> When pupils leave school they are far more likely to read about science than they are to ever do it…the ability to read about science carefully, critically, and with a healthy skepticism is a key element of scientific literacy. Moreover, it is a prerequisite of citizenship and playing a part in a democracy (p. 42).

Scientists must be able to have a high level of comprehension when reading science texts in order to share ideas and theories and to argue the value of those ideas and theories. She notes that the language of science is somewhat different from the language students use in their daily lives. She asserts that there is a need to instruct students in learning the meanings and uses of the language of science that they do not receive in a classroom outside of the science department. Patrick's dissertation offers an answer to one of my earlier questions by strongly supporting the concept that teaching reading skills should indeed be a part of a science teacher's curriculum.

The skills used by good readers are comparable to the skills used in "doing" science. According to Armbuster (1992), "The same skills that make good scientists also make good readers: engaging in prior knowledge, forming hypotheses, establishing plans, evaluating understanding, determining the relative importance of information, describing patterns, comparing and contrasting, making inferences, drawing conclusions, generalizing, evaluating sources, and so on" (p. 347). In other words, teaching science and teaching reading skills are parallel processes. Armbuster's comparison in drawing a connection between the characteristics of a good reader and a good scientist, establishes more reasons that science teachers should be teaching reading alongside teaching science. Armbuster's description of reading skills can also be viewed as parameters to identify a "better" reader as a reader who demonstrates these skills.

According to Robb (2005), when students have the reading skills needed for comprehension of informational text or textbooks, a teacher can structure learning activities so that students can rely on text for information instead of looking toward the teacher as the sole source of information (2005, p.6). When students have confidence in reading skills, learning is placed into the realm of self-motivation and need that will be more likely to result in authentic learning rather than only memorizing facts and terms for a test.

Theory gives us evidence that reading skills are important to students as individuals but also as members of a global society. It has also been shown that the teaching of reading skills directly related to the disciplinary science subject areas can and must happen simultaneously as science content is taught for attaining the greatest level of effective instruction.

METHODOLOGY

As I explored strategies for the treatment, I had some basic ideas about what factors might need to be present to make a strategy effective. In my past experience, I knew these strategies would have to be simple enough for a student to understand and use on their own, as minimally time consuming as possible, address different modalities of learning- visual, auditory, and kinesthetic (VAK), and be specifically appropriate for science content. I also wanted strategies that I could incorporate into my current curriculum, effectively blending them in seamlessly with what I already teach. The strategies fell into three categories-first, pre-reading/vocabulary building strategies, second, comprehensive strategies that incorporate pre-reading, during reading and post reading components and finally post-reading strategies.

I introduced individual strategies at a time appropriate for the strategy- before, during or after reading a chapter. I used each strategy at least three times. The shorter strategies were used with shorter selections like a chapter section with the more complete strategies for an entire chapter. If a certain strategy proved not to be effective for the students, it was modified. All strategies were used in a three part cycle- an introduction with the teacher demonstrating the strategy, students doing the strategy either with teacher prompts or with another student and finally with students doing the strategy on their own. After using the strategy through all three parts of the cycle students should have been able to evaluate how effective the strategy was for them personally. The number of strategies that were introduced had to be limited to a certain degree to assure effectiveness and minimize confusion. As students became more comfortable in using reading strategies, attitudes towards reading informational or expository text changed.

Table 1
Matrix of Treatment Strategies

Pre-reading/ Vocab Strategies	Word Alert
	Flashcards/Expanded Vocab
Comprehensive Strategies	Reading Process for Science (Modified)
	Cornell Notes
Post-reading Strategies	Concept (Word) Map
	Chunking and Rereading Text

The pre-reading/ vocabulary strategies included the Word Alert and Flashcards/ Expanded Vocabulary. In the Word Alert strategy students activate prior knowledge and self-assess their knowledge of key words in the section they will be reading. Students utilized a think sheet (Appendix A). Initially I preselected the words but suggested when students do this on their own that words listed at the beginning, in the margins or bolded are probably words that might be important.

For the Flashcards/ Expanded Vocabulary students selected words at the beginning of each section, bolded words from the text, words highlighted in the margins and made corresponding flash cards. When writing definitions on the backside of the flashcards, students were instructed to include diagrams, daily life applications, equations or anything that made the definition of the term more relevant. Students were encouraged to flip through the stack of terms whenever they had free time. After having done this several times, they were told to take out the terms that were mastered and to concentrate on the terms that were still difficult. Students were also instructed to add words as necessary as they encountered them in the reading or in class. It was also pointed out that sometimes the words that weren't bolded within the text but that the student didn't know were also important, maybe more so because they are often the words that the student personally didn't understand.

The first comprehensive strategy, the reading process for science is a strategy that is used by our school reading specialist. The steps in the process include

A. **Preview**- Get an idea of what to expect before reading-

the title, the first and last paragraphs of the chapter, the headings, any words set in bold type or repeated, any boxed material, any photos, charts, pictures, and their captions.

B**. Set a purpose**-Turn headings and sub- headings into a question.

C. **Plan**-Strategy to connect with text as you read-

outlining, cause-effect organizer, classification notes, problem-solution organizer

D. **Read with a purpose**

E. **Connect**-How does the text connect to the world, another text or yourself?

F. **Pause and Reflect**- Ask yourself these questions-

- Did I accomplish the reading purpose I set in the beginning?
- Do I know what the main topics in the chapter are?
- Do I understand how the material is organized?
- Would you feel comfortable taking a test on this material now?

G. **Reread**- Only go back over the parts that created confusion.

H. **Remember**- To do this, try researching, making study cards, or creating a practice test.

A second comprehensive strategy was Cornell Notes Taken During Reading. Students were told to draw a vertical line about two inches from the left side of a sheet of paper. They were then instructed to draw a line about two inches horizontally across the bottom of the paper (Appendix B). As students read, they wrote down short-hand notes about the ideas and topics as they read on the right side of the paper. After reading, on the left side column of the paper, they wrote down the main ideas or key terms matching where they were described and written in the notes as they did the reading. After that, students wrote a summary across the bottom about what they had read in their own words and were encouraged to make relevant connections to their daily life.

The first post-reading strategy included having students create a Concept/Word Map that connected the ideas presented in the reading and reviewed the material covered. Students were instructed on how to make a concept map. They were shown that an effective concept map not only shows some definitions and applications but also interrelationships between the vocabulary words. One of the concept map strategies was modified to have a pre-reading segment. Students were given main ideas and sticky-notes by the teacher. They were asked as a group of three or four to arrange them on a poster board using their previous knowledge to show how they thought the terms were related. Students then took turns reading the section aloud, discussing what they read as they covered two or three paragraphs at a time. They were instructed to rearrange the concept map as necessary after discussing what they had read.

The second post-reading strategy, Chunking and Rereading Text, used a think sheet (Appendix C). Students were instructed after reading to go back and look at sections that were read and to think about what was important in that section. After rereading to confirm that what they thought was important was what was emphasized in that section, they wrote that down, and proceeded to the next section.

As strategies were introduced, I would use one of the strategies within a chapter. It was necessary to divide a chapter into workable sections to fit the specific strategy used and to allow using each strategy at least three times. The timeline for using strategies and what chapters and topics were being covered is shown in Table 2.

Table 2
Matrix of Schedule, Treatment Strategies, Chapters Covered

Chapter Covered	Strategy used	Scheduled Implementation
Chapter 8, Motion and Forces	Flash Cards/ Expanded Vocabulary	9/27 – 10/18
Chapter 9, Work and Energy	Science Reading Process	10/19- 11/18
Chapter 10, Heat and Temperature	Word Alert	11/19-12/16
Chapter 11/12, Waves and Wave Properties, Sound and Light	Concept Mapping	12/17-1/23
Chapter 13, Electricity and Magnetism	Rereading and Chunking	1/24-2/7
Chapter 2, the Nature of Matter	Cornell Notes	2/8-3/1

In deciding which instruments to use to evaluate how effective the strategies were in addressing each sub-question, triangulation of data was kept in mind. Each sub-question had

1.) an instrument that directly involved the students whether it was an assessment of comprehension or skill levels, a survey of confidence and attitude levels, or a students evaluation of an implemented strategy, 2.) an instrument that had the students and the teacher discussing the strategy through an interview process, whether as a focus group or as individuals

3.) support through what was observed by the teacher in a journal (field notes).

The instruments above were administered either before the treatment period or before a specific strategy to establish a baseline and after the treatment to document any changes in comprehension, reading skills and/or student attitudes. I believe that by having input from the students as individuals, along with interviews with the teacher and students working together and finally from the teacher's documented observations, there was adequate data to see any themes that would support whether strategies in general or specific strategies are effective or not. Student numbers were assigned to help maintain a level of student confidentiality on surveys; however, the teacher had a master list in order to consult if there were remarkable individual results.

While parents were made aware of reading strategies being used in the classroom (Appendix D), they were not a part of the evaluation process.

The first survey (Appendix F), Student Confidence and Attitude Survey (SCAS), initially was created as only set of questions with a Likert scale with responses on a scale of 1-5. But it was modified to include some qualitative questions synchronous with the numerical scales. I compiled the questions for this survey as well as for the pre and post interviews from surveys done by myself and other capstone projects that focused on reading in the secondary classroom. The SCAS survey had a greater focus on science textbooks and to assess if students had a previous knowledge of reading strategies.

Scoring of this survey was done by adding the numerical values and given a sum total score. And then the qualitative data was grouped according to common themes with any outliers being evaluated for any relevance. By looking at the qualitative data presented on this survey, it was possible to get more insight into how the students are feeling and thinking through using their own words.

Table 3
Data Collection Matrix

Focus Question	Sub-Questions	Sources of Supporting Data	Timeframe
How will reading strategies implemented in the secondary science classroom impact students to become more effective readers and learners taking them to a higher level of science literacy?	How will reading strategies impact students' comprehension of science content material?	Qualitative Reading Inventory	At the beginning and end of AR treatment
		Chapter Reading Assessment in the form of assorted CATs and summative assessments	Pre and Post strategy and after a chapter is finished
		Teacher Field Notes	During application of each strategy
	Which strategies will students find effective and useful for future use?	Reading Strategy Rating Sheet	At the end of the AR Treatment
		Student Reading Strategy Attitudes	At the beginning and end of AR treatment
		Individual Interviews	After a strategy is used
		Teacher Field Notes	During application of each strategy
	How will students' attitudes change if they are comfortable with reading strategies that focus upon reading science text?	Student Attitude and Confidence Survey	At the beginning and end of AR treatment
		Strategy Focus Group Interview and Follow-up	At the beginning and end of AR treatment
		Motivation to Read survey	At the beginning and end of AR treatment
		Teacher Field Notes	During application of each strategy
	What impact will the results from the main question be upon my classroom and me as a teacher?	All of the above	Throughout the action research process
		Teacher's journal	

One instrument used was the Adolescent Motivation to Read Profile (Appendix G). It is a standardized survey that was initially intended for elementary school classrooms but was modified to evaluate older students. It was created to assess the motivation and attitudes that adolescent students have for reading in general. This survey was taken from a 2007 research study done by 11 researchers working as a team to revise the already established, tested and familiar elementary school age version that was developed and standardized by Gambrell, Palmer, Codling, and Mazzoni (1996). The modifications made were based on recommendations from adolescent research, the members of the teams' experience working with teens, and research literature reviews. The result of their survey was field tested and shown to have validity and reliability (Pitcher, Albright, Delaney, Walker, Mogge, Headley, Ridgway, and Peck, pp. 379-380). Each question had a choice of four answers varying in degree from least positive to most positive, relative to the question asked. The answers were shuffled from question to question as to least to most and most to least so it had to be scored with a coded answer sheet. Questions answered with the least positive response were given one point working up to four points given for the most positive. Half of the 20 questions are related to the student's self-concept as a reader while the other half are related to the student's value of reading. Points were added up and reported for each of the two categories along with a sum total of both categories.

Another instrument used was the Qualitative Reading Inventory, Fifth Edition (Appendix H). This reading inventory was designed for graduate students, reading assessment specialists and school district personnel working in reading assessment. The portion of the QRI-5 used in this study measured reading comprehension on explicit and implicit levels of expository science-specific text on the high school level. Explicit questions had answers that were directly stated in the text. Implicit questions had the reader using clues in the passage to make inferences in order to give the correct answer. In looking at the scoring key on p. 71, Appendix H, questions 2, 3, 5, 6, and 8 have explicit answers and 1, 4, 7, 9, and 10 have implicit answers. As an informal reading inventory, scores are not norm-referenced but use a traditional percentage to determine independent, instructional and frustration reading levels of individual students. “The difficulty of the reading passages has been assessed using readability formulae, lexiles, and Fountas and Pinnell Guided Reading Levels” (Leslie & Caldwell, 2011, p. x). The intention of this instrument was to use it to chart growth after the treatment period.

I recorded the data from surveys and assessments in Excel spreadsheets where I compared the overall group percentages in bar graphs of how each question was answered in the pre and post treatment time frames and how students performed on pre and post treatment instruments. I also compared how each individual student answered both pre and post treatment and by *how much* higher or lower they answered in the post treatment. Bar graphs helped to present this data. I compared student attitudes for the individual strategies and if specific strategies were more effective. Data from other instruments was also compared, using the “sort” feature of Excel, in looking for patterns, themes, and relationships. After recording and analyzing the quantitative data, I analyzed the data for qualitative themes. In looking for qualitative themes, I included students’ background in reading science texts, whether they were currently using reading strategies; if they were using them, where did they learn them; and if they would like to learn more strategies. Any of the interviews conducted, individual or focus groups, were recorded and then transcribed to facilitate analysis.

The research methodology for this project received an exemption by Montana State University's Institutional Review Board and compliance for working with human subjects was maintained (Appendix E).

DATA AND ANALYSIS

The students involved in the study were my 2011-2012 physical science students at Hastings (NE) High School. There were 91 ninth grade students with 4 sophomores and 1 junior. There were two sub-groups, one of 81 honors physical science (HPS) students and another of 15 conceptual physical science (CPS) students. The demographics of the school district that were reflected in my classroom are as follows:

- Percentage of Students Eligible for Free or Reduced Price Lunch

  District 51.88% State 41.22%

- Mobility Rate

  District 12.62% State 11.89%

- Percentage of Students Qualified as English Language Learners

  District 8.59% State 6.56%

- Percentage of Students Qualified for Special Education Services

  District 20.94% State 15.26%

- Race/Ethnicity (District State)

  White, not Hispanic 78% 74%

  Hispanic 18% 14%

Black, not Hispanic 2% 8%

Asian/Pacific Islanders 2% 2%

American Indian/Alaska Native Less than 1% Less than 2%

Since the implementation of this study occurred in a high school *science* classroom, it became evident that the results from analyzing data surrounding the first sub-question were of a priority concern. This sub-question asks, “how will reading strategies impact students’ reading comprehension of science content material?” This was measured indirectly by administering a Qualitative Reading Inventory (QRI), more directly by looking at pre and post assessments specifically related to the material covered within a chapter, by interviewing students and through reference to the teacher’s journal.

The QRI was administered on 10/31/11 and re-administered 3/8/12. During the four months between testing dates, reading strategies were presented and practiced by the students. The QRI was scored for a full value and then sub-scored for explicit and implicit portions. Explicit questions had answers that were directly stated in the text. Implicit questions had the reader using clues in the passage to make inferences in order to give the correct answer. In looking at the number of students in Figure 1, who were at the frustration, instructional, and independent levels in the full inventory, it can be seen that the numbers shifted in a positive direction, however slightly. The number of students at a frustration level decreased 5 % (5/96), numbers at the instructional level increased 1% (1/96) and also increased 4% (4/96) at the independent level.

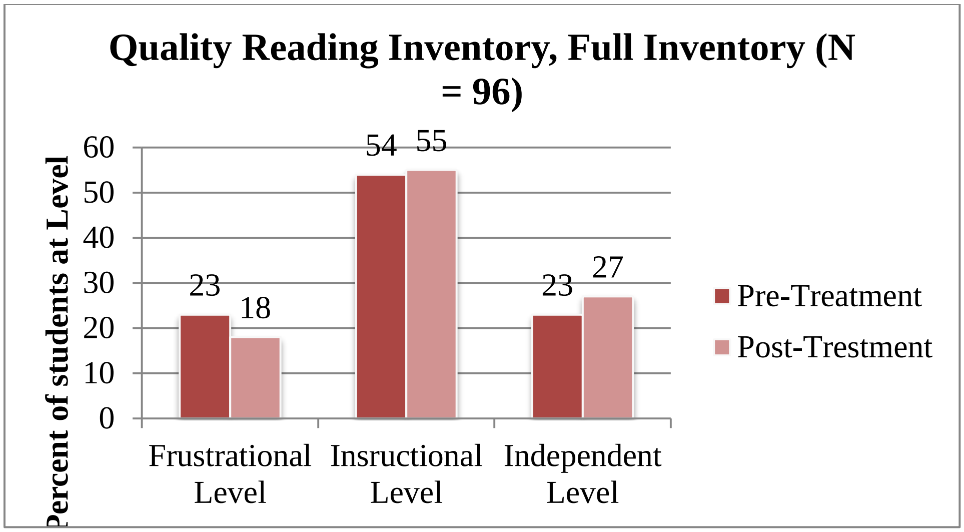

Figure 1. Percentages of how students scored on the full inventory of the QRI.

Looking more closely at the shift of numbers in the explicit and implicit portions (Appendix H), it can be noted that most of the improvement was observable in the explicit portion. From Figure 2, which shows how students performed on the explicit portion, there was no change on the frustration level, with a 7% (7/96) drop in the instructional level and a corresponding 7% (7/96) rise in the independent level. If students are reading more carefully, the explicit questions and answers should be easier to respond to correctly.

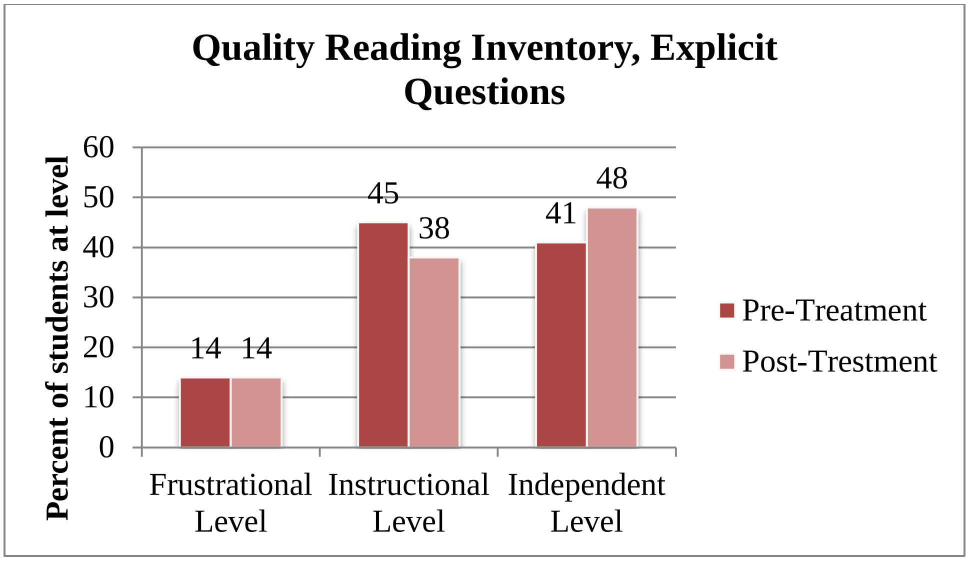

Figure 2. Percentages of how students scored on the explicit portion of the QRI.

There was not as notable a shift in the number of students in the implicit question and answer portion of the QRI. As is shown by Figure 3, 4% (4/96) students shifted from the frustration level to the instructional level. Shifts from the instructional level to the independent level were also noted, which in this case was 2% (2/96). As an instructor seeing students shift from a level of frustration to one of instructional, especially on the implicit level, is somewhat more satisfying. Implicit answers are by nature more challenging so even if the changes were small, they were noteworthy.

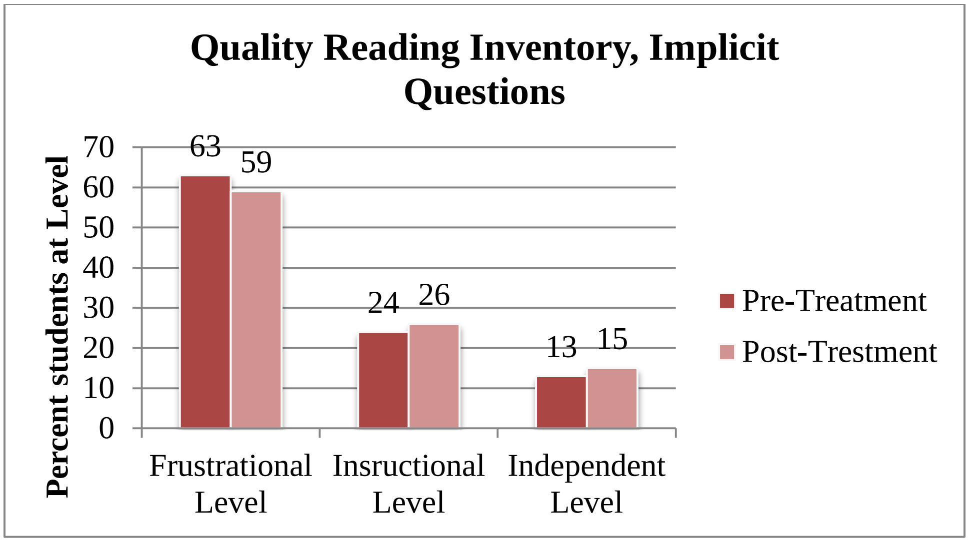

Figure 3. Percentages of how students scored on the implicit portion of the QRI.

In comparing the pre and post treatment results in the QRI the differences, although small, increased or decreased appropriately in a positive direction with the number of students at lower levels decreasing and higher levels increasing in all cases. Improvement was observed at almost all levels with only one result remaining the same and no negative changes. Only the objective part of the QRI was used in this study due to time constraints and the number of students involved. If the more in-depth or oral parts of the QRI were utilized, the results might have been more strongly supported.

Another set of data that supported that reading strategies were useful in positively impacting student's reading comprehension of science material utilized several classroom assessment techniques (CATs) before and after using a strategy. CATs used included a memory matrix (distinguishing between mass, volume, weight and density), concept map (showing relationships between different types of energy and work), approximate analogies (making connections between concepts and the units used to measure them, i.e.- velocity: m/s, acceleration: m/s^2, etc) and muddiest point responses. Short vocabulary quizzes were also administered pre and post treatment.

Before the first reading strategy was implemented, a simple concept map with five blank spaces to be filled in was given as a pre-test. The concept map (Appendix L) showed basic relationships between different vocabulary words and concepts for Chapter 9, entitled "Work and Energy." Students were then instructed in how to do the reading strategy, Modified Science Reading Process. After the students learned and applied the strategy on two sections of Chapter 9, students were given the concept map as a post-treatment assessment (and also as a formative assessment). Students were exposed to the material only through the reading strategy. Results shown in Table 4 indicated that for this section, the reading strategy used was highly effective.

Table 4
Number of students and correct answers on a pre and post treatment concept map, *N*=78

Number of Correct answers	0	1	2	3	4	5
Pre-treatment, Number of students	29 (37%)	7 (9%)	14 (18%)	18 (23%)	5 (6%)	5 (6%)
Post-treatment, number of students	0 (0%)	1 (1%)	3 (4%)	11 (14%)	21 (27%)	42 (54%)

While the results from the aforementioned initial treatment indicated the most dramatic improvement, similar positive results were observed with the other formative assessments. I think that it was also important to note that the implementation of this strategy was one of the few strategies that the sole learning opportunity before and after treatment was the reading of the material accompanied by the strategy. There weren't any lecture notes, labs or discussions to further contribute to the learning process. Overall, there weren't any negative results after applying a strategy.

In Chapter 2, a Memory Matrix (Appendix L) was given before and after using the strategy of the Cornell Notes. There was a definite positive shift as seen in Table 5. Some of these terms were covered earlier in Chapter 1 (mass, volume, weight). Density is introduced in Chapter 2, so students completed the Memory Matrix before and after reading the section describing density and using the Cornell Notes. While students had other opportunities to learn the material in the Memory Matrix, one student commented, "I wish we had used reading strategies in Chapter 1 because I might have actually learned about mass and volume already." The information covered in the Memory Matrix (Appendix L) is very basic and important science terms. As indicated by Table 5, 57 % of the students are still scoring below 70 % (9 out of 13 correct answers). Along with reading strategies, I will probably be using the Memory Matrix as a formative assessment several times throughout the year, maybe even as part of the end of the year final.

Table 5
Number of students and correct answers on a pre and post treatment memory matrix, N=81

Number of Correct answers	0-2	3-4	5-6	7-8	9-10	11-13
Pre-treatment, Number of students	9 (11%)	12(15%)	17 (21%)	26 (32%)	14 (17%)	3 (4%)
Post-treatment, number of students	3 (4%)	7(9%)	10 (12%)	26(32%)	25 (31%)	10 (12%)

Whenever strategies were used, students were allowed/forced to interact with the material producing some degree of a positive impact. It was discovered that the difference between strategies was more likely to be found in the time necessary to do it effectively and the amount of work it involved as perceived by the students.

As I worked my way through the study, I routinely made entries in a journal. One observation that I made was that when students had completed a strategy alongside reading, the muddiest points were not as numerous and often would extend beyond what was in the material being taught. It was as if the reading strategy established a stronger foundation, enabling students to begin to think beyond the immediate classroom experience. An example of this happening was one student questioning how a football can actually move forward if action-reaction forces cancel each other out when the football is kicked. This muddiest point question was made before we discussed it in class as part of the chapter that came a few days later.

During student interviews, there was a common theme from students that reading strategies do help some of them learn the material faster. One student informed me, ”you need to assign strategies all the time because it really helps me learn.” I pointed out that he could use strategies without having them officially assigned.

There was also a shift in some common themes from early interviews. One student in October asked, “What are reading strategies?” By the end of the treatment period, the same student was curious as to “how many strategies are there?” Several other students initially felt they “didn’t need any reading strategies because they were already good readers.” One of these students, after the treatment period, “Science stuff this year was a lot harder and I liked having ways to help me understand what I was reading." Another of these students added, " I have figured out that while I can still do very well on a chapter by just skimming the book and listening to the teacher, I understand concepts even better if I read the text."

The second question of my AR, "Which strategies will students find more effective and useful for future use?" was the focus of a survey administered at the end of the study. The results of three questions from this survey are shown in Figure 4.

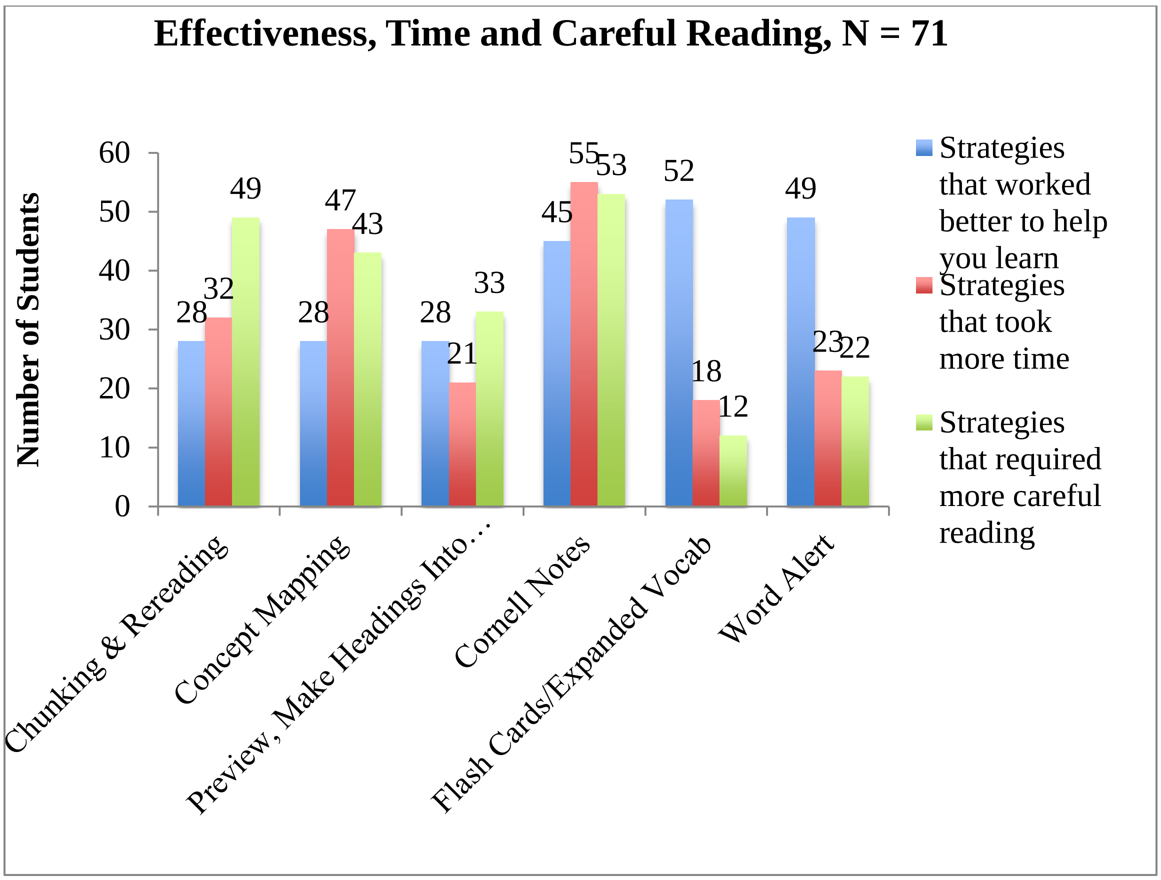

Figure 4. Student opinion on three questions from the Strategy Usefulness Survey.

The results showed that students thought that three of the six strategies were definitively more effective in helping them learn. Of the three strategies 52/71(73%) students selected Flash Cards/Expanded Vocab as more effective, 49/71(69%) selected

Word Alert and 45/71(63%) selected The Cornell Notes. Two of these strategies are vocabulary strategies completed near the beginning of a chapter. The third strategy was structured notes to be taken during and after reading. The ranking of the three remaining strategies was only 28/71(39%).

As an instructor, I know that “front-loading” or introducing terms used in a chapter can be vital to a better comprehension. Students also seemed to observe this as beneficial to their personal understanding of the science text. As far as the time to complete the two vocabulary strategies, students thought they took the least time of all the strategies. Students did not necessarily rank strategies by relating effectiveness and time invested because the strategy that took almost the least time, Preview& Turn Headings Into Questions had one of the lowest rankings for effectiveness. However, students also noted that the vocabulary strategies did not require as much careful reading as the third most effective strategy, Cornell Notes.

The third strategy, the Cornell notes, had students more involved as they read by taking notes as they read, separating out main terms and concepts and summarizing. Students also reported that this took more time *and* more careful reading. Students must have seen the extra time required to do the careful reading as worth the effort because it was ranked as the third most effective. The Cornell notes proved to be very helpful to one student because ” you need to read more to fill them out.”

Figure 5 considers how students ranked strategies and how likely they might implement certain ones in the future.

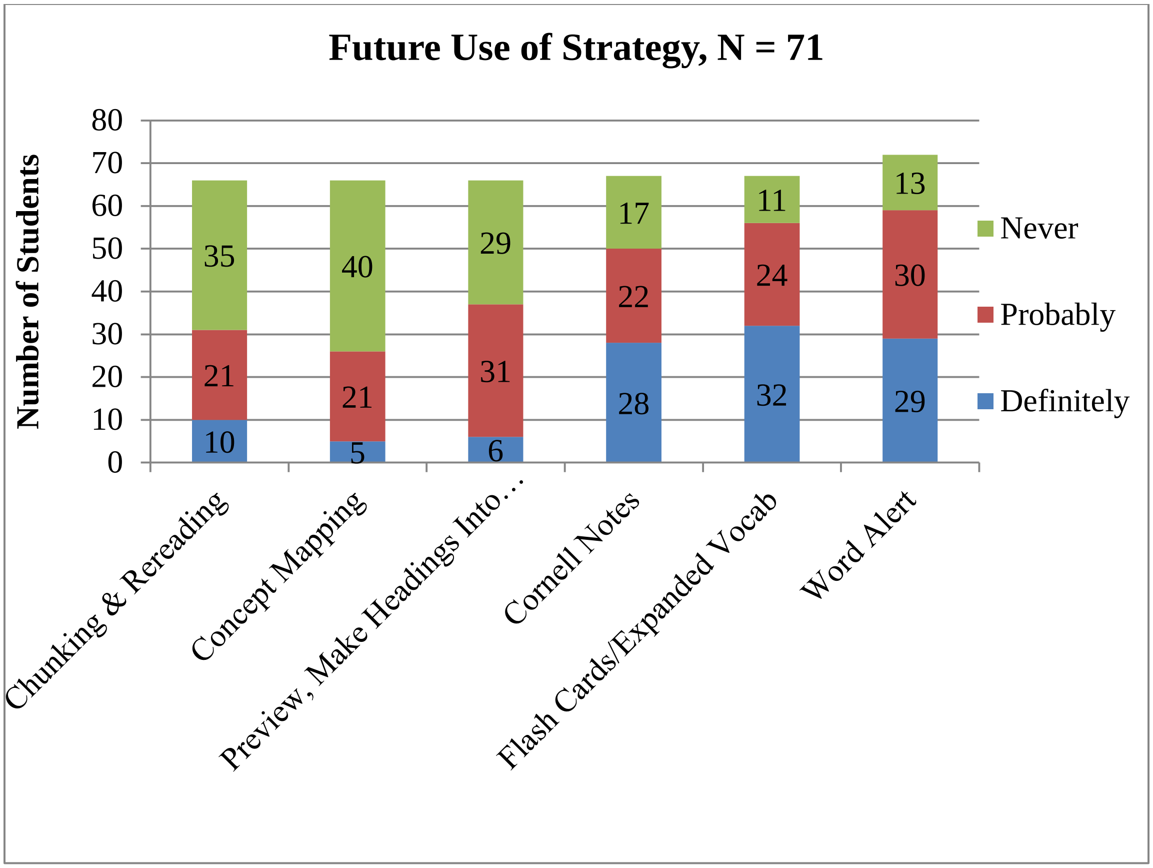

Figure 5. Student opinion on future usefulness of strategies from the Strategy Usefulness Survey.

The results from the question on the survey that asked students to indicate which strategies they would be more likely to use in the future reflected the results from the question on the survey related to effectiveness. By adding the responses of "definitely" and "probably", the top three strategies were Word Alert 59/71(83%), Flashcards / Extended Vocabulary 56/71(79%) and Cornell Notes 50/71(70%). Traditionally students have used vocabulary lists. Students are so comfortable with this type of strategy that even when the expectations are broadened, a vocabulary list is still the strategy of choice. The structure of the Cornell notes provides students with specific areas for different types of content. The other strategies require students to be more metacognitive or to determine what in the material being covered is important and why. The concept mapping is especially metacognitively challenging. One student verbalized this by saying, “I had to think and work harder to do the concept map. And then I didn’t even know if it was right.”

In the interviews and surveys of students at the beginning of the AR less than 35% of the students claimed to be able to identify a “reading strategy”, let alone use one. After the treatment period, one student commented, “when some things get to be too much to understand, the reading strategies make me get organized so I can understand better so I know I will use them again in school.” Another student added that reading strategies help him “get the bigger picture and that will be important in the college classes.”

The third sub-question was “How will students’ attitudes towards reading science text change if they are comfortable with strategies that focus upon reading science text?” Two surveys were given before and after treatment to measure the impact on the students’ confidence and attitudes. The Student Confidence and Attitude Survey (SCAS) (Appendix F) and Adolescent Motivation to Read Profile Survey (AMRPS) (Appendix G) were administered a week apart near the end of the first quarter, October 13 and October 20. The following responses on Figure 6, were found on select questions from the Student Confidence and Attitude Survey before and after the treatment.

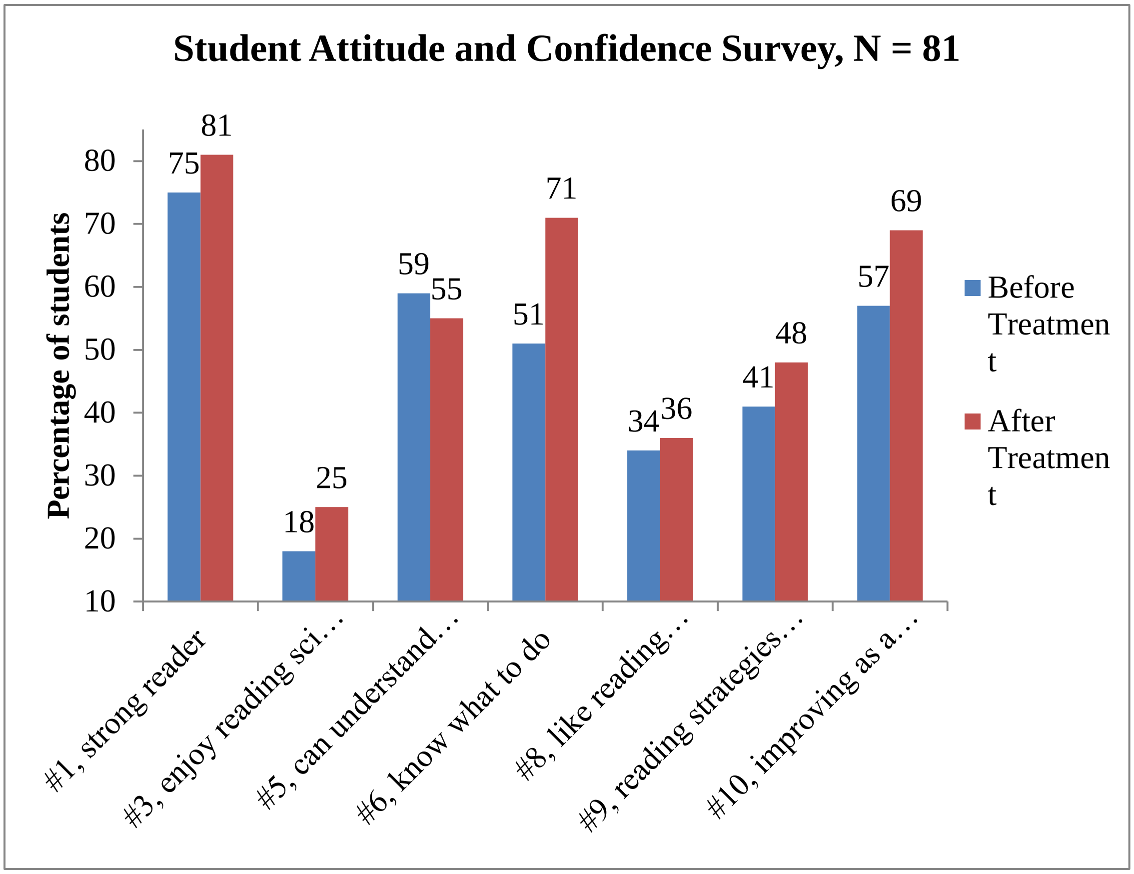

Figure 6. Student attitudes and levels of confidence on reading, pre and post-treatment.

Questions #1, #5, #6 and #10 relate to the students' confidence as readers. The survey used a Likert scale of 1-5 showing degrees of agreement, with 1 being the lowest and 5, the highest. The "4" and "5" responses indicating strong and strongest for agreement on the Likert scale were counted. Three of the four questions showed a positive increase. Question #1 asked whether they agreed to the statement, "I am a strong reader." Students answering with 4's and 5's, increased by 6% (from 61 to 66 students). Question #6 asked, "When there is a more difficult paragraph in any textbook, I know what I can do to understand it better." Responses to this question increased by 20% (from 41 to 56 students). Question #10 asked students feelings on, "I am improving as a reader in all of my classes." Numbers on this question increased by 12% (from 46 to 56 students). In the four months of treatment, student's confidence in their reading skills showed significant improvement.

Question #5 showed a decrease in the confidence of students. The question, "I can read and understand my textbook", fell by 4% (from 48 to 46). In interviews, when I asked these students why they weren't confident about reading and understanding their science text, there was a general consensus that "science is a lot harder this year"; "it is more advanced stuff"; " there is so much more to learn"; and that they learn better "when the teacher explains to them especially formulas."

The remaining selected questions showed a positive improvement in students' attitudes. Scored in the same way as the confidence questions, Question #3, "I enjoy reading science textbooks" increased 7% (from 15 to 20 students). When asked during interviews what they liked about reading science text, it was pointed out that it isn't just the printed words that are appealing but also that the pictures make it more interesting and the graphs and tables help with understanding. Four students commented that the subject matter is getting "more fun than in middle school."

Question #8, "I like to use reading strategies when I read ", increased by only 2% (28 to 30 students). One student thought he liked them because "they make you fill things out as you read and that helps me learn better." Another student believed the opposite to be true, "I don't like writing things down while I read. It takes too long and interrupts what I am thinking." These opposing viewpoints show that a variety of reading strategies could be important in order to differentiate for diverse learning styles in a classroom.

Question #9, "Reading Strategies can help me understand while reading my science textbook", increased by 7% (33 to 39 students). This question showed an improvement in students' attitudes toward how beneficial reading strategies can be when reading science text.

The Adolescent Motivation to Read Profile Survey (AMRPS) was a second instrument used to measure any change in student's attitudes toward reading in general, pre and post treatment. The survey was given to all of my students but the conceptual physical science (CPS) were taken out as a sub-group (*n*=12) from the honors physical science (HPS) group (*n*=87). Students are placed in an honors or conceptual class by their middle school teachers. The honors physical science students generally have higher math and science skills. A student in an honors science class is not necessarily in an honors English class. The differences in responses for the AMRPS survey were more obvious than in the other assessments administered (see Figures 7 and 8). While the conceptual students scored distinctly lower overall before and after, they scored higher after treatment in all areas. The opportunity to improve for these students is greater. When a teacher can make an impact on these students, the students can really benefit. The most notable shift for the conceptual students was in the self-concept portion of the AMRPS. The honors students maintained a high level of self-concept but increased in how they view the value of reading. The strategies enabled them to "discover" or "unravel" science concepts as a consequence of reading on their own. One student pointed out, "I learned that if I read, I have more knowledge of the material before class discussions and labs."

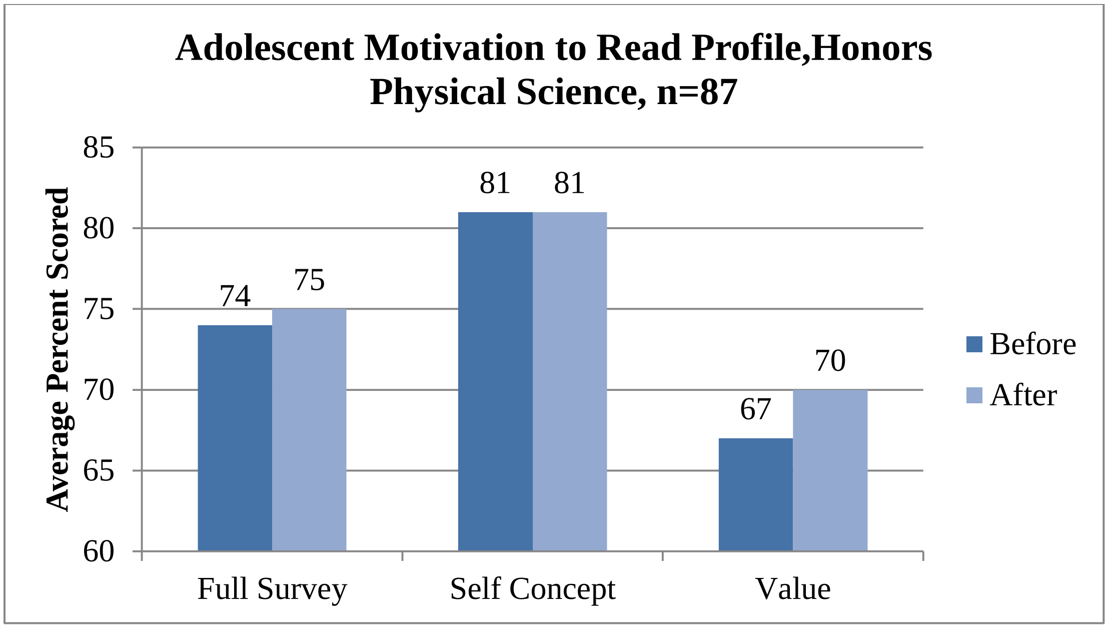

Figure 7. Comparing HPS average percent scored on AMRPS, pre and post treatment.

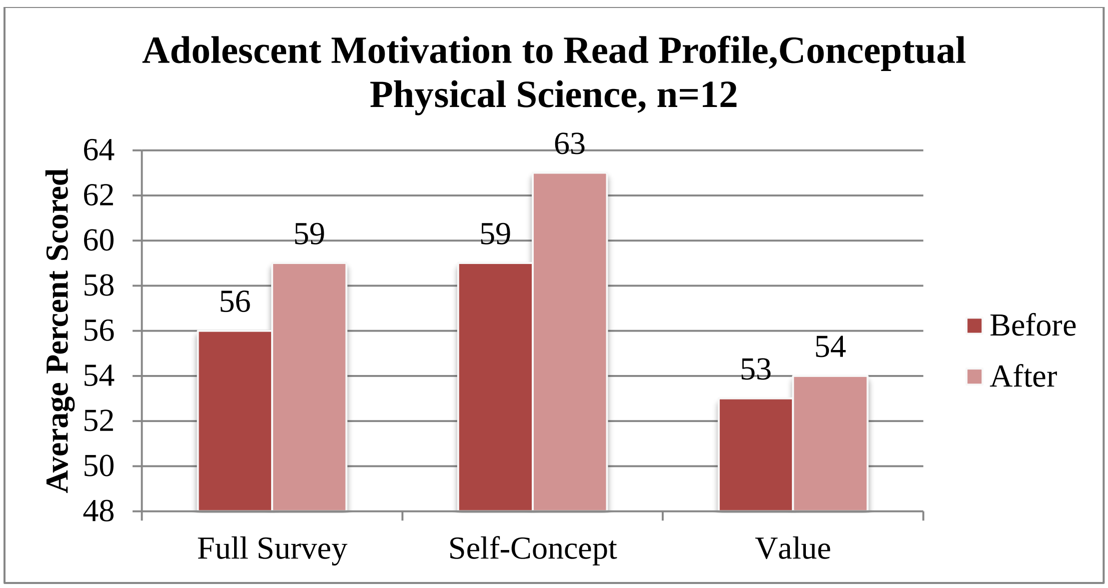

Figure 8. Comparing CPS average percent scored on AMRPS, pre and post treatment.

Figure 9 looks more closely at a select group of questions from the AMRPS where three of the questions are correlated to self-concept and three are correlated to the value of reading. The most remarkable change occurred with the CPS students increasing their score by 50% in how they view themselves as readers. Questions #7 (I understand what I read), #9 (I am a good reader), and #15 (Reading is easy) reflected the students' self-concept as a reader. When looking at the results from question #1, conceptual students displayed no change in judging their level of understanding, but increased by 50% in the self-perception of being a good reader as well as increasing by 30% in how easy they think reading is. This appeared to be somewhat conflicting where understanding had not seemingly been connected to ability to be a good reader. When questioned concerning this in interviews, several students in the conceptual class said, "I read better because I can read faster." Some of these students have been involved in a reading program that was offered this past school year that places an emphasis on increasing the rate of reading. This is a good example of how reading faster does not necessarily translate into better comprehension that is especially true for science text.

How students' value reading was measured in questions #2 (I like to read), #12 (Reading ability is important), and #15 (Time spent reading is good). While there was an increase in positive responses for all three questions, the honors students showed a greater increase in their personal value for reading in questions #2 (29%) and #15 (32%) and the conceptual students increased more in a value for reading ability in question #12 (20%). This might be explained by the fact that the honors students initially scored higher in placing a value on the importance of reading ability. The might have also been a magnification of the change for the conceptual due to the low n-value of 12 students being surveyed.

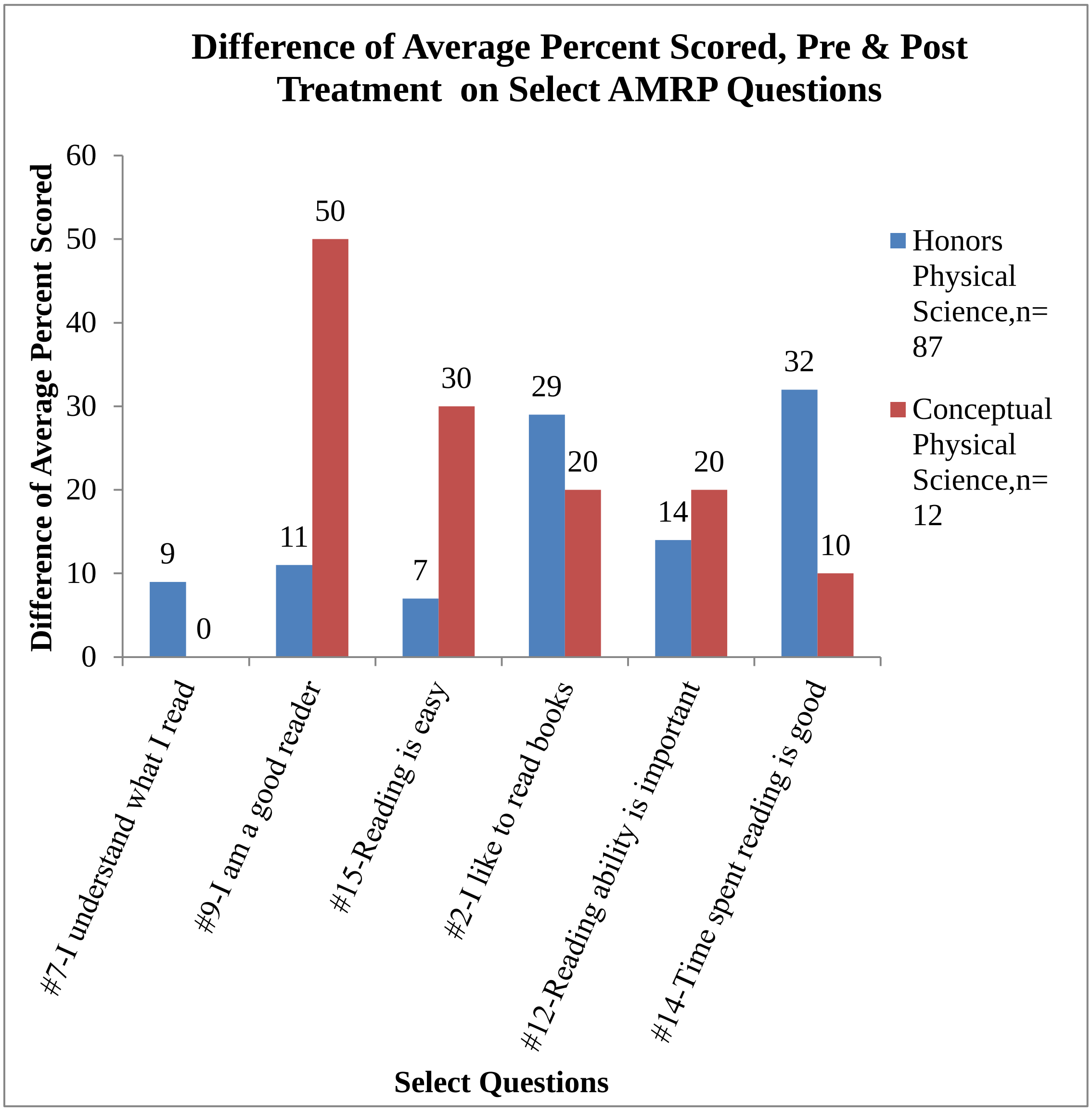

Figure 9. Comparing average percent scored from both sub-groups in responding to selected questions on the AMRPS.

At the beginning of the research study, thirty-two percent of the students said science books are "boring or not what I like to read about " (31/96). Thirty-one percent commented, "vocabulary words are challenging (or "too big") in science books" (30/96).

A couple of students asked, “What do you mean by reading strategy?” The most frequent reading strategy students mentioned pre-treatment was what they called “looking for context clues.” Twenty-four percent said, “looking for context clues helps to understand vocabulary” (23/96). Another set added, “rereading is a good strategy to help learning from a science book” (18/96). At this point, some students measured improvement by speed of reading, “My reading is improving since middle school because I can read faster” (22/96, 23%).

After treatment a smaller percentage (23%, 23/98), pointed out that reading science text was boring. Several students even added, “some of this science stuff really is pretty interesting.” Only one student suggested “looking for context clues” as a possibility for helping them understand a paragraph better. Even if students couldn’t name a strategy exactly by what it was labeled as they learned them, they could describe the process involved. “Just looking words up and copying the definition doesn’t usually help me understand. It helps to make diagrams or find examples.” While some students continue to link reading fast with being a good reader, 15% (15/98), “ a good reader has to be able to understand what they are reading or be able to get the big picture.” Several students mentioned that they are becoming better readers because they are practicing more and reading more challenging texts since they are now in high school.

In comparing early entries in my journal to later entries, I can note that students are more willing to take the time to use a reading strategy and complain somewhat less. Upon introducing the second strategy, I noted in my journal, five or six students from each class section would question, “why do we have to do another strategy?” with several other students nodding in agreement. By the time the final strategy was introduced, only one or two students in each class responded negatively. While the level of enthusiasm was not necessarily high, students were much more receptive and at least willing to try. Some students have even shown some insight, “you need to keep assigning reading and strategies, they really do help because I won’t do them on my own unless you make us do them.”

After collecting and analyzing the data, the impact of reading strategies was becoming obvious in positively affecting the reading comprehension, skills and values of reading for my students.

INTERPRETATION AND CONCLUSION

The purpose of my AR study was to see how reading strategies would affect my students’ skills and attitudes relating to reading science text. A secondary purpose looked at whether students would find strategies that were effective and useful for future their personal independent use. The students who I hoped to impact through my AR were like the one who said that when she reads science text, ” It makes no sense…the words go straight through my head”, or another young man who simply wrote, “non-fiction sucks.” Another student added that he was improving in his reading skills in most of his classes but “not in science.”

My first AR question was “How will reading strategies affect students’ reading comprehension of science content?” Results from the study supported my belief that the more directly students become involved with the subject matter in front of them, the more they will learn. No matter which reading strategy was utilized, students had to engage more closely with the concepts within the text. Evidence to support this came through many of the formative assessments given during the AR time span. Often I would take quick, informal thumbs up/thumbs down surveys to determine whether students had actually read the reading assignment. When reading was assigned with an accompanying strategy, only three to four students would indicate they hadn't read. If there was only a reading assignment with no written strategy attached, the numbers increased with one class actually having had only one-half of the students having done the reading. At times I was able to assess just what was gained from reading by using memory matrices, concept maps and quizzes immediately after students used a reading strategy. Significant gains were observed. Sometimes after a formative assessment was checked and returned, I would have students take a minute to look back into their textbook to find the exact page where the information was given for the missed questions. One student observed, "Oh yeah, I remember reading that now. I need to read more carefully."

I didn't feel that chapter tests were an objective way to evaluate reading improvements because by the time we reached the end of a chapter, students had done labs, participated in discussions and completed worksheets. Also comparing one chapter with a treatment to a chapter without a treatment cannot be viewed as objective due to the diversity of the material being covered (as an example, a chapter with more math versus one with less math). However, when students were interviewed, they felt that they had a better understanding in the chapters where reading strategies were assigned. Having taught the same class for several years, I wrote in my journal that students seemed to be doing better on chapter tests than previous years by noting that the grading "curve" applied decreased by several points from years past.

Students' reading skill levels increased slightly during the study. This positive shift could be seen in the standardized Quality Reading Inventory (QRI) that was administered before and after the study, formative assessments, student interviews and the teacher's journal. In the QRI, 5 % of the students moved from a frustration level to higher levels of instructional or even independent levels. While I wish I could have seen larger numbers here, I am reminded that the study only happened over a four-month time span, a relatively brief period of time. I was left to wonder if the importance of reading was emphasized more consistently in the context of specific classes from year to year how students would be impacted. While most of my students have been reading since early childhood, they haven't been reading higher-level expository text extensively. I think that skills for being a more effective reader of higher-level expository texts lie in the use of effective reading strategies. One comment I heard from several students who did improve, "reading the science book just seems easier now." One student stated, "when I don't understand something we talk about in class, I go read the book now (after treatment) and I understand better after reading."

Regarding my third AR question, surveys after the treatment showed that students confidence and attitudes have changed. Both instruments, the Adolescent Motivation to Read Profile Survey (AMRPS) and the Student Confidence and Attitude Survey (SCAS) showed positive impacts.

Before treatment the conceptual students were shown to have an especially low motivation to read (an average full score of 56% compared to the honors students of 74%). According to the authors Pitcher, et al (2007),

> motivation is defined in terms of 'beliefs, values, needs and goals that individuals have.' Thus, the closer that literacy activities and tasks match these values, needs and goals, the greater the likelihood that students will expend effort and sustain interest in them. When students judge reading and literacy activities to be unrewarding, too difficult, or not worth the effort because they are peripheral to their interests and needs, they become *nonreaders or aliterate adolescents* who are capable of reading but who choose not to do so (p. 378).

Many of my conceptual students were honest in admitting they are the non- readers mentioned above. The conceptual students full SCAS score increased by 3%, once again, not very substantial but definitely headed in the right direction.

Conceptual science students' responses changed from 56% to 59% in considering their self-concept as a reader on the SCAS. However, when looking at select questions on the AMRPS, conceptual students scores increased by 50% when asked if they were a good reader or by 30% increase when asked to rate how easy reading was for tthem. The definitive increase in positive attitude was also recorded in the teacher journal. It was observed students were more eager to read aloud and participate in classroom discussion about what they read.

Even with a 3% improvement conceptual students' SCAS scores didn't come close to the unchanging 81% self-concept as a reader shown by the honors students. I was surprised to see how confident the honors students were in their in their self-concept as readers (81% both before and after). But I have noted several times in my journal how regardless of which group they are in, they are reluctant to read science material at times. Students who claim to be good readers will often resist reading if they can learn through another mode. I frequently had to remind them to read the procedure to a lab before they come to me with questions that are clearly explained in the written theory and procedure. This has not changed even with reading strategies in place. There seems to be a gap between reading and applying what was read.

My second AR question addressed which strategies students would find effective and useful for future use. When I was researching strategies to use in the AR, I knew from experience that students would probably prefer strategies that took less time to use. The data supported this with two of the strategies implemented, the Word Alert that 73% (52/71) preferred, and the Flashcard/Expanded Vocab, 69% (49/71) preferred. However, I was pleasantly surprised when 45% (63/71) of the students choose the Cornell Notes as a highly effective strategy. The Cornell Notes were polled to take the most time by students, 77% (55/71), and 75% (53/71) of the students also felt the Cornell Notes required the most careful reading, both processes students typically avoid. As a teacher, the strategy that resulted in more careful reading and more time spent on material means more direct engagement by the students and subsequently a higher degree of learning. This strategy also covered the material more broadly and comprehensively, not just focusing on vocabulary. Acknowledging that a lot of science vocabulary is more than a simple word definition but often encompasses much larger concepts, in the usage of Cornell Notes students would be more likely to move more deeply into relationships between the concepts. Having students be in consensus with this as their experience affirms the genuine effectiveness of this strategy.

When students were asked which strategies they would be more likely to use in the future the Cornell Notes ranked a close third, 50/71, 70% behind the two vocabulary strategies. One of the goals of this AR was to find strategies that students could find useful and would realistically use in the future. The Word Alert, Flashcard/Extended Vocab, and Cornell Notes would appear to fit into this category. I am aware however, that although the other three strategies, Chunking and Rereading, Concept Mapping and Preview, Make Headings Into Questions were not favored by the majority, they were well liked by the students who did prefer them, 28/71 (39%). One student pointed out, "The concept mapping made the most difference to me. I'm a very visual learner and it made the most sense for me when I finished it. I used it to study for the test and that was the test I did the best on this whole year."

One other favorable result was the students' response to a survey question that was asked concerning how frequently they did the assigned reading. Fifty-seven of the seventy- one students (80%) answered that they did all of the assigned reading. When the others were questioned why they didn't, their responses were very honest- "I forgot," "I don't like reading and I don't learn when I read," and "I'm lazy." One of my concerns before I started this research project was that as teachers we often do not assign reading because students are highly likely to not do it. Seeing my students actually do the reading, and having them realize how much reading can benefit them was a rewarding outcome. The reading strategies themselves were entered as a minimal completion grade so getting a good grade was not necessarily a motivating factor. Of the seventy-one students polled, forty-nine (69%) wrote that they have better skills for reading and understanding their science textbook.

When presenting a new strategy, I would model it, have students do it with me or another student and finally have students do it on their own. When asked if they thought they had enough instruction to do the strategies, their responses were overwhelmingly positive. Learning the concept mapping was the most time-consuming instructionally. As one of my personal favorites, I will continue to use it but keep looking for how I can improve teaching students how to use it. At one point I had students work as groups constructing a concept map before and after the chapter was read using sticky-notes. The final product of one group, see Appendix L, was well structured and showed the depth of thought and discussion that went into it.

I can say with confidence after my AR that reading strategies can help students better comprehend science concepts and become better readers of science text. I also was reminded that students learn differently so students need to find the strategy that works better for them individually. There were some strategies that were more broadly preferred and not necessarily the easiest and/or the least time-consuming. The study did not show students to change their attitudes to the point that a science text is their favorite reading material, but they did learn to appreciate science text for its learning values and how to better access what a textbook has to offer.

VALUE

There has been a ripple effect moving beyond the limits of my classroom. I have experienced a strong sense of curiosity as to what I was doing, why I was doing it and what were the results. Teachers and administrators have asked questions. After having read more extensively for the literature review, I feel even more strongly that what I am doing is "good for students." Reading is an essential skill that is beneficial for any walk in life. It is reassuring to have research-based supportive data. There is little doubt in my mind that I will continue to work on discovering better strategies to make reading a more manageable task for my students even after this capstone. I have had to limit the number of strategies to fit into the time constraints of the study. There are many more researched-based effective strategies that have caught my attention that I hope to use in the future. I would like to explore strategies that have students reflect more upon what they have read.

Having seen from this study that students can improve their skills in reading science text more efficiently through the use of reading strategies, I will continue to instruct students in the use of reading strategies. Knowing that productive time in the classroom is limited because of the volume of material that needs to be covered, if I were forced to choose which strategies to fit into a compact time frame, I would choose one that focuses on building vocabulary such as the Word Alert or Flash Card/Expanded Vocabulary strategies. Students also favored vocabulary strategies for the amount of benefit to time-invested ratio. The vocabulary strategies were proven effective and could easily fit into the mind-set “at least do these if you don’t do anything else.” I will continue to use some sort of reading strategy for each chapter having built them into most of my curriculum in the process of my AR.

It has also become more obvious to me that reading for comprehension is not a superficial activity and anytime time students “dig deeper” and spend more time with the assigned material, higher levels of comprehension are achieved. Students felt the impact of the Cornell Notes as a strategy the made them think more deeply about what they were reading and it’s implications, something a simple vocabulary strategy cannot do as well. I will definitely continue to teach students how and have them complete the Cornell

Notes in the future. The Cornell Notes not only worked well as a reading strategy but also are easily adapted for use as lecture notes.

I will probably start strategy instruction earlier in the year. I would like to help students become more comfortable with the strategies that encourage higher level thinking skills, when time allows.

Through the process of teaching reading strategies to my students, I discovered the importance of differentiating instruction, especially for the students in my conceptual class. They proved to be especially challenging by being more resistant to learning strategies and using them independently. Because of this, I had to alter the flow of my AR and only use three of the reading strategies with them. These students are not as mature academically and have to be more heavily scaffolded in the classroom. Their reading skills, values and attitudes were substantially below those of the honors students. This class had a high percentage of what teachers at our school loosely term "intentional non-learners". The question that came to my mind, are their reading skills lower because they choose not to learn or are do they have a tendency to be non-learners because they are poor readers. Either way, these students were impacted, even if minimally by the reading strategies. I will continue to look for ways to take these students to higher levels of comprehension although reading strategies probably will not play as strong a role initially.

The study has helped reinforce in my mind the necessity of teaching reading within the context or disciplinary area of my science classroom. I have begun to establish professional relationships with several fellow teachers who feel similarly to how I feel concerning helping students become better readers of expository text. In essence, a new support group has been forming without me seeking them out. It is definitely a feeling of affirmation. In the process of having to execute an action research, I have seen myself becoming stronger as a teacher, and building a better professional foundation as a leader in my building.

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APPENDICES

APPENDIX A

WORD ALERT THINK SHEET

Name_______________________
Chapter and Section _____________
Date______________

Word Alert Think Sheet

Important Word	Do I already know the word? Y/N	Definition in Context	Example showing how the word is used	Does this word have an equation and/or units? Write it

APPENDIX B

CORNELL NOTES

Class_____________________________ Topic (Chapter)________________________________

Main ideas, key points,	Notes

SUMMARY AND REAL LIFE APPLICATION

APPENDIX C

CHUNKING AND REREADING THINK SHEET

Chunking and Rereading Think Sheet

Name ___________________

Period __________

Directions: Read the selected pages. After reading, determine the main concepts and write down the page(s) where they are found. Reread and then briefly summarize the idea.

PAGE #	DESCRIPTION OF MAIN IDEA

APPENDIX D

PARENTAL INFORMATION SHEET

Fall, 2011

Dear Parents/Guardians,

As a science teacher for your student, I wanted to let you know that I am conducting a study of reading strategies in my classrooms this year. Most of the study will include regular classroom work and assignments. I am writing to inform you that I will be using data collected from your student. The type of data that will be collected from your student will be related to their opinions, attitudes, and skill level for reading in general as well as reading informational science text from their science books. While most of the study will be regular classroom activities that students are expected to participate in, using data from certain surveys and questionnaires is voluntary. You may contact me at any time if you have questions or concerns. Mr. Opperman, the principal, has approved this study.

The purpose of this study is to teach students to use strategies before, during, and after reading that will help them learn and understand the material better. My goal is to teach them strategies that they can apply not only to my class but also to other classes or situations when they need to read informational text. During the introduction and use of strategies, I will be collecting different forms of data that will help determine if the strategies are successful. I will be looking at student work, conducting interviews and having students fill out surveys. Participation or non-participation will not affect your student's grade.

I will be assigning numbers and assure you that confidentiality will be maintained. Any information supplied by your student will be strictly confidential. I am currently part of a master's program at Montana State University, Bozeman. I will be presenting the results of my study next summer in Montana. While it is highly probable that any specific references to your student will not be necessary, if it would be useful to describe the experience of a certain student, the reference would be by a number only. You may contact me if you do not wish to have your student's data included in my study.

My email address is yhart@esu9.org or you may call me at school and leave a message and I will get back to you as soon as possible. The school's phone number is 402-461-7550.

I'm looking forward to an exciting year and working with your student!

Sincerely,

Yvette Hart, Hastings High Science Teacher

APPENDIX E

INSTITUTIONAL REVIEW BOARD RESEARCH EXEMPTION

MONTANA STATE UNIVERSITY

INSTITUTIONAL REVIEW BOARD

For the Protection of Human Subjects
FWA 00000165

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

Chair: Mark Quinn
406-994-4707
mquinn@montana.edu
Administrator:
Cheryl Johnson
406-994-4706 or 6783
cherylj@montana.edu

MEMORANDUM

TO: Yvette Hart

FROM: Mark Quinn, Ph.D. Chair *Mark Quinn cyj*
Institutional Review Board for the Protection of Human Subjects

DATE: November 4, 2011

SUBJECT: *"Reading Strategies in the High School Science Classroom" [YH110411-EX]*

The above research, described in your submission of November 4, 2011, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal Regulations, Part 46, section 101. The specific paragraph which applies to your research is:

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

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

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

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

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

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

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

APPENDIX F

STUDENT ATTITUDE SURVEY

Name ________________________

Student Confidence and Attitude Survey

Please answer the following questions by circling how you feel on a scale of 1 to 5. (Participation is voluntary and will not affect your grade. You may write on the back of this sheet for the written responses.)

1 -strongly disagree
2- somewhat disagree
3- agree
4- strongly agree
5- very strongly agree

1. I am a strong reader. 1 2 3 4 5
   When did you first realize that you were or weren't a strong reader?

2. I enjoy reading textbooks. 1 2 3 4 5
3. I enjoy reading science textbooks. 1 2 3 4 5
   What do you find challenging about reading science textbooks?

4. I enjoy reading non-fiction science when it isn't in a textbook. 1 2 3 4 5

5. I can read and understand my science textbook. 1 2 3 4 5
What is the best thing (or worst thing) about reading your science textbook?

6. When there is a more difficult paragraph in any textbook, I know what I can do to understand it better. 1 2 3 4 5

7. I already know specific reading strategies that will help me have a better understanding of textbooks that are hard to read. 1 2 3 4 5

8. I like to use reading strategies when I read. 1 2 3 4 5
Please tell me about any reading strategies that you already use.

9. Reading strategies can help me understand while reading my science textbook. 1 2 3 4 5

10. I am improving as a reader in all of my classes. 1 2 3 4 5
Why do you feel you are (or aren't) improving?

1.)

3.)

5.)

8.)

10.)

Any other comments?

APPENDIX G

ADOLESCENT MOTIVATION TO READ SURVEY

Figure 1
Adolescent Motivation to Read Profile reading survey

Name: ______________________ Date: ______________

Sample 1: I am in ______________.
- ❑ Sixth grade
- ❑ Seventh grade
- ❑ Eighth grade
- ❑ Ninth grade
- ❑ Tenth grade
- ❑ Eleventh grade
- ❑ Twelfth grade

Sample 2: I am a ______________.
- ❑ Female
- ❑ Male

Sample 3: My race/ethnicity is ______________.
- ❑ African-American
- ❑ Asian/Asian American
- ❑ Caucasian
- ❑ Hispanic
- ❑ Native American
- ❑ Multi-racial/Multi-ethnic
- ❑ Other: Please specify ______________

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
- ❑ almost none of what I read
- ❑ none of what I read

8. People who read a lot are ______________.
- ❑ very interesting
- ❑ interesting
- ❑ not very interesting
- ❑ boring

9. I am ______________.
- ❑ a poor reader
- ❑ an OK reader
- ❑ a good reader
- ❑ a very good reader

(continued)

Figure 1 (continued)
Adolescent Motivation to Read Profile reading survey

Name: ______________________ Date: ______________

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 kids 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

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

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

Note. Adapted with permission from the Motivation to Read Profile (Gambrell, Palmer, Codling, & Mazzoni, 1996)

Figure 5
Scoring directions: MRP reading survey

The survey has 20 items based on a 4-point scale. The highest total score possible is 80 points. On some items the response options are ordered least positive to most positive (see item 2 below) with the least positive response option having a value of 1 point and the most positive option having a point value of 4. On other items, however, the response options are reversed (see item 1 below). In those cases it will be necessary to recode the response options. Items where recoding is required are starred on the scoring sheet.

Example: Here is how Maria completed items 1 and 2 on the Reading Survey.

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

To score item 1 it is first necessary to recode the response options so that
a poor reader equals 1 point,
an OK reader equals 2 points,
a good reader equals 3 points, and
a very good reader equals 4 points.

Because Maria answered that she is a good reader the point value for that item, 3, is entered on the first line of the Self-Concept column on the scoring sheet. See below. The response options for item 2 are ordered least positive (1 point) to most positive (4 points), so scoring item 2 is easy. Simply enter the point value associated with Maria's response. Because Maria selected the fourth option, a 4 is entered for item 2 under the Value of reading column on the scoring sheet. See below.

Scoring sheet

Self-concept as a Reader	Value of reading
*recode 1. 3	2. 4

To calculate the Self-concept raw score and Value raw score add all student responses in the respective column. The full survey raw score is obtained by combining the column raw scores. To convert the raw scores to percentage scores, divide student raw scores by the total possible score (40 for each subscale, 80 for the full survey).

Note. Reprinted with permission from the Motivation to Read Profile (Gambrell, Palmer, Codling, & Mazzoni, 1996)

Figure 6
MRP reading survey scoring sheet

Student name ______________________________

Grade ______________ Teacher ______________________

Administration date ______________________________

Recoding scale
1=4
2=3
3=2
4=1

Self-concept as a reader		Value of reading	
*recode	1. ____		2. ____
	3. ____	*recode	4. ____
*recode	5. ____		6. ____
*recode	7. ____	*recode	8. ____
	9. ____	*recode	10. ____
	11. ____		12. ____
	13. ____		14. ____
*recode	15. ____		16. ____
	17. ____	*recode	18. ____
	19. ____	*recode	20. ____

SC raw score: ____/40 V raw score: ____/40

Full survey raw score (Self-concept & Value): ______/80

Percentage scores
Self-concept ____
Value ____
Full survey ____

Comments: ______________________________

____

____

____

Note. Reprinted with permission from the Motivation to Read Profile (Gambrell, Palmer, Codling, & Mazzoni, 1996)

APPENDIX H

QUALITATIVE READING INVENTORY-5

Characteristics of Viruses—Part 1

Similarities and Differences between Viruses and Cells

If you ever had a cold or the flu, you probably hosted 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.

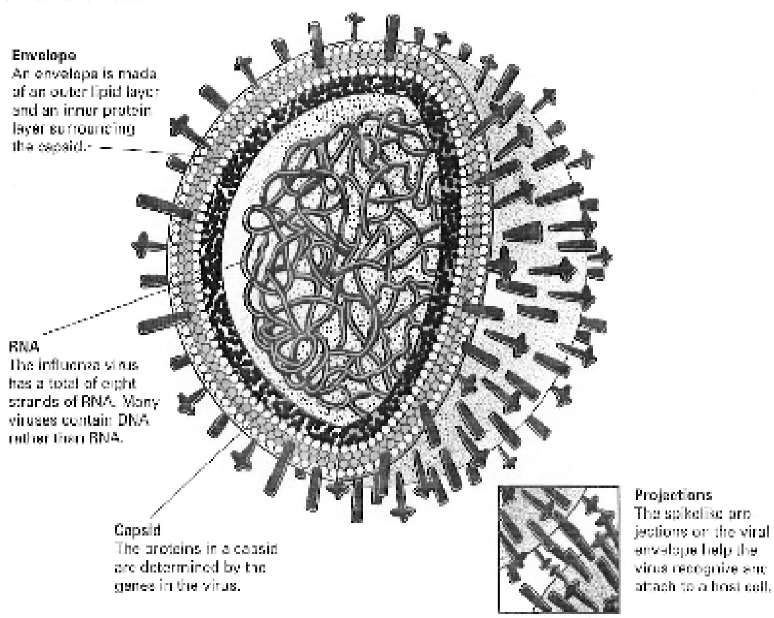
Compared to even the smallest cell, a virus is tiny. The virus that causes polio, for example, measures only 20 nanometers in diameter. One nanometer is one billionth of a meter. At that size, 3000 polioviruses could line up across the period at the end of this sentence.

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*.

An Influenza Virus



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.

Name ______________________

Characteristics of Viruses

1. What two things is this section mainly about?

2. What are the two parts of a virus?

3. What is the function of the protein coat of the virus?

4. Why isn't a virus a cell?

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

6. What determines the proteins in a capsid?

7. How is the envelope of the influenza virus different from the capsid?

8. What types of viruses have envelopes?

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

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

Level: High School

___ to changes.
___ Viruses contain fewer genes
___ than a human cell.
___ A human cell has 100,000 genes
___ and a virus has 5 genes.

39 Ideas

Number of ideas recalled ______

Other ideas recalled, including summary statements and inferences:

Questions for "Characteristics of Viruses—Part 1"

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 acid (nucleic not required) and a protein (or protective) coat

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

4. Why isn't a virus a cell?
   Implicit: it doesn't have a nucleus or a membrane or organelles (Ribosomes, mitochondria, and chloroplasts are 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 the 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 makeup is less complex; or they don't do as many things as cells do (That they don't respire or eat is correct but not required.)

Without Look-Backs
Number Correct Explicit: ____
Number Correct Implicit: ____
Total: ____
____ Independent: 9–10 correct
____ Instructional: 7–8 correct
____ Frustration: 0–6 correct

With Look-Backs
Number Correct Explicit: ____
Number Correct Implicit: ____
Total: ____
____ Independent: 9–10 correct
____ Instructional: 7–8 correct
____ Frustration: 0–6 correct

Rate: 357 × 60 = 21,420/____ seconds = ____ WPM

High School

APPENDIX I

PRE-TREATMENT INTERVIEW

Pre-Strategy Treatment Interview Questions

Class______________________________________ Period____________

Date ________________ *(Remind students that participation is voluntary and will not affect their grade.)*

Names of students in the Group ______________________________________

____

____

____

____

1. Do you think of yourself as a good reader of your science textbook? Why or why not?
2. What has been your experience with reading science books in the past? Can you remember a time that you really liked (or didn't like) to read? Do you enjoy reading other materials? How much time do you spend on reading?
3. Do you like to read your science textbook? Why or why not? Do science textbooks seem harder or easier to read? What could be done to improve science textbooks in terms of being a good reading tool?
4. Do you ever use your science book to help you understand material that is being presented in your science class? How frequently do you do that?
5. Can you pick out the important ideas as you read? How do you know they are important? Would you be interested in learning strategies to help in reading? Why or why not?
6. As you are reading your science book, do you think about how what is being described is related to something you might already know? Can you give an example of when this happened?
7. Do you always understand what you read in your science book? If you don't understand, what do you do next?
8. Before you read the assigned pages what do you do? For example, do you look at the pictures, read the objectives, or anything else specifically? How often?
9. What features of the science book do you use most of the time, like the bold words, headings, key concepts, etc?
10. After reading, what do you do with the information presented to help you remember what you have just read?
11. Do have any other comments, ideas or experiences that involve reading a science textbook?

APPENDIX J

POST-TREATMENT INTERVIEW

Post-Strategy Treatment Interview Questions
Class____ Period_____________
Date _________________ (*Remind students participation is voluntary and will not affect their grade..)*
Names of students in the Group ____
____
____
____

1. Do you read assigned reading in this class more frequently than you did before this? If yes, what motivates you to read? If no, why don't you do the reading? If sometimes, what factors determine when you read? If you were the teacher how would you encourage students to read?
2. Do you feel like you have better skills/strategies to effectively read and understand your science textbook? If yes, which strategies have helped you? Do you want to learn more strategies? If no, would you like to have some strategies? Why or why not?
3. Have your attitudes changed about reading your science textbook? How have they changed? If they haven't changed, what was your attitude before learning reading strategies? Do you think reading a science textbook is important? Why or why not?
4. Does reading your science textbook seem harder or easier now that you have used strategies? What could be done to improve science textbooks in terms of being a good reading tool?
5. Do you ever use your science book to help you understand material that is being presented in your science class even if reading isn't assigned? How frequently do you do that?
6. Can you pick out the important ideas as you read? How do you know they are important? Which strategy helped you the most with this skill?
7. As you are reading your science book, did you ever think about how what is being described is related to something you might already know? Can you give an example of when this happened?
8. Do you always understand what you read in your science book? If you don't understand, what do you do next?
9. Before you read pages that have been assigned what do you do? For example, do you look at the pictures, read the objectives, or anything else specifically? How often? What features of the science book do you use most of the time, like the bold words, headings, key concepts, etc?
10. After reading, what do you do with the information presented to help you remember what you have just read?
11. Have you used any reading strategies from this class in another class? Which class and which strategies? Have you learned strategies in other classes that you have used in this class? Which ones?
12. Do have any other comments, ideas or experiences that involve reading a science textbook?

APPENDIX K

STRATEGY USEFULNESS SURVEY

Name ______________________________

Strategy Usefulness Survey

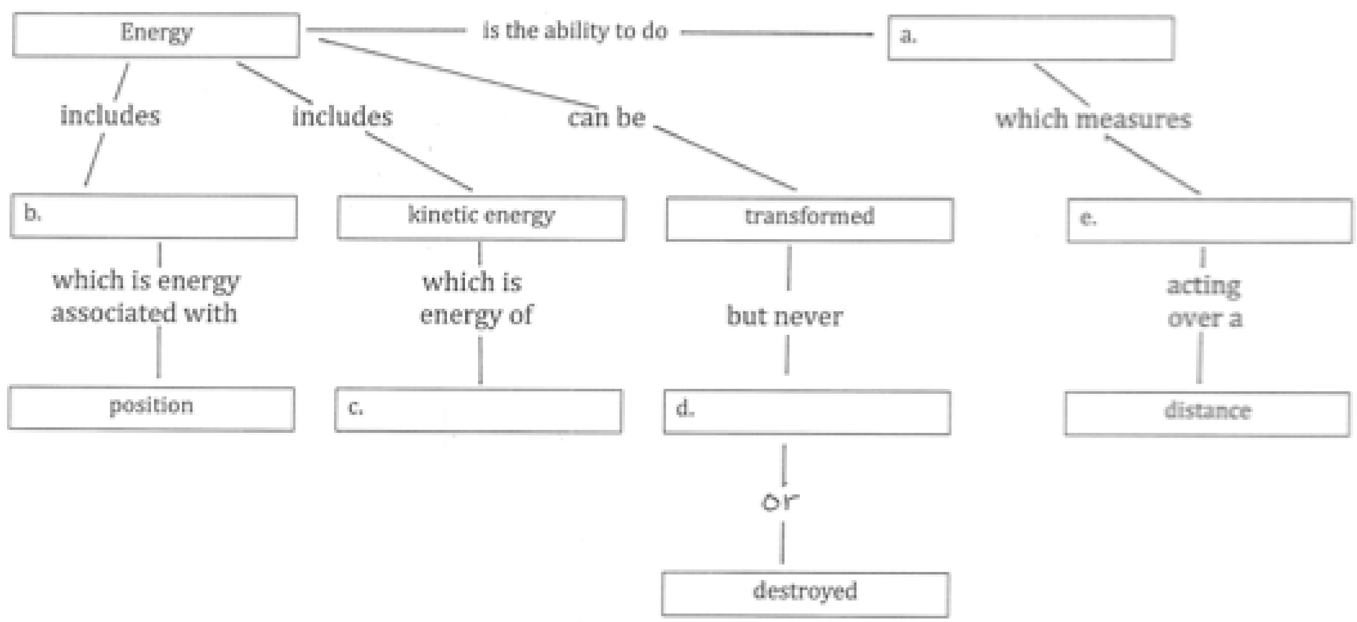
	Word Alert Think Sheet	Flash Cards / Expanded Vocab Sheet	Preview, Make Headings Questions	Concept Mapping, Pre and Post	Chunking and Rereading	Cornell Notes
Was the strategy helpful in learning assigned material?						
What was the purpose of this strategy?						
Did you feel you had enough instruction and practice to use this strategy?						
Which strategies worked the best for you?						
Which strategies made you read the assignment more carefully ?						
Which strategy took the most time? The least?						
Which strategy would you recommend to a friend who was having trouble understanding reading his science book?						
I will use this strategy (definitely, probably or never)						

APPENDIX L

SAMPLE CLASSROOM ASSESSMENT TECHNIQUES (CAT'S)

Honors Physical Science
Chapter 9 Concept Map

Name________________________
Period____



Any other ideas about energy? Write below.

Name_______________________________________ Period ______________

	Density	Weight	Volume	Mass
A measure of the amount of matter in an object				
A measure of the amount of space an object takes up				
The effect of gravity upon a mass				
Relates how much matter an object has to how much space it takes up				
Unit used is liters (L) or milliliters (ml)				
Unit used is grams(g), kilograms(kg) or milligrams (mg)				
Unit used is a Newton (N)				
Unit used is g/ml				
Changes with location (ex-the moon)				
Can be measured with a scale or balance				
Can be measured with a graduated cylinder				
Is calculated with the formula (m x g)				
Is calculated with the formula (m / v)				

APPENDIX M

SAMPLES OF STUDENT WORK

$C^\circ \to F^\circ$ conversion

$T_F = \frac{9}{5}t^{(c)} + 32.0$

$C^\circ \to K^\circ$

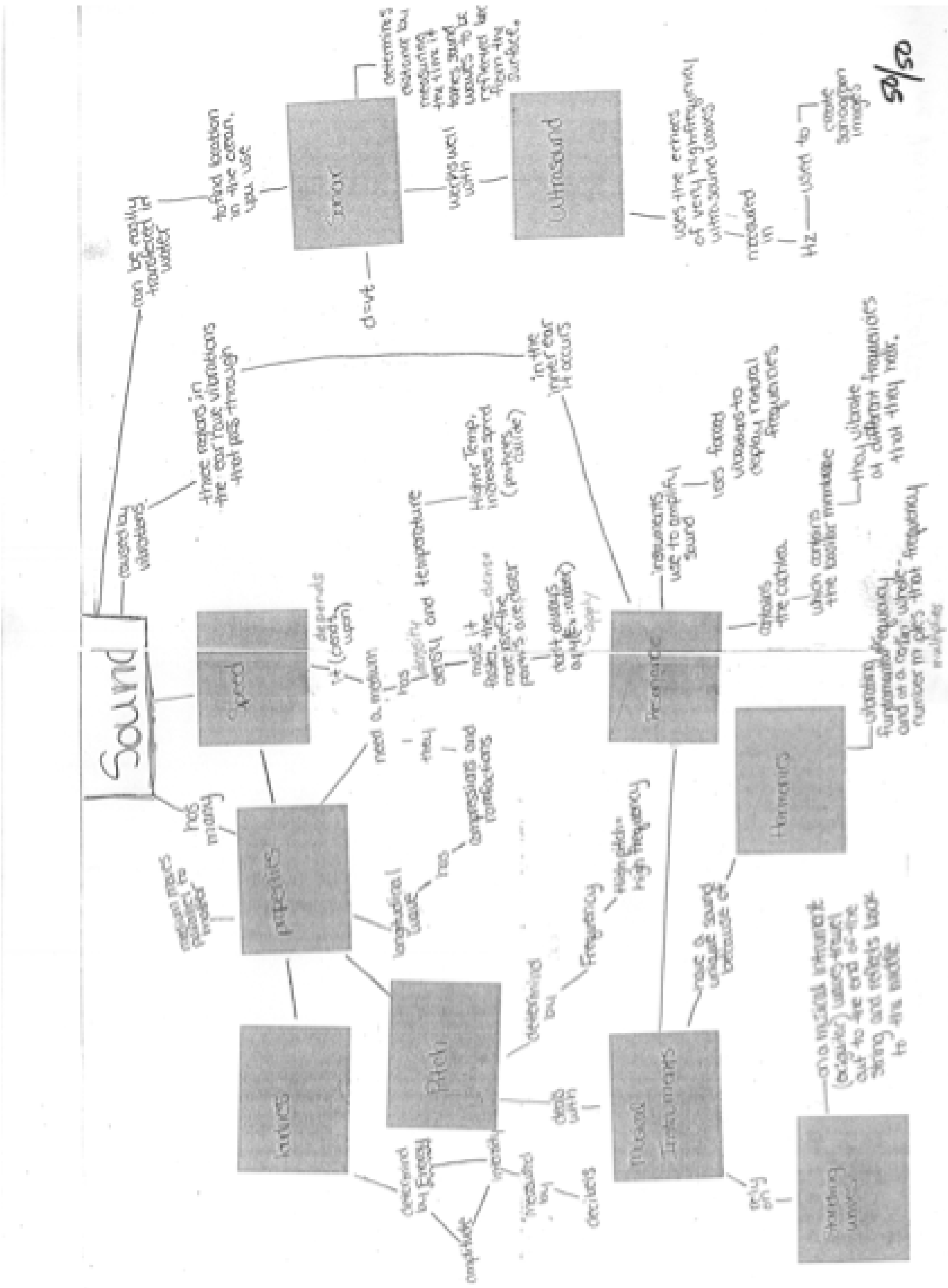
$T = t^{(C^\circ)} + 273$

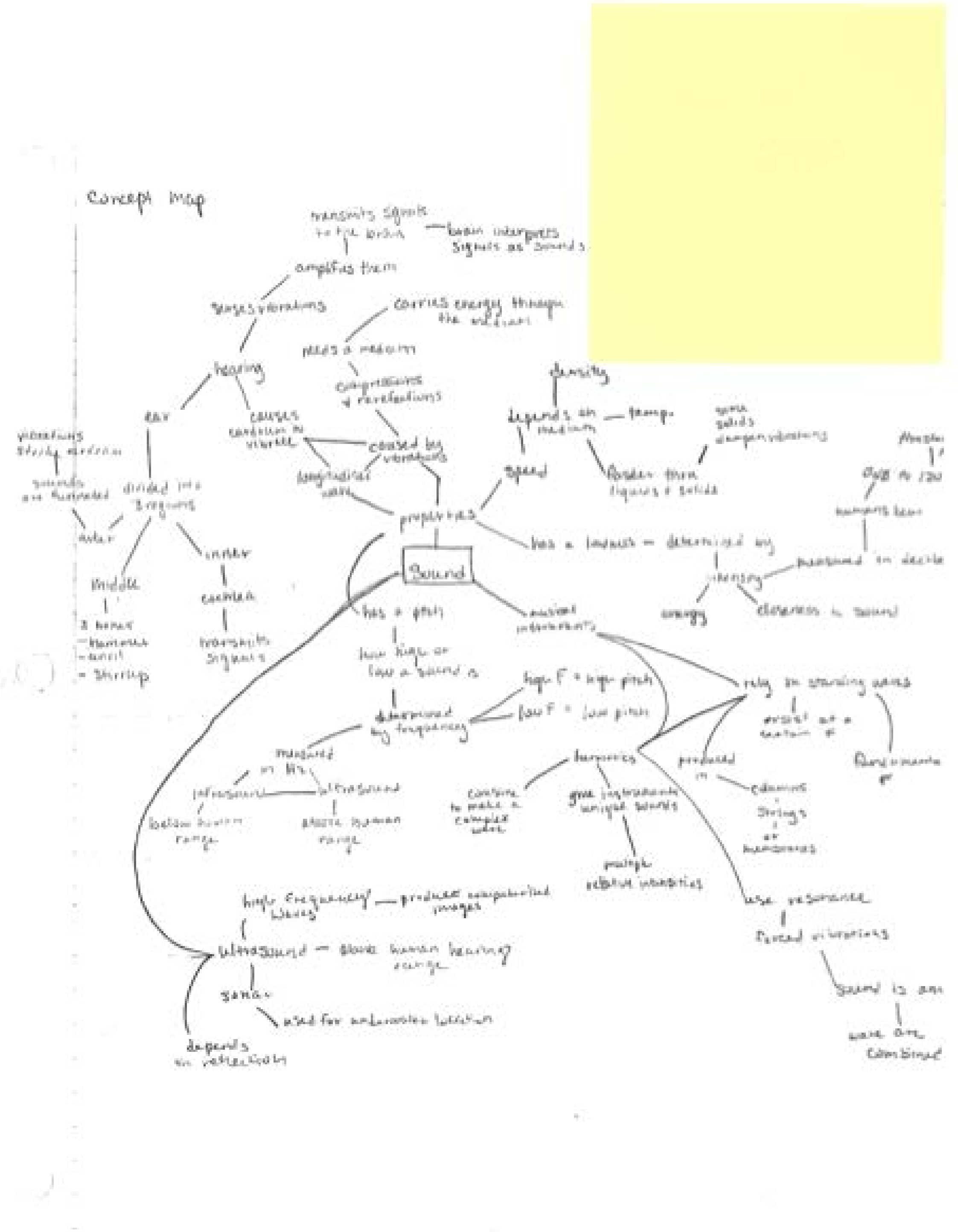
Word Alert Think Sheet

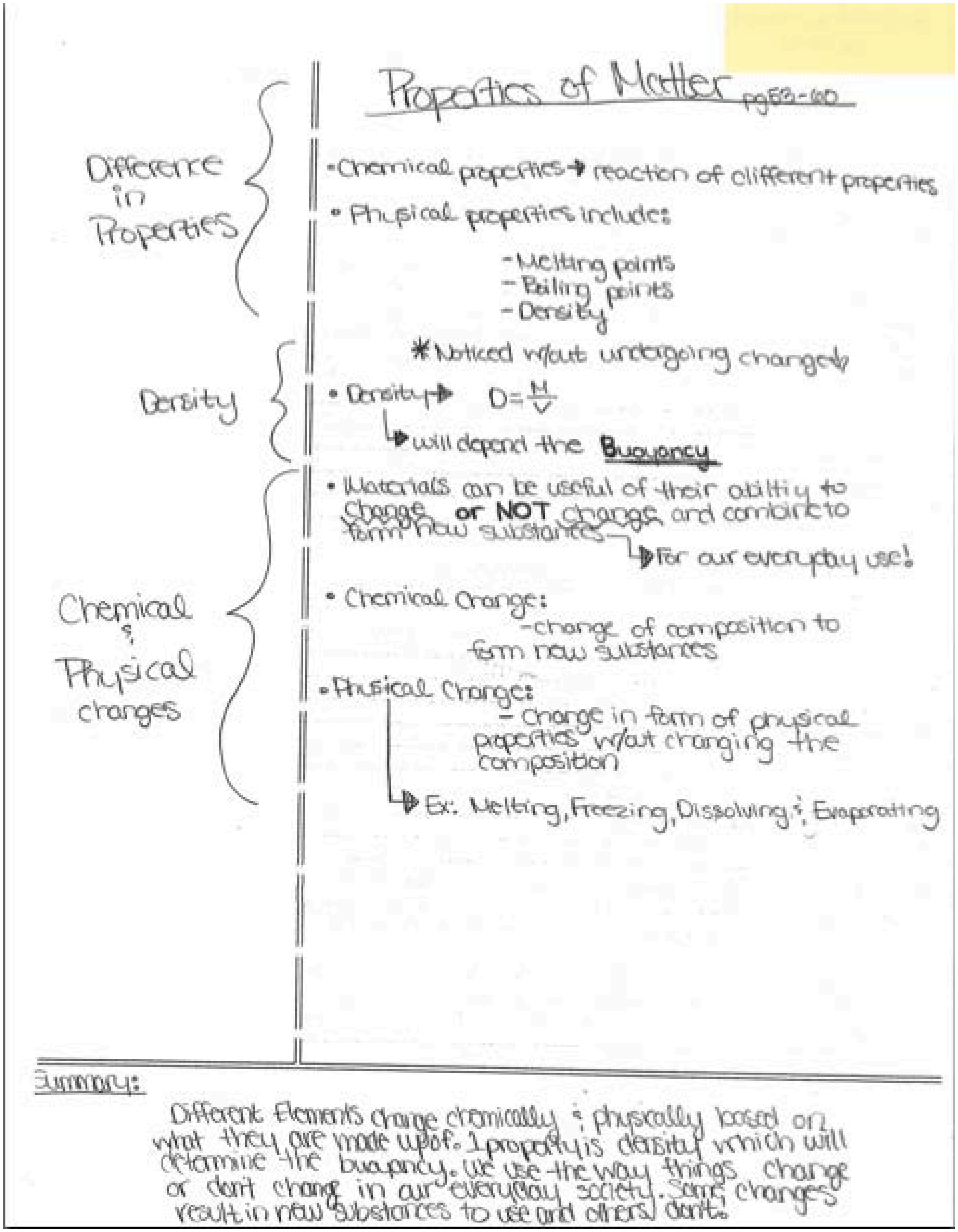
Important Word	Do I already know the word? Y/N	Definition in Context	Example of how the word is used	Does this word have an equation and/or units? Write it
absolute zero	y	At absolute zero particles barely move at all.	the temperature at which an object's energy is minimal	
conduction	y	Particles bounce into each other and make others do the same to make heat "move" along an object	transfer of energy as heat between particles as they collide within a substance or between 2 objects in contact.	
conductor	y	Metal is a good conductor, wood isn't.	material through which energy can be easily transferred as heat.	
cooling system	n	Heat is transferred from one object to another in a cooling system.	device that transfers energy as heat out of an object to lower its temperature.	
convection	y	In Convection, the heated liquid itself must move.	transfer of energy by the movement of fluids with different temperatures.	
convection current	y	When glowing embers rise from a campfire, a convection current is made surrounding the fire	flow of a fluid due to heated expansion followed by cooling and contraction	
heat	y	When particles speed up and hit each other, heat is made.	transfer of energy from the particles of one object to those of another object due to a temperature difference between the 2 objects	

Word Alert Think Sheet

Important Word	Do I already know the word? Y/N	Definition in Context	Example c… i…	
Temperature	Y	A measure of the average kinetic energy of all the particles within an object.	The temperature of a roasting turkey is monitored to see if it is cooked properly	$T_F = \frac{9}{5}t + 32.0$ (F) $T = \frac{5}{9}(T_F - 32.0)$ (C)
Thermometer	Y	A device that measures temperature.	Measure the temperature of the air on a sunny day with a thermometer.	C F K
Absolute Zero	N	The temperature at which an object's energy is minimal.	Winter days that are at ~~-40 is absolute zero.~~ No	(C) $T = t + 273$ (kelvin)
Heat	Y	The transfer of energy from the particles of one object to those of another object due to a temperature difference	When a hot water bottle touches your skin your skin starts to get hot until it reaches the same temp as the water.	
Conduction	N	The transfer of energy as heat between particles as they collide within a substance or between to objects in contact.	A wire in a camp fire the wire starts to get hot and so does your hand.	
Convection	N	The transfer of energy by the movement of fluids with different temperatures.	Smoke rises up from the fire and becomes less dense and soon will disappear.	
Convection Current	N	The flow of a fluid due to heated expansion followed by cooling and contraction	The glowing embers from the fire are cought in a convection current.	


Sound
Sonar
Ultrasound
Harmonics


Concept Map
Sound
properties
hearing
ear
senses vibrations
amplifies them
transmits signals to the brain
brain interprets signals as sounds
carries energy through the medium
needs a medium
compressions & rarefactions
caused by vibrations
longitudinal wave
density
depends on medium
temp.
speed
divided into 3 regions
outer
middle
inner
cochlea
transmits signals
3 bones
hammer
anvil
stirrup
has a loudness
determined by
intensity
energy
has a pitch
how high or low a sound is
determined by frequency
high F = high pitch
low F = low pitch
measured in Hz
infrasound
ultrasound
below human range
above human range
musical instruments
harmonics
rely on standing waves
use resonance
forced vibrations
high frequency waves
produce computerized images
ultrasound — above human hearing range
sonar
used for underwater location
depends on reflection



Properties of Matter pg53-60

Difference in Properties

- Chemical properties → reaction of different properties
- Physical properties includes:
  - Melting points
  - Boiling points
  - Density

*Noticed w/out undergoing change

Density

- Density → $D = \frac{M}{V}$
  - → will depend the **Buoyancy**

Chemical & Physical changes

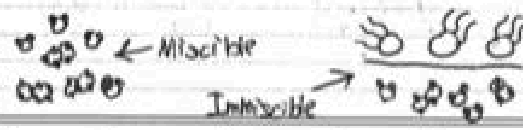
- Materials can be useful of their ability to change **or NOT** change and combine to form new substances → For our everyday use!
- Chemical change:
  - change of composition to form new substances
- Physical change:
  - Change in form of physical properties w/out changing the composition
  - → Ex: Melting, Freezing, Dissolving & Evaporating

Summary:

Different Elements change chemically & physically based on what they are made up of. 1 property is density which will determine the buoyancy. We use the way things change or don't change in our everyday society. Some changes result in new substances to use and others don't.

Matter

What is matter?	Everything is made up of matter. Anything you can hold or touch. Air is als made up of matter. Light, sound and electricity are not matter
What are Elements?	Elements are made up of atoms, Each element has a one ~~ee~~ or two letter symbol Carbon=C copper=CU aluminum= AL. Elements cannot be broken down into simpler substances
What are compounds?	A compound is a substance that is made up of atoms of more than one element bound together. Nylon is made by aluminum and Iron. Compounds can be made up of two or more elements.
What are molecules made of?	Atoms that join together can make millons of different molecules. Molecules are the smallest units of substances.
What do chemical formulas represent?	Chemical formula shows how many atoms of an element are in each substance. In chemical formulas, numbers go after the element symbol. There is no number if one element is presented. EX CO_2 ✓ C_1O_2 X Numbers shows how many molecules are in that substance
What's the differance between Pure substances and Mixtures?	A pure substance is matter with a fixed composition and definite properties. Elements and compounds are pure substances. It can not be broken down by physical change. ~~Most~~ Mixtures are many pure substan such as water, acid, and vitamins. Mixtures can be seperated like grape juice can evaporated and sugar, acids are left behind but water is seperated.
What's the difference between miscible and immiscible?	Heterogeneous mixtures are mixtures that don't mix very well like flour & water. Homogeneous mixture are mixtures that the individuals units is the same throughout like water and salt. Gasoline's compounds are miscible (100 compounds in various quantities). It looks like a pure substance even though its not. (Homogeneous) Oil and water form a ~~Immiscible mixture~~, heterogeneous mixture. They both are immiscible because you can see the layers between them.



~~Everything~~ Most things are made up of matter, and elements, Elements are up of atoms. Molecules are also made up of atoms chemical formulas represent the number of atoms in a substance The difference between Pure Substances and Mixtures is seperation. Miscible atoms can be mixed than Immiscible