

EFFECT OF METACOGNITIVE READING STRATEGIES
ON IMPROVING CONCEPT UNDERSTANDING
IN HIGH SCHOOL BIOLOGY STUDENTS

by

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ABSTRACT

The main purpose of this project was to determine how specific reading strategies impacted student understanding of genetics, evolution, populations, and ecology in high school biology. Forty-seven students in three achievement levels were tracked for changes in their abilities to answer high-order questions, as well as changes in their attitudes and motivations. Teacher attitude and motivations were also measured. The study revealed that students showed overall improvement in high-order thinking compared to non-treatment, and that student attitudes and motivations improved slightly during the project. Teacher attitudes and motivations improved as students progressed through the treatment.

INTRODUCTION AND BACKGROUND

The following scenario is an example of my 2011 biology class as they began the genetics unit. I started the class by addressing the students, “Students, open up your books to page 244. Today we are going to start learning about DNA. Here is a guided worksheet that can help you as you read.” Nathan groaned and muttered, “Great...reading again. I really dislike this!” Eli said (a little too loudly). “If I read one more sentence today, my head’s gonna explode!” Megan complied but had a look of quiet desperation in her eyes as she found the right page. Students were not motivated and were having problems understanding.

As I have reflected on my teaching and the students’ learning, I realized that many of my students struggle with reading comprehension, especially in science. Since most high school students acquire scientific knowledge by constructing ideas from reading and inquiry activities, I chose to focus student use of a reading-specific strategy as a way to acquire knowledge through reading for my capstone. When students understand the purpose for each reading assignment, access their prior knowledge to gain confidence while learning new material, and have the proper tools to construct meaning while reading, they should be able to more successfully acquire knowledge. My project focused on strategies to improve students’ reading comprehension by offering them a way to monitor their own learning while they are reading informational text.

I chose this project after realizing that much of my own knowledge has been constructed through reading, and that reading is an essential part of a rigorous science curriculum. My goal was to demonstrate that even reluctant readers can improve their

reading comprehension and use reading as an integral part of the learning process. In addition, data from my high school showed that students who had higher reading scores on state standardized tests also fared better on the science portion of the state test, which is reading intensive and required higher level thinking skills.

After reflecting and researching the topic of reading strategies in the content areas, I developed my focus questions. My project focus question was, what are the effects of using metacognitive reading strategies on my biology students' understanding of high school genetic and evolutionary concepts? My project sub questions were: what are the effects of using metacognitive reading strategies on my students' answering high-order cognitive questions; what are the effects of using metacognitive reading strategies on students' attitudes and motivation toward learning science; and what are the effects of using metacognitive reading strategies on my attitudes and motivations for planning and implementing lesson plans using these strategies? Metacognition is literally "thinking about thinking", but for this project it more specifically referred to "what people know and how they apply that knowledge" (Jacobs & Paris, 1987, p. 255). For the purpose of this study, metacognitive strategies included: implementing various techniques for students to use to monitor their own learning while reading; grouping students to work collaboratively to construct meaning; and a reading self-perception survey. The attitudes I assessed include participation and engagement by students during the lesson.

The project intervention took place in the two months leading up to the administration of the Ohio's standardized test for science, which is part of the requirements for high school graduation and is administered initially in the spring of students' sophomore year (Ohio Department of Education [ODE], 2010). The

participants were sophomore biology students attending Hamilton High School, a large urban high school in southwest Ohio. Approximately 60% of the student population are eligible for free or reduced lunch (ODE, 2011). Students at Hamilton High School have consistently underperformed in science compared to the state expectation of 75% proficiency (ODE, 2011).

The members of my team included Jewel Reuter, Ph.D., my Montana State University Master of Science Education instructor and advisor. Jewel provided guidance and direction during all phases of the project development and implementation. Members of my validation team were Dennis Malone, Patricia Gibbons, and Betty Quantz, who served as editors and critics, providing thoughtful insight and perspective on philosophies of teaching. Rachel Rice served as a peer observer and colleague during my research and implementation. Shannon Walden, Biology Faculty at Montana State University – Great Falls, served as reader on my graduate committee and provided constructive feedback. Members of my MSSE cohort offered value throughout the writing process.

CONCEPTUAL FRAMEWORK

Since the National Science Education Standards were published by the National Research Council (NRC) in 1996, most of the emphasis on science learning has focused on science as inquiry (Carin, Bass, & Contant, 2005; NRC, 1996, 2000). Textbook publishers and teachers have made strides to incorporate inquiry into the process of teaching and learning science by including inquiry activities. However, reading must continue to be an integral part of the science curriculum in order for students to construct

meaning, make connections, and become scientifically literate. With inquiry only, students are not prepared to take high-stakes tests, which require a significant amount of reading (Rupley, 2010; Visone, 2010). In addition, authentic scientific learning employs written text during all phases of experimental inquiry (Greenleaf et al., 2011; Miller, 2006; Yore et al., 2004). Finally, today's workforce requires employees to read and comprehend a significant amount of technical nonfiction text during training, and reading comprehension is considered *very important* by today's employers (National Endowment for the Arts, 2007).

Incorporating reading comprehension in the science classroom is essential to increasing students' understanding and competence in science. Reading strategies have been largely overlooked in high school science classrooms, where teachers assume that students are prepared to read complex text (Snow, 2010). However, the new Common Core State Standards for English and Language Arts (CCSS ELA) specifically address literacy in the content areas, including science. "Reading is critical to building knowledge in history/social studies as well as in science and technical subjects," (National Governors Association Center for Best Practices and Council of Chief State School Officers [NGA Center/CCSSO], 2010, p. 60). Specific reading skills required for students to understand and be able to do include inferring, interpreting meaning, analyzing, evaluating, and citing evidence (NGA Center/CCSSO, 2010). Today's content area teachers are now required to teach these reading skills in addition to their content-specific curriculum.

Unfortunately, most research to date on reading in science has focused on middle school students and is published in journals geared toward reading specialists rather than

science teachers. Because comprehension of scientific concepts is necessary to create a scientifically literate community, a clear integration of inquiry-based lessons and intentional reading activities is needed to improve comprehension by science students (Pine et al., 2006). Students who, during reading, use skills such as “identifying the main idea, recalling details, relating facts, drawing conclusions, and predicting outcomes” (Collins, 1996, p. 3) tend to perform better in all subject areas than those students who are not able to use these skills.

Several reading comprehension strategies implemented in upper primary, secondary, and post-secondary content area classrooms have been shown to increase student understanding, including the K-W-L strategy (Heller, 1986; Ogle, 1986), which uses three-steps for students to self-assess, “what I Know; what I Want to learn; and what I did Learn as a result of reading” (Ogle, 1986, p. 565); PLAN (Caverly, Mandeville, & Nicholson, 1995) where students Predict, Locate, Add, and Note; and SQ3R (Carlston, 2011; Tadlock, 1978) which asks students to Survey, Question, Read, Recite, and Review. The K-W-L strategy was first introduced by Heller (1986) as a metacognitive tool for middle school students to access prior knowledge, develop a focus question that gives purpose to their reading, and assess their ability to answer their focus question. Ogle (1986) named the K-W-L technique and several others have further refined or personalized the K-W-L strategy for different levels of readers (Carr & Ogle, 1987; Glaser, 1999; Huffman, 1998; Sippola, 1995; Szabo, 2006). The PLAN strategy allows students in middle and high school to construct meaning from informational text through the use of concept maps (Caverly et al., 1995; Radcliffe, Caverly, Hand, & Franke, 2008), while SQ3R is a strategy where high school and college students preview text in

order to activate prior knowledge and predict what they will read (Carlston, 2011; Tadlock, 1978). Call (1991) recommends combining the K-W-L and SQ3R strategies to provide students an integrated approach to monitor their reading comprehension and enhance student learning.

Metacognitive reading strategies create active learners as students predict, construct outcomes, and question the text. Boulware-Gooden et al. (2007) found that multiple-metacognitive strategies, which focused on vocabulary acquisition, significantly increased third-grade student understanding during reading. The teachers in this study provided focus questions to their students and modeled metacognitive strategies to question the text, use context with unfamiliar words, and summarize the passage using supporting evidence. Wilson and Smetana (2011) advocated using Questioning as Thinking (QAT), which moved students away from finding the answer “right there” toward students answering questions beyond the text which required activating prior knowledge. By actively questioning and monitoring understanding, students in grades 4 through 12 improved their comprehension through the QAT approach.

Each of these strategies is designed to provide a scaffold to build on prior knowledge and to give students a way to devise a purpose for reading. In order for my students to better understand genetic and evolutionary concepts, they must be able to monitor their own constructs of these concepts, build on the framework established in middle school, and add new information logically and appropriately to that framework (Lewis & Wood-Robinson, 2010; Nelson, 2008). Metacognitive strategies address each of these issues as students interact with the text and take ownership of their learning.

Neufeld (2005) states that “many students benefit from instruction that explicitly teaches them a few research-supported strategies and then, over time, helps them learn to use such strategies in a flexible, coordinated, and self-regulated fashion,” (p. 303).

Veeragavu, Muthusamy, Marimuthu, and Subrayan (2010) found that university students improved their performance on higher level test questions when they were able to activate prior knowledge, preview text, and monitor their comprehension while reading. Intentional reading strategies allow students to do this, while also providing ways for students to summarize the information they read in the text and to determine areas that they need to revisit to better understand them. This metacognitive strategy gives students control over their learning processes and helps them organize their thoughts and use higher level critical thinking to learn about difficult biological concepts (Crowe, Dirks, & Wenderoth, 2008).

As students take control over their learning, how do their attitudes toward learning change? Are students more motivated to learn when they have the necessary tools to construct meaning from what they read? Solheim (2011) concluded that engaged readers were motivated readers and were more likely to perform well on multiple-choice and constructed-response questions that used higher order thinking. Fifth-grade students who perceived themselves as good readers had a positive attitude toward reading and were more proficient readers (Petscher, 2010). Improving students’ self-perceptions in reading comprehension has overarching benefits that include increasing science literacy, improving performance in testing situations, and improving self-perception of reading proficiency (Eklof, 2006; Hagaman, Luschen, & Reid, 2010).

When shifting the focus to teacher attitudes, those teachers who were confident in

their own reading abilities were better able to teach reading strategies to their own students and had a higher level of confidence in their teaching ability (Akyol & Ulusoy, 2009; Conaway, Saxon, & Woods, 2003; Melnick, Henk, & Marinak, 2009). Content area teachers who took the responsibility of teaching reading within the context of their classes expressed a more positive attitude about their instruction (Hall, 2005). These studies indicate that purposeful reading instruction within content areas is beneficial to both students and teachers.

Overall, the research suggests that providing focused metacognitive reading strategies within the content areas leads to improved student understanding of the subject matter. This is especially true in science, where content reading is highly technical and often builds upon prior knowledge. The K-W-L, PLAN, QAR, and SQ3R strategies have all shown to improve reading in the content areas. As content area teachers incorporated reading strategies into their curricula, students were able to think more critically and answer higher order questions in Bloom's Taxonomy. Students' attitudes toward reading improved when they were given both a strategy and purpose for reading, and teachers reported greater confidence when they took the responsibility to incorporate reading strategies into their lessons.

METHODOLOGY

Project Treatment

Students in this project were taught using a non-treatment unit and two subsequent treatment units in order to compare the results of the intervention on their understanding of biological concepts. The non-treatment unit was taught using my

traditional approach, while the treatment unit incorporated specific metacognitive reading strategies. A general timeline for the project can be found in Appendix A.

The non-treatment unit was approximately two weeks long, covering modern genetics, including DNA and RNA structure and function, genetic engineering, and the human genome. I taught this unit with a traditional approach, where students read a total of 46 pages from the textbook using guided reading worksheets such as the example in Appendix B, completed a lab where they modeled DNA transcription and translation, performed a karyotyping activity, analyzed pedigrees, and completed Venn diagrams. Students took a pre-assessment and post-assessment that consisted of multiple-choice and constructed-response questions of varying levels of complexity based on Bloom's Taxonomy. This assessment instrument can be found in Appendix C.

Treatment Unit 1 was three weeks long and covered evolution, including Darwin's theory, the evolution of populations, and the history of life. Students read 44 pages from their textbooks during Treatment Unit 1. Ecology was taught in Treatment Unit 2, which incorporated a three-week period spanning 58 pages in the textbook that included cycles of matter, the biosphere, ecosystems and communities, populations, and renewable and nonrenewable resources. During each of the treatment units, I used specific reading strategies and incorporated heterogeneous group discussions, labs, and computer simulations. The specific reading strategies were used each time students accessed information from the textbook, and students developed higher order focus questions to answer while they read each selected reading assignment. Specific lessons for Treatments 1 and 2 can be found in Appendices D and E, respectively. Each treatment unit had a pre-assessment and post-assessment consisting of multiple-choice

and constructed-response questions of varying levels of complexity (Appendices F and G). Prior to Treatment Unit 1 and after Treatment Unit 2, students completed a reading assessment survey (Appendix H) to compare their reading perceptions prior to and after the intervention.

Treatment 1 began with an activity designed to help students determine what higher order questions look like (Appendix I). Students were given a variety of questions and a set of prompts to determine if the given questions were higher order. In addition, students evaluated the higher-order questions they identified for clarity and purpose. During the next lesson, students began using the What I Know (WIK) sheet (Appendix J), which I modeled using the WIK sheet during reading. With subsequent uses of the WIK sheet, students took increasing control over their use of the WIK sheet while I guided them in their heterogeneous groups. In subsequent lessons during Treatment 1, I introduced Survey, Question, Read, Write, and Review (SQ3R) as a reading strategy (Appendix K), again modeling the use of the strategy with the entire class, then gradually giving students control over their learning. The final strategies that I introduced in Treatment 1 were combined WIK and SQ3R techniques which allowed students to integrate the two reading strategies and to continue becoming more independent readers (Call, 1991). Warm-up activities continued, such as displaying a graphic used the prior day, which helped students recall stored information and develop a higher level purpose question to focus them while they read. Students worked in heterogeneous groups of three to four students to develop their purpose question and to discuss ways to find the answer. As students discussed their purpose for reading, I walked around to listen to their discussions and offer them hints on where they could find potential focus questions.

In the culminating activity of Treatment 1, each group chose two closely related species and showed through heredity, DNA structure, habitat niche, and speciation how the two species diverged from each other.

During Treatment Unit 2, warm-up inquiry activities built upon prior knowledge of the concepts of genetics, heredity, DNA structure, natural selection, and the theory of evolution. During reading activities in this Treatment, students continued using the WIK, SQ3R, or combined strategies depending on the assignment. Students worked collaboratively to create relationships between the concepts and to connect prior learning with ecological principles. During both treatment units, I kept a running list of the focus questions students created during pre-reading. These focus questions were used during the units to allow students to reactivate prior knowledge, to give students the opportunity to extend their learning, and to allow students to make connections with new material.

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.

Data Collection Instruments

Hamilton High School is a large urban public high school with approximately 1,800 grade 10 to 12 students located in the county seat of Butler County, which is located just north of Cincinnati, Ohio. U.S. Census data (2009) indicate that the population of Hamilton was approximately 62,000 people, and the district enrollment for the 2011-2012 school year was 9,436 students (ODE, 2011). Major employers in Hamilton include city and county government entities, Fort Hamilton Hospital, a satellite

campus of Miami University, regional banks, and light and heavy industry, although several factories have closed or relocated during the last 20 years. The U.S. Department of Education has designated Hamilton High School as a medium-high poverty school, and the school received more than \$3.5 million in Title 1 funds in 2008 to provide additional academic support to its students (U.S. Department of Education, 2008). According to the U.S. Census in 2000, 26.7% of Hamilton city residents age 18 or older had not achieved a high school education, and only 12.2% had obtained a four-year degree or higher (U.S. Census Bureau, 2009). While the statistics seem to indicate a low level of educated adults in the community, high school students perform better than students in other comparable Ohio urban schools and achieve state proficiency in all subjects other than science (ODE, 2011).

The students in my study are 47 sophomore biology students in two biology classes in the Community/Technical College Academy (CTA) of Hamilton High School, who have indicated that they plan on attending a community college or enter into an apprenticeship program after graduating from high school. I chose these two classes as a representative sample of the students enrolled in the CTA. An additional class of CTA biology students participated in the intervention, but were not included in the study due to poor attendance during the intervention. The representative sample included an equal number of male and female students, and included white (57%), African American (28%), and Hispanic (15%) students. Students in this academy display a wide range of academic abilities and motivations, and all of the students participated in the non-treatment and treatment units. Based on past classroom performance, I placed students in high, middle, or low achievement groups. I selected six students of varying abilities to

interview individually before, during, and after treatments while I made notes and recorded them (see Appendices L, M, N, and O for all interview questions).

The entire project was conducted over eight weeks, including two weeks of non-treatment and two treatment units spanning three weeks each. A detailed timeline for the project is outlined in Appendix P.

In order to assess my project questions, I collected data that included samples of student work to assess whether they intentionally used the worksheets during non-treatment and reading strategy sheets during treatment; comparative samples to determine how the quality of work by individual students changed during the project; scores of pre and post unit assessments to determine how well students learned the concepts and could apply higher order critical thinking; interviews by selected students to assess their attitudes and motivations about reading during the project; and my personal journal during the project to review my attitudes and observations. The triangulation matrix in Table 1 summarizes data collection instruments used for each focus question. Data were collected from both non-treatment and treatment units for comparison.

Table 1
Triangulation Matrix

Project Questions	Data Source		
	1	2	3
Understanding	Pre and Post unit Assessments	Pre and Post unit Student Interviews	Non-treatment worksheets Treatment WIK sheets Treatment SQ3R activities
Answering High-level Questions	Pre and Post unit Assessments	Pre and Post unit traditional guided worksheets, WIK sheets, and SQ3R activities	Pre and Post unit Student Interviews
Student Attitudes and Motivations	Pre and Post-treatment Student Survey	Pre and Post unit Student Interviews	Teacher Observations
Teacher Attitudes and Motivations	Reflective Journal	Non-treatment and Treatment Peer Observations	Pre and Post-treatment Self-Evaluations

To determine the effects that the specific reading strategies had on student understanding, students were administered assessments prior to and after each non-treatment and treatment unit (Appendices C, F, and G). Data from non-treatment and treatment units were compared to determine the change in student understanding.

I interviewed selected students before and after each unit to assess the level of understanding they achieved. Two high-achieving students, two average students, and two low-achieving students participated in each interview session throughout the project. Student interviews took place during class time when students were working independently, or were administered before or after regularly scheduled class time.

Student interviews used to assess understanding can be found in Appendices M, N, and O.

The instruments that students used during reading activities were analyzed traditionally in non-treatment units and using the rubric in Appendix Q in treatment units to assess whether the instruments were utilized effectively and whether their use led to an increase in student understanding. The information that students wrote on their worksheets was compared to the answers they gave on specific test questions to determine the effect of their use on student understanding.

In order to assess how effective the specific reading strategies were on students' abilities to answer high-order cognitive questions, students took pre and post unit assessments which contained both low- and high-order questions. Pre and post unit interviews were also used to assess students' abilities to answer higher order questions, in conjunction with assessing for student understanding (Appendices M, N, and O).

The effect of the specific reading strategies on student attitudes and motivations was measured through a pre and post treatment reading skills assessment survey (Appendix H). The survey utilized a Likert scale to measure the change in their ability to construct meaning from the textbook in an organized way, their confidence in reading, and their ability to adapt to reading various genre of text. During the project, I kept a journal using prompts (Appendix R) to track student responses, which indicated their attitudes motivations toward performing their reading assignments. Student interviews were used to get feedback regarding students' comfort with using various reading

strategies and the effect of the reading strategies on their motivation to carefully read each assignment.

To assess the effects that employing specific reading strategies had on my attitudes and motivations, I kept a reflective journal that I completed at the end of each class period during the project. The prompts I used during my reflections are in Appendix S. During the pretreatment and treatment phases, I had a peer teacher observe my classes using guided prompts (Appendix T) during times when they used the specific reading strategies, and discussed with her what she observed about my interactions with my students. At the end of the project, I performed a self-evaluation to compare the attitudes I held prior to the intervention with my new attitudes. I used my reflective journal along with the larger questions, “Will I expand this intervention to other units for my students this year, and will I continue employing these strategies in future years, and why or why not?”

The data collected and analyzed in this project were both quantitative and qualitative in order to most effectively determine the effectiveness of the intervention on my students’ understanding, ability to answer high-order questions, change in attitudes and motivations, as well as the change in my attitudes and motivations. Quantitative data in student assessments and student surveys were used to determine the percent change between the non-treatment and treatment units, while qualitative data uncovered trends in attitudes and overall effectiveness of the reading strategies on student understanding and ability to think at higher levels.

DATA AND ANALYSIS

During the project, I collected data during non-treatment and treatment units to determine the efficacy of metacognitive reading strategies in improving student understanding of tenth grade biology concepts. I used a variety of assessment methods to allow for triangulation and validation of the intervention strategies. I will discuss each data collection instrument and correlate each to my project focus questions.

Data from the pre and post unit assessments enabled me to calculate the percent change in understanding of unit concepts, and then compare growth between non-treatment and treatment units. These assessments consisted of six to eight short-answer questions that included both low- and high-cognitive levels based on Bloom's Taxonomy. Table 2 shows the percent change in student scores from pre-assessment to post-assessment for the non-treatment unit as well as the two treatment units.

In both treatment units, students showed overall improvement in their understanding of biology concepts compared to the non-treatment unit. In treatment unit 1, all groups improved their percent increase in comparison to the non-treatment unit, except for the low-achieving students who showed lower percent increase than the non-treatment unit. However, students better explained their answers in the post treatment assessment. For example, a low-achieving student on the non-treatment post-assessment answered several questions using incomplete sentences, such as "Explains who the parents are." Contrastingly, in the post-assessment for treatment unit 1 the same student wrote, "The weather will kill out the leaves with less waxy coating and the leaves with thick waxy coating will survive through the drought." While the student was only partially correct during the both the non-treatment and treatment post-assessments, the

student was able to write a more complete thought after the treatment unit. In the second treatment unit, only students from the high-achieving group improved their scores compared to the non-treatment unit. Once again, I observed an increase in students' ability to explain their thinking. Students in the high-achieving group responded well to the treatment strategies and consistently improved their understanding.

Table 2

Average Scores and Percent Increase from Pre-assessment to Post-assessment for All Units Split into Low-achieving (n=10) Mid-achieving (n=29) High-achieving (n=8) and All Students (N=47)

Group Description	Non-treatment			Treatment 1			Treatment 2		
	Pre-unit	Post-unit	% Change	Pre-unit	Post-unit	% Change	Pre-unit	Post-unit	% Change
Low	2.77	3.88	39.5	6.15	7.44	21.0	5.57	6.89	23.7
Mid	4.52	5.31	17.5	6.92	8.93	29.0	8.30	9.54	15.0
High	5.42	6.00	10.5	8.96	10.9	22.7	9.88	14.6	47.6
All	4.30	5.15	19.6	7.18	8.98	25.0	8.14	9.83	20.7

The other measurements of student understanding that supported my pre and post-assessments were based on interviews conducted with six students, two from each cognitive level, which allowed further insight into student understanding. Table 3 shows the averages for each group of students for all three units. The interview data showed that during the non-treatment unit, most students showed growth. One high-achieving student showed lower growth from the pre-assessment to the post-assessment. In the post unit interview, she was better able to articulate the higher order concepts than the lower order definitions. She demonstrated a high ability to make connections and draw conclusions, but did not always use the correct vocabulary or needed to be reminded of the words. A midlevel student was much more fluent in his vocabulary, could remember from the worksheet where he had learned the concept, and could give specific examples.

A low-level student acquired the vocabulary needed to answer the questions and was able to link concepts together.

Table 3

Scores and Percent Increase from Pre-interview Questions to Post-interview Questions for All Units by Achievement Groups (n=2 for each group)

Achievement Level	Non-treatment			Treatment 1			Treatment 2		
	Pre unit	Post unit	% Change	Pre unit	Post unit	% Change	Pre unit	Post unit	% Change
Low	3	5.5	83	7	7	0	8.5	7.5	-13.3
Mid	7	7.5	7.1	8.5	13	52.9	13	15	15
High	6	5	-17	7	11.5	64	7.5	16	113

During the first treatment unit, interviewed students showed more growth than the non-treatment unit, with the exception of one low-achieving student. The mid and high-achieving groups improved their overall average from the non-treatment unit. The data indicate that the high-achieving group showed the most growth and the low-achieving group showed the lowest growth.

During the second treatment unit, four of the six interviewed students increased their average compared to the non-treatment, with the low-achieving students showing the least improvement. The midachieving students showed moderate growth because one student had prior knowledge of the concepts from seventh grade. The high-achieving students demonstrated high growth and showed complete mastery of the concepts. One low-achieving student and one midachieving student did not increase their percent growth from the non-treatment unit.

After completing the formal interview questions, I asked each student to explain how the questions in the interview related to specific concepts. In the non-treatment unit, students were asked why a pedigree is used to show relationships among family

members. During the pre-unit interview, all students had a difficult time describing how to interpret a pedigree and its importance in genetic relationships. They did not make the connection between a Punnett square and a pedigree. During the post unit assessment, students had a much clearer grasp of the concept. A low-achieving student said, “The circles are girls and the colored circles are girls with a disease.” She was able to write the genotype of the individual, while the other low-achieving student could not. A midachieving student stated, “The colored circle indicates an affected female.” When I asked him to write a Punnett square to demonstrate how the female could have acquired the disease, he was able to correctly locate her parents and complete the Punnett square. A high-achieving student said “The female is homozygous recessive.” She could also give possible genotypes of an unaffected sibling based on the Punnett square that she constructed. Each group of students had the correct idea; however, the high-achieving student was better able to put her thoughts into words and answer the question more completely. A similar pattern was noticed in both the treatment units.

In treatment unit 1 on evolution, students were asked to describe how organisms adapted to a changing environment. In the pre-unit interviews, students were unable to use the term adaptation correctly. Many used the term “adapt” to define adaptation. During the post unit interview both low-achieving students were still unable to describe how an adaptation would arise in a population. One midachieving student responded that it would allow it to survive under changing conditions, while another said it would allow the animal to live in its surroundings. The high-achieving student said, “The turtles changed their bodies over time to survive on the different islands.” When I showed them images of the Galapagos turtles, all students successfully gave three ways that the turtles

were different from one another, but only one student correctly answered that the turtles were no longer able to interbreed because their adaptations resulted in speciation. That high-achieving student went further and said, “If different types of turtles mated, the offspring would come out sterile.” The low-achieving students did not achieve even basic understanding, which was lower than the understanding in the non-treatment unit. The greatest gains were made by the high-achieving students who were able to make the connection between genetics and evolution.

In treatment unit 2 on populations, students were asked to compare the abilities of two cubs from the same litter to reach maturity and produce offspring. During the pre-unit interview, students were quite engaged, especially in the low- and midachieving groups. These two groups really studied the question and made articulate answers about the smaller, weaker cub. However, during the post unit interview, the high-achieving students were better able to describe how the ability to survive and produce offspring was central to “survival of the fittest.” The low- and midachieving students were much less interested during the post unit interview. They indicated only that the smaller cub would die, but did not make the connection between survival and passing favorable genes to the next generation. The low-achieving students had short concise answers, while the midachieving students were fairly uninterested and distracted during the interview.

Finally, to assess student understanding of biological concepts, I compared student work using the non-treatment worksheets and treatment WIK sheets and other treatment activities. Table 4 summarizes student scores using the various non-treatment and treatment reading strategies. During the non-treatment unit, student averages on worksheets were comparable between all cognitive groups. One student in the low-

achieving group caused the average to drop from 91.2 to 78.4. During treatment unit 1, students completed their first WIK sheets as I modeled the strategy with them on the board. Half (five) of the low-achieving students were absent during the first WIK modeling activity, so I modeled the activity a second time two days later using another section of the text. All of the lower level students who had been absent during the first activity were present during this second modeling phase. During the third administration of the WIK sheet, students worked in collaborative heterogeneous groups. Grades on this third WIK activity indicated that high-achieving students responded well to this format, while low-achieving students struggled to determine a purpose for reading and summarize what they had learned while reading the section. During treatment unit 2, low-achieving students continued to struggle in identifying the purpose for reading, summarize what they had read, and provide specific examples of concepts presented in the text.

Table 4

Average Scores on Reading Strategy Instruments for All Units Split into Low-achieving (n=10,) Midachieving (n=29), High-achieving (n=8), and All Student (N=47) Groups

Group Description	Non-treatment	Treatment 1	Treatment 2
Low	78.4*	73.3	69.4
Mid	86.0	82.0	83.3
High	94.8	92.0	98.4
All	86.2	82.2	83.5

Note. One student reduced the average from 91.2 to 78.4.

The results from these three different forms of assessment suggest using metacognitive reading strategies were more effective in assisting high-achieving students in understanding biology concepts than those employed during the non-treatment unit.

Midachieving students experienced gains during treatment unit 1, but not during treatment unit 2. Low achieving students did not benefit from this reading strategy.

My second focus question was to determine if employing metacognitive reading strategies increased understanding in high level cognitive concepts. Students answered low and high level questions on each of their pre and post unit assessments to determine their understanding. Table 5 summarizes the scores of all students answering low and high level questions. During the non-treatment unit and treatment unit 1, I chose two level one questions, which measured comprehension and knowledge of the material, and two level two questions, which asked students to apply and analyze what they learned during the unit. I chose three level one and three level two questions during treatment unit 2. I scored each question pre and post unit to assess gains in understanding and application of the content. Overall, students demonstrated growth in understanding both low and high cognitive questions during non-treatment and treatment.

Table 5

Average Percent Change in Understanding from Pre-assessment to Post-assessment by Question Level in the Class (N=47) and Split into Low-Achieving (n=10), Midachieving (n=29) and High-Achieving (n=8) Groups

Achievement Level and Question Level	Non-treatment			Treatment 1			Treatment 2		
	Pre unit	Post unit	% Change	Pre- unit	Post unit	% Change	Pre unit	Post unit	% Change
Low Level 1	0.6 4	0.7 5	17.2	3.7	3.9	5.4	3.0	4.0	33.3
Mid Level 1	1.0	1.0	0.0	3.8	4.3	13.2	4.4	4.7	6.8
High Level 1	0.7 1	1.3	83.1	3.9	4.3	10.3	4.5	7	55.6
All Level 1	0.9	1	11.1	3.8	4.2	10.5	4.2	5.0	19.0
Low Level 2	0.2	0.9	350	0.8	1.2	50.0	2.3	2.2	(4.3)
Mid Level 2	0.8	1.0	25	0.8	2.1	163	2.9	3.6	24.1
High Level 2	1.0	1.3	30.0	1.6	2.5	56.3	3.3	5.1	54.5
All Level 2	0.7	1.0	42.9	0.9	2.0	122	2.9	3.6	24.1

Note. Level 1 = Knowledge and Comprehension; Level 2 = Application and Analysis.

These findings suggest low-achieving students did not respond to the reading strategies in improving their ability to answer high-level cognitive questions, but showed improvement in answering low-level questions during treatment unit 2. Lower-achieving students may be better served by using the textbook-generated materials to construct knowledge. Midlevel students initially improved their ability to answer high-level cognitive questions, but returned to non-treatment levels of improvement during treatment unit 2. However, midlevel students did show moderate gains in their ability to answer low-level cognitive questions during both treatment units. High-achieving students were better able to construct high-order understanding employing strategies using the metacognitive reading strategies, but showed lower gains in their understanding of lower cognitive concepts.

During the course of the study, I observed ways that students used the non-treatment and treatment classroom worksheets. During non-treatment, students were familiar with the format of the guided reading worksheets and did not struggle in completing the assignments. Several high-achieving students finished their worksheets quickly and spent extra time reading another book or working on assignments from another class. Several midachieving students talked with each other while they completed the reading worksheet, as did many of the low-achieving students. One low-achieving student spent two full days trying to avoid the assignment. When I confronted her, she got defensive but eventually pulled her book out and completed one quarter of the worksheet.

When comparing student answers on the treatment unit WIK sheets, low-achieving students struggled to determine a purpose for reading, make connections with previous knowledge, and summarize what they had learned during the reading. One low-achieving student wrote in the “Purpose for Reading” section, “The purpose for reading is to learn.” The same student wrote in the section titled “What I already knew”, “Darwin’s Theory of Evolution” and “mutation.” In the next column the student wrote terms like “heterozygous,” “gene pool,” and “frequency,” but failed to define or link these terms with her previous knowledge. She had nothing written in the boxes labeled “What I still don’t understand” or “Summary of reading assignment.”

By contrast, a high-achieving student determined her purpose for reading the same section as “to determine the main sources of heritable variation in a population.” She had six terms written in the “What I already knew” column, identified six new terms that she fully defined in the second column, and asked, “What would have happened if

Mendel and Darwin could have worked together?” Her summary stated, “Genes change through mutation. Evolution is defined in genetic terms by genetic variation.” The student demonstrated a high level of metacognitive thought processing as she read the section and constructed new knowledge using prior knowledge. She also recognized the historical perspective of the timing of Darwin’s theory and Mendel’s genetic breakthroughs.

I interviewed these same two low- and high-achieving students to determine how effective the strategy was to understanding high-level cognitive questions. The low-achieving student showed a greater understanding of low-level cognitive concepts using the non-treatment worksheet, but not during treatment. The student did not improve in understanding high-level cognitive questions during either non-treatment or treatment. The high-achieving student improved in understanding all levels of cognition, but showed greater gains in understanding high-level cognitive questions during the treatment. During the treatment unit, results indicated that the high-achieving students were better able to answer questions correctly. This trend was also observed during the non-treatment unit.

Students completed a reading skills survey pre and post treatment to determine the effects of metacognitive reading strategies on their attitudes and motivation. Students were asked to take a pretreatment and post treatment survey in order to judge their attitudes and motivation about reading in science. The survey questions asked students to rate the difficulty they had in finding the main idea, their confidence in using vocabulary to strengthen reading skills, whether they pay attention while they read, their ability to interpret charts and graphs, and their confidence while reading the science textbook. All

students indicated during the pre and post treatment surveys that they were usually or always able to interpret charts and graphs. Low-achieving students showed the greatest gains in their attitudes during the treatment, especially in their confidence in understanding vocabulary, as shown in Figure 1.

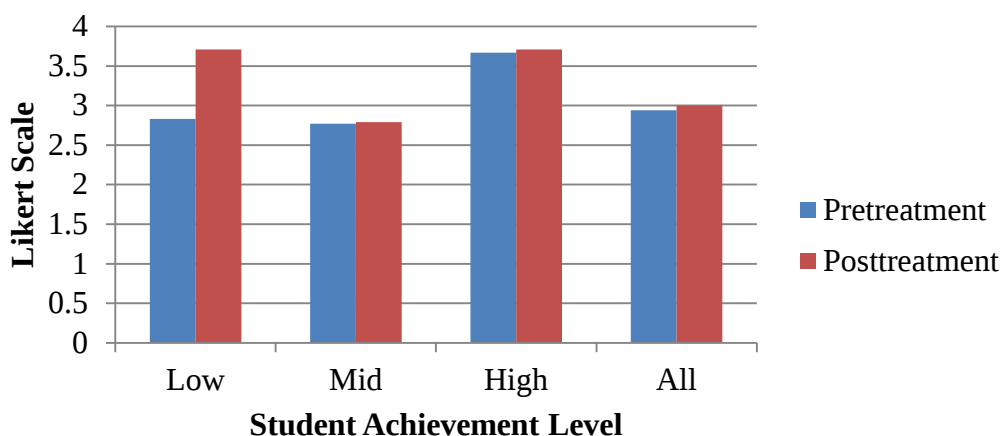


Figure 1. Comparison of average scores on pretreatment and post treatment student surveys to measure confidence in using reading and vocabulary skills. Low-achieving students ($n=10$), midachieving students ($n=29$), high-achieving students ($n=8$), all students ($N=47$).

Note. Likert scale 4=always, 3=usually, 2=sometimes, 1=rarely.

Low-achieving students also indicated increased confidence in reading the science textbook, while high achievers' confidence decreased over the course of the project (Figure 2). Midlevel students demonstrated moderate gains in their attitudes regarding reading and vocabulary. High-achieving students also indicated that they were more likely to go into autopilot while reading in the post treatment survey. Detailed data of each survey question can be found in Appendix U.

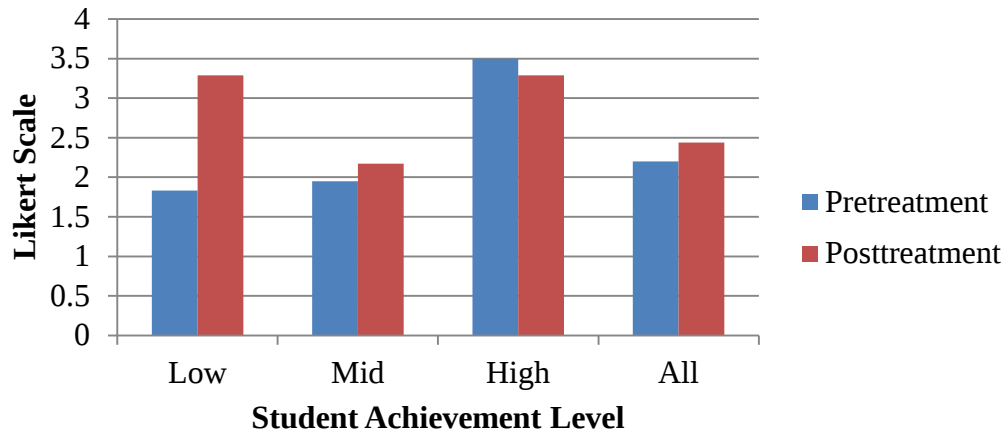


Figure 2. Comparison of average scores on pretreatment and post treatment student surveys to measure confidence in reading the science textbook. Low-achieving students ($n=10$), midachieving students ($n=29$), high-achieving students ($n=8$), all students ($N=47$).

Note. Likert scale 4=always, 3=usually, 2=sometimes, 1=rarely.

To measure student motivation, I asked students about the strategies they used while reading. Students were asked to rate the likelihood of creating a reading plan, pre-reading the section, using context clues while reading, employing a variety of reading strategies, and connecting the reading to their previous knowledge. The low- and midachieving students were more likely to create a reading plan (Figure 3) and use context clues during reading (Figure 4) when surveyed post treatment, while the high-achieving students indicated that they were less likely to create a reading plan or use context clues.

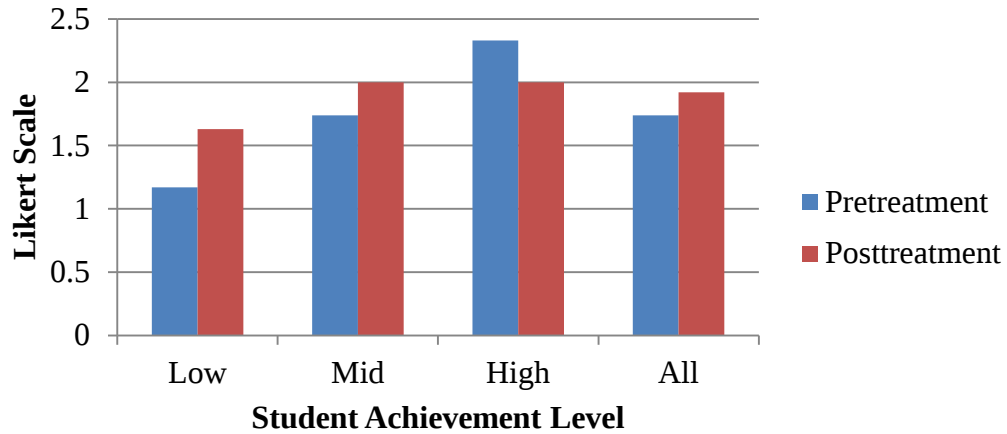


Figure 3. Comparison of average scores on pretreatment and post treatment student surveys to measure student motivation in creating a reading plan. Low-achieving students ($n=10$), midachieving students ($n=29$), high-achieving students ($n=8$), all students ($N=47$).

Note. Likert scale 4=always, 3=usually, 2=sometimes, 1=rarely.

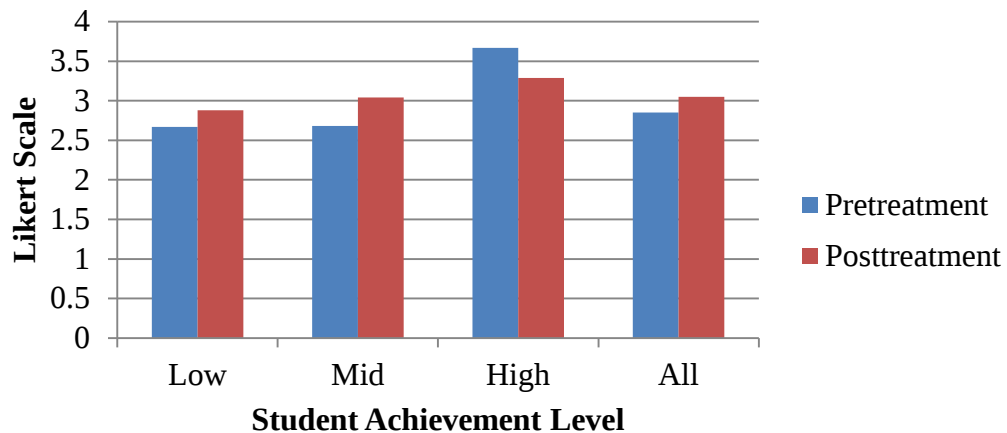


Figure 4. Comparison of average scores on pretreatment and post treatment student surveys to measure student motivation in using context clues. Low-achieving students ($n=10$), midachieving students ($n=29$), high-achieving students ($n=8$), all students ($N=47$).

Note. Likert scale 4=always, 3=usually, 2=sometimes, 1=rarely.

As a group, students indicated that they were more likely to pre-read a section before completing an assignment; however, students indicated that they were less likely to use a variety of reading strategies while reading compared to pretreatment, perhaps because they got better at using the WIK sheets during the course of the treatment. Only the high-achieving students were more likely to connect current reading with previous knowledge compared to the pretreatment survey. Interestingly, Figure 5 illustrates that the gains were so great in this group that the results for all students indicated an overall increase in the ability to connect new knowledge with previous concepts. Refer to Appendix V to view detailed results of the student survey on student motivations.

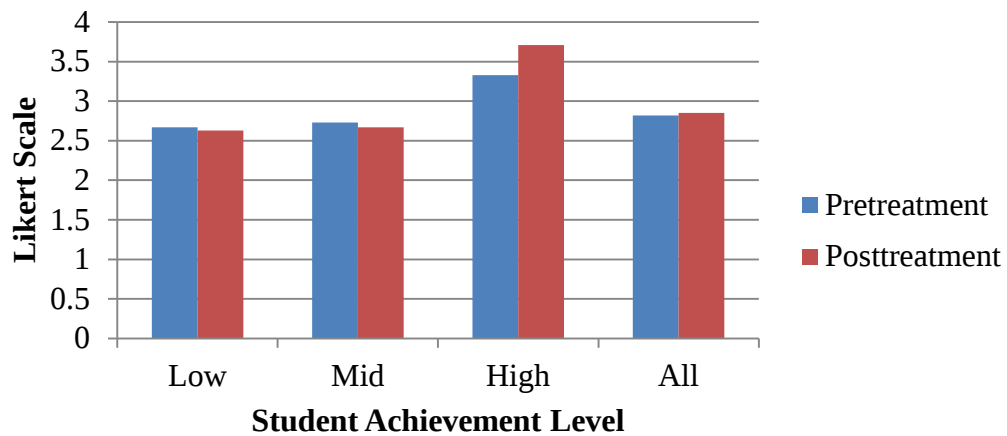


Figure 5. Comparison of average scores on pretreatment and post treatment student surveys to measure student motivation in connecting new information with previous knowledge. Low-achieving students ($n=10$), midachieving students ($n=29$), high-achieving students ($n=8$), all students ($N=47$).

Note. Likert scale 4=always, 3=usually, 2=sometimes, 1=rarely.

During student interviews, their attitudes were overall negative when asked about the treatment reading strategy. While students of all achievement levels thought the pretreatment worksheets were “easy” or “boring,” most were initially quite frustrated

when we switched to the WIK sheets. This was especially true among low-achieving students, even when they were paired with a higher achieving student. Only three students specifically stated that they preferred the WIK sheet to the guided reading sheet, and all three students were in the high-achieving group. Students grew weary of using this strategy multiple times in a row. When I showed them the different reading strategies we used during the non-treatment and treatment units, most of the low- and midachieving students preferred the non-treatment instrument, although several mid and high-level students preferred when I modified the WIK sheet into triangles rather than columns. They did not initially recognize that this was the same strategy. While many students could see the benefit of being more metacognitively aware of what they understood, they wanted me to remind them of what they already knew about the content. The reading strategy had a negative impact on their level of enjoyment in class and their motivation to fully develop their own thoughts on the WIK sheets.

The final focus sub question in this project was to determine the effect of metacognitive reading strategies on my attitudes and motivation as a teacher. To answer this question, I used a reflective journal, peer observations, and a self-evaluation throughout the non-treatment and treatment units. During each unit, I reflected on my attitudes and motivation each time my students completed a reading activity. I noted that during the treatment units, I more completely read the textbook in order to help students complete the WIK sheets. During non-treatment, I had only looked for the answers in the guided worksheets while I read the text. As a result, I felt more prepared to assist students in going further and questioning the text during treatment than I did during non-treatment. However, I got frustrated during treatment because students were unable or

unwilling to make connections with what they already knew before reading the section. Student complaints increased during the treatment phase because we were doing things differently and my expectations for them changed. However, one high-achieving student kept me motivated because he really thrived while using the WIK sheets and integrated his prior knowledge while employing the new reading strategy. I reflected during treatment 2, “He really gets it! He sees the mechanism for evolution and how populations shift when Hardy –Weinberg equilibrium is upset. Yeah!”

A peer observed my class to measure my attitude during non-treatment and treatment. She indicated that students were more on-task during treatment, and that I had to remind students less often to get back to work. She observed me interacting more with students and asking them questions about what they already knew, rather than just show them where to find the answer in the book. She noted that when we met after class, I was much more interested in how students interacted during class than during non-treatment. During my self-evaluation, I recognized that I was much better able to engage my high-achieving students than during non-treatment, but that low-achieving students needed alternative strategies to facilitate their learning.

To address the question, “what motivates me to keep or change this lesson plan?” I wrote after all but one non-treatment lesson that I would start by activating prior knowledge to get students started with the lesson. During three of the first seven treatment reading assignments, I reflected that students did not have sufficient prior knowledge to fully understand the current assignment and had difficulty determining their purpose for reading. I realized that while significant improvements in student learning is possible, I need to continue strategizing ways to differentiate learning in the

classroom to meet the needs of all students and learning styles. It motivated me to do additional research to determine how best to serve all of my students in one learning environment using a variety of methods. I realized that learning is not “one size fits all,” regardless of the strategy.

INTERPRETATION AND CONCLUSION

During the course of the project, my quantitative and qualitative data showed that high-achieving students responded well to metacognitive reading strategies and were successful in transferring their knowledge to new situations during assessments. Average students increased their understanding using metacognitive reading strategies, but at a lower rate than the high-achieving students. Low-achieving students generally did not respond to treatment and achieved lower gains in understanding using the intervention strategy. Students in the lower achievement group were generally unable or unwilling to effectively use the reading strategy, and were more likely to struggle in achievement on assessments. However, the qualitative data suggest that these lower students greatly improved their confidence in reading and were more likely to pre-read a section before completing a reading assignment. The average and lower level students may need continued exposure to these reading strategies to become proficient in their use, which could produce a long-term increase in achievement.

In answering high-order questions, low-achieving students did not improve in their ability to answer application and analysis questions. Midachieving students initially made great gains in their ability to apply and analyze, but their gains reverted to non-treatment levels later in the intervention. High-achieving students continued to show

growth in their ability to answer high-order questions, indicating that this subgroup most successfully adapted to using these reading strategies during the intervention.

During treatment, results indicate that I improved my attitudes and motivations for implementing metacognitive reading strategies. As students learned how to use the new tools for reading science text, I noticed an improvement in students' time-on-task, especially in the high-achieving group. Overall, my attitude improved during the intervention because we were no longer simply going through the motions during assignments. This motivated me to continue to utilize these strategies and create more independent learners.

The goals in the Common Core State Standards for English Language Arts indicate that students need confidence and independence while reading complex informational text (CCSSO/NGA, 2010). As part of the implementation of the new standards, content area teachers will assume more responsibility for modeling and promoting reading strategies to achieve these goals. Incorporating intentional reading strategies such as the ones I implemented during my project are important and vital to producing students who are college and career ready.

After my project was implemented, the following is an example of one of my classroom lessons. "Students, today we are going to discover what we already know about DNA. Let's start with the acronym 'DNA'. On the WIK (What I Know) sheet in front of you, write the word 'DNA' in either the first box if you can define it, or in the second box if you thought to yourself, 'DNA means Don't Know Anything!'" Several students look up with grins on their faces. Aha! "Now, open up your books to page 244

and note the section heading and key concepts. Again, write these key concepts in the appropriate box based on what you know about them.”

In the above narration, the difference between the non-treatment and treatment units was not the material that students learned, but rather the strategy I gave them to learn. By giving my students a way to monitor their learning and self-assess what they already understood, it allowed them more freedom to build upon their prior knowledge. In this instance, a targeted WIK sheet provided my students a tool they used to become owners of their knowledge and to have understanding of scientific concepts.

VALUE

During this project, I did not initially see the significance in the strategies I used with my students. I realized I was changing the way that I taught, but could not properly reflect on the value of this project on my students, the school, or me personally.

However, students took the state graduation test two weeks after the intervention was complete, and the results of the state test astonished me. During the previous two administrations of the state tests, my students had pass rates of 55% and 58% in science, respectively. During this year’s test, 72% of my students passed the science portion of the Ohio Graduation Test. Other teachers in my school who teach the same level students did not see increases in their student pass rates. Looking at these numbers by ability level, the high-achieving students had a 75% pass rate, mid-achieving student had a 79% pass rate, and 50% of low-achieving students passed the exam.

The implications of this increase are profound. I believe that my students, especially in the mid-achieving group, thought more critically about what was being

asked of them and how to better construct their answers. With metacognitive reading strategies, students were able to apply their existing knowledge base to novel questions, with improved scores. While the results of the short intervention were unremarkable for the mid-achieving group, the long term benefits are realized when asking the question, “Are my students’ career and/or college ready?”

I also realized during this project that my students have wide reading abilities which are largely determined by their motivation to sit and read. Those students who took the time to read the textbook were also the ones with higher attention spans and who exhibited higher levels of self-control. The readers were much more likely to be in the high – or midachieving ability levels. Those students who were not motivated to sit and read were ones who were fidgety, easily distracted, and more likely to score lower on the post-assessments. Reading is a learned behavior and so are the traits that determine whether students are able to pay attention long enough to complete the assignment. In the future, I will address the behaviors that lead to higher success in reading, and create a classroom environment that is conducive to quiet reading.

As a result of this intervention, the school administrators have asked me to present these reading strategies to other teachers at my school. This presentation will coincide with the rollout of the new Common Core State Standards, where reading in the content areas and understanding informational text becomes the emphasis. As the English/Language Arts curriculum shifts away from fiction, content area teachers must be ready to pick up these strands in the curriculum to better prepare students for careers and college. I am honored that my school’s administration supported my work during this project and recognized the benefits it reaped for my students. I look forward to

working with other teachers to help them prepare their students for the new curricular demands.

The next step for me and my students is to begin next year using metacognitive reading strategies. Rather than changing course midyear, I plan on getting students accustomed to using critical thinking skills and reading strategies during the first week of instruction. With the implementation of the new science curriculum, this will afford me the opportunity to analyze the lessons I have been using with my students and determine whether they truly promote critical thinking. I will also administer the reading skills survey at the beginning of the year, to determine student attitudes and motivations as they enter tenth grade.

I will be co-teaching with intervention specialists in my two biology classes during the upcoming school year. With these teachers, we plan to identify students who struggle with reading and work together to promote reading in science. These specialists will bring another set of experiences and strategies into my classroom, which I believe can only build on the small intervention I implemented this year.

As I reflect over this entire project, I realize that I chose a difficult intervention, but one that could only lead to improvements in student learning. I learned about reading strategies for the first time, which is not usually covered while preparing preservice science teachers. I had tried new strategies before, but never had concrete data to determine the effects of the new strategy. This project improved me as a teacher because I now have the resources to measure how a particular change in instruction impacts student learning.

REFERENCES CITED

- Akyol, H. & Ulusoy, M. (2009). Pre-service teachers' use of reading strategies in their own readings and future classrooms. *Teaching and Teacher Education*, 26, 878-884.
- Barton, L.G. (1997). *Quick flip questions for critical thinking*. Dana Point: Edupress, Inc.
- Boulware-Gooden, R., Carreker, S., Thornhill, A., & Maletesha Joshi, R. (2007). Instruction of metacognitive strategies enhances reading comprehension and vocabulary achievement of third-grade students. *The Reading Teacher* 61(1), 70-77.
- Call, P.E. (1991). SQ3R + what I know sheet = one strong strategy. *Journal of Reading*, 35(1), 50-52.
- Carin, A.A., Bass, J.E., & Contant, T.L. (2005). *Methods for teaching science as inquiry*. (9th ed.). Upper Saddle River: Pearson Prentice Hall.
- Carlston, D.L. (2011). Benefits of student-generated note packets: A preliminary investigation of SQ3R implementation. *Teaching of Psychology*, 38(3), 142-146.
- Carr, E. & Ogle, D. (1987). K-W-L plus: A strategy for comprehension and summarization. *Journal of Reading*, 30(7), 626-631.
- Caverly, D.C., Mandeville, T.F., & Nicholson, S.A. (1995). PLAN: A study-reading strategy for informational text. *Journal of Adolescent & Adult Literacy*, 39(3), 190-199.
- Collins, N.D. (1996). Motivating low performing adolescent readers. *ERIC Digest*. Retrieved on February 26, 2011 from <http://www.eric.ed.gov/PDFS/ED396265.pdf>.
- Conaway, B.J., Saxon, T.F., & Woods, M.B. (2003). A comparison of the reading abilities of teacher candidates. *The Teacher Educator*, 39(1), 1-17.
- Crowe, A., Dirks, C., & Wenderoth, M.P. (2008). Biology in bloom: Implementing Bloom's taxonomy to enhance student learning in biology. *CBE – Life Sciences Education*, 7, 368-381.

- Eklof, H. (2006). Development and validation of scores from an instrument measuring student test-taking motivation. *Educational and Psychological Measurement*, 66(4), 643-656.
- Glazer, S.M. (1999). Using KWL Folders: A three-section folder to encourage an independent working environment for children. *Teaching Pre K-8*, 29(4), 106-107.
- Greenleaf, C.L., Litman, C., Hanson, T.L., Rosen, R., Boscardin, C.K., Herman, J., et al. (2011). Integrating literacy and science in biology: Teaching and learning impacts of reading apprenticeship professional development. *American Educational Research Journal*, 48(3), 647-717.
- Hagaman, J.L. Luschen, K., & Reid, R. (2010). The “RAP” on reading comprehension. *Teaching Exceptional Children*, 43(1), 22-29.
- Hall, L.A. (2005). Teachers and content area reading: Attitudes, beliefs and change. *Teaching and Teacher Education*, 21, 403–414.
- Heller, M.F. (1986). How do you know what you know? Metacognitive modeling in the content areas. *Journal of Reading*, 29(5), 415-422.
- Huffman, L.E. (1998). Spotlighting specifics by combining focus questions with K-W-L. *Journal of Adolescent & Adult Literacy*, 41(6), 470-472.
- Jacobs, J.E. & Paris, S.G. (1987). Children’s metacognition about reading: Issues in definition, measurement, and instruction. *Educational Psychologist*, 22(3 & 4), 255-278.
- Lewis, J. & Wood-Robinson, C. (2000). Genes, chromosomes, cell division and inheritance - do students see any relationship? *International Journal of Science Education*, 22(2), 177-195.
- Melnick, S.S., Henk, W.A., & Marinak, B.A. (2009). Validation of a reader self-perception scale (RSPS2) for use in grades 7 and above. Paper presented at the annual meeting of the Northeastern Educational Research Association, Rocky Hill, CT
- Miller, R.G. (2006). Unlocking reading comprehension with key science inquiry skills. *Science Scope*, Sept. 2006, 30-33.
- Miller, K.R., & Levine, J. (2008). *Prentice hall biology*. Upper Saddle Ridge: Pearson Prentice Hall.

National Endowment for the Arts. (2007). *To read or not to read: a question of national consequence*. (Research Report #47). Washington, DC: Office of Research & Analysis.

National Governors Association Center for Best Practices & Council of Chief State School Officers. (2010). *Common core state standards for English language arts & literacy in history/social studies, science, and technical subjects*. Retrieved April 2, 2012 from http://www.corestandards.org/assets/CCSSI_ELA%20Standards.pdf.

National Research Council. (1996). *National science education standards*. Washington, DC: National Academy Press.

National Research Council. (2000). *Inquiry and the national science education standards: A guide for teaching and learning*. Washington, DC: National Academy Press.

Nelson, C.E. (2008). Teaching evolution (and all of biology) more effectively: strategies for engagement, critical reasoning, and confronting misconceptions. *Integrative and Comparative Biology*, 48(2), 213–225.

Neufeld, P. (2005). Comprehension instruction in content area classes. *The Reading Teacher*, 59(4), 302-312.

Ogle, D.M. (1986). K-W-L: A teaching model that develops active reading of expository text. *The Reading Teacher*, 39(6), 564-570.

Ohio Department of Education. (2009). *Ohio graduation tests: science*. p. 23.

Ohio Department of Education. (2010). *Frequently asked questions about the Ohio graduation tests*. Retrieved February 26, 2011 from <http://www.ode.state.oh.us/GD/Templates/Pages/ODE/ODEDetail.aspx?page=3&TopicRelationID=216&ContentID=4904&Content=86709>

Ohio Department of Education. (2011). *2010-2011 School report card: Hamilton high school, Butler county*. Retrieved September 24, 2011 from <http://www.ode.state.oh.us/reportcardfiles/2010-2011/BUILD/036822.pdf>.

Petscher, Y. (2010). A meta-analysis of the relationship between student attitudes towards reading and achievement in reading. *Journal of Research in Reading*, 33(4), 335-355.

- Pine, J., Aschbacher, P., Roth, E., Jones, M., McPhee, C., Martin, C. et al. (2006). Fifth graders' science inquiry abilities: A comparative study of students in hands-on and textbook curricula. *Journal of Research in Science Teaching*, 43(5), 467-484.
- Radcliffe, R., Caverly, D., Hand, J., & Franke, D. (2008). Improving reading in a middle school science classroom. *Journal of Adolescent & Adult Literacy*, 51(5), 398-408.
- Rupley, W.H. (2010). Linking reading and science: Focusing on a broader base of understanding. *Reading Psychology*, 31(3), 203-205.
- Sippola, A.E. (1995). K-W-L-S. *The Reading Teacher*, 48(6), 542-543.
- Snow, C.E. (2010). Academic language and the challenge of reading for learning about science. *Science*, 328, 450-452.
- Solheim, O.J. (2011). The impact of reading self-efficacy and task value on reading comprehension scores in different item formats. *Reading Psychology*, 32(1), 1-27.
- Szabo, S. (2006). KWHHL: A student-driven evolution of the KWL. *American Secondary Education*, 34(3), 57-67.
- Tadlock, D.F. (1978). SQ3R – Why it works, based on an information processing theory of learning. *Journal of Reading*, 22(2), 110-112.
- U.S. Census Bureau. (2009). State and county quick facts: Hamilton (city) Ohio. Retrieved on October 15, 2011 from <http://quickfacts.census.gov/qfd/states/39/3933012.html>.
- U.S. Department of Education. (2008). Fiscal year 2008 Title I grants to local educational agencies – Ohio. Retrieved on October 15, 2011 from <http://www2.ed.gov/about/overview/budget/titlei/fy08/ohio.pdf>.
- Veeragavu, J., Muthusamy, C., Marimuthu, R., & Subrayan, A. (2010). Using Bloom's taxonomy to gauge students' reading comprehension performance. *Canadian Social Science*, 6(3), 205-212.
- Visone, J.D. (2010). Science or reading: What is being measured by standardized tests? *American Secondary Education*, 39(1), 95-112.
- Wilson, N.S. & Smetana, L. (2011). Questioning as thinking: A metacognitive framework to improve comprehension of expository text. *Literacy*, 45(2), 84-90.

Wong, L. (2009). *Essential study skills* (6th ed). Boston: Houghton Mifflin Company.

Yore, L.D., Hand, B., Goldman, S.R., Hildebrand, G.M., Osborne, J.F., Treagust, D.F. et al. (2004). New directions in language and science education research. *Reading Research Quarterly*, 39(3), 347-352.

APPENDICES

APPENDIX A

OVERALL TIMELINE FOR IMPLEMENTATION

Appendix A
Overall Timeline for Implementation

Start Project Implementation: January 6, 2012

January 6, 2012: Non-treatment, 2 weeks – DNA & RNA; Genetic Engineering; The Human Genome (Modern Genetics)

January 23, 2012: Treatment Unit 1, 3 weeks – Darwin's Theory of Evolution; Evolution of Populations; The History of Life (Evolution)

February 13, 2012: Treatment Unit 2, 3 weeks – The Biosphere; Ecosystems & Communities; Populations; Renewable and Non-renewable Resources (Ecology)

Complete Project Implementation: March 1, 2012

APPENDIX B

NONTREATMENT GUIDED READING WORKSHEET

Appendix B
Non-treatment Guided Reading Worksheet

Section 12-3 RNA and Protein Synthesis
(pages 300-306)

Key Concepts – write the three key concepts for Section 12-3.

- _____
- _____
- _____

The Structure of RNA (page 300)

1. List the three main differences between RNA and DNA.
 - a. _____
 - b. _____
 - c. _____
2. Why is it important for a cell to be able to copy a single DNA sequence into RNA?

Types of RNA (pages 300-301)

3. What is the main job for most RNA molecules?

4. Complete the table about the types of RNA.

TYPES OF RNA

Type	Function
Messenger RNA	
Ribosomal RNA	
Transfer RNA	

Transcription (page 301)

5. What is transcription? _____

6. Where in the cell does transcription take place? _____

The Genetic Code (pages 302-303)

7. Proteins are made by joining _____ into long chains called polypeptides.

8. How can only four bases in RNA carry instructions for 20 different amino acids?

9. What is a codon?

10. How many possible three-base codons are there? _____

Is the following sentence true or false? All amino acids are specified by only one codon. _____

11. Use Figure 12-17 in your book to determine the letter of the codon that serves as the “start” codon for protein synthesis.

a. UGA b. UAA c. UAG d. AUG

Translation (pages 303-305)

12. What occurs during the process of translation?

13. Where does translation take place?

The Roles of RNA and DNA (page 306)

Match the roles with the molecules. Molecules may be used more than once.

Roles	Molecules
_____ 14. Master plan	a. DNA
_____ 15. Goes to the ribosomes in the cytoplasm	b. RNA
_____ 16. Blueprint	

_____ 17. Remains in the nucleus

Genes and Proteins (page 306)

18. Many proteins are _____, which catalyze and regulate chemical reactions.

19. Is the following sentence true or false? Genes are the keys to almost everything that living cells do. _____

Adapted from Prentice Hall Biology, 2008

Miller, K.R., & Levine, J. (2008). *Prentice hall biology*. Upper Saddle Ridge: Pearson Prentice Hall.

APPENDIX C

PRE AND POSTASSESSMENT OF CONSTRUCTED RESPONSE QUESTIONS FOR
NONTREATMENT UNIT

Appendix C

Pre and Post unit Assessment for Constructed Response Questions – Non-treatment Unit

1. Give one example of each type of organic compound that is found in living organisms.
- | | |
|---------------|--------|
| carbohydrates | lipids |
|---------------|--------|

nucleic acids

proteins

Use the following information to answer questions 2 and 3.

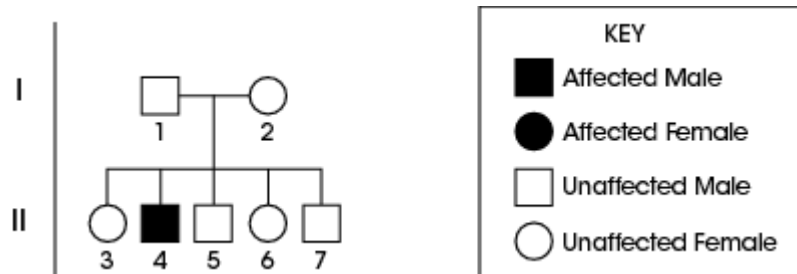
Gregor Johann Mendel was an Austrian monk who is considered to be the father of genetics. In the 1850s Mendel began doing experiments on pea plants. In one experiment, Mendel took one pea plant with smooth seeds and crossed it with another pea plant with wrinkled seeds. Then, he looked at the offspring from this cross. He found that all of the offspring produced only smooth seeds.

- Why did the offspring of Mendel's cross all have smooth seeds? Draw a Punnett square to explain your answer.
- After doing the initial cross with smooth and wrinkled seeds, Mendel then took the offspring (all smooth) and crossed them with each other. If Mendel looked at 300 seeds in the next generation, approximately how many seeds would you expect to show each trait? Draw a Punnett square to explain your answer.

4. John has one recessive allele for blue eyes (b) and one dominant allele for brown eyes (B). Amy also has one recessive allele for blue eyes and one dominant allele for brown eyes. What phenotype is an offspring of John and Amy most likely to express? Use a Punnett square to explain your answer.

5. Sex chromosomes are indicated by the letters X and Y. The 23rd pair of chromosomes in a female is XX, while this pair in a male is XY. The male gamete determines the sex of the offspring. What percentage of a population is likely to be male? Use a Punnett square to explain your answer.

6. The pedigree below shows the inheritance pattern of a recessive allele (z) that results in a genetic disease.



Ohio Department of Education. (2009). Ohio graduation tests – science. p. 23.

Based on the inheritance pattern, what are all the possible genotypes for individual 6?

APPENDIX D

LESSON PLAN FOR TREATMENT UNIT 1

Appendix D
Lesson Plan for Treatment Unit 1
Reading about Darwin's Theory of Evolution

Objectives:

- Introduce WIK Sheet to students
- Model metacognitive reading strategies using Darwin's Theory of Evolution, Chapter 15-1 in Prentice Hall Biology

Teacher Notes:

- Use the topic of Darwin's Theory of Evolution as a way to determine what students already know about this topic
- Students will probably have some prior knowledge, but may also have misconceptions about the theory
- Use the WIK sheet to model metacognitive reading strategies
- Help students determine a purpose for reading this section – it may be a way to address misconceptions or validate their prior knowledge – and write their focus question at the top of the page
- Work with students to fill in the first column with items they already know about Darwin's Theory
- Preread the chapter section by pointing out headings, vocabulary, images, and diagrams located throughout the section
- Read the section aloud, stopping frequently to question the text, make connections with previous knowledge, and fill in the second column "What I Now Know"
- Once the section has been thoroughly investigated, now would be a good place to determine what parts students still do not fully understand and fill in the third column "What I Still Don't Understand"
- Point out that this is just the first section of the chapter, and these questions may be uncovered in subsequent sections. This will create anticipation for further reading assignments
- Work with students to summarize what they learned at the bottom of the WIK sheet
- Collect student sheets to check for understanding of the techniques, concepts, and strategies modeled using this reading strategy

APPENDIX E

LESSON PLAN FOR TREATMENT UNIT 2

Appendix E
Lesson Plan for Treatment Unit 2
Reading About Factors that Limit Growth of Populations

Objectives:

- Use the SQ3R reading strategy as they learn about limiting factors
- Allow students to create test questions after reading about factors that limit growth, Chapter 5-2 in Prentice Hall Biology

Teacher Notes:

- Students should be familiar with metacognitive reading strategies that have been used over the last three weeks
- Students will work in small heterogeneous groups (teacher will choose groups)
- Students will change each heading into a question, then answer these questions as they read
- Teacher will walk around and assist students as they read and discuss the assignment
- Point out that students can predict the impact that each factor will have on population changes using their prior knowledge
- When reading is complete, have each student group devise a scenario about how populations could be impacted by a limiting factor.
- Student groups will exchange scenarios and answer each other's questions
- Teacher will collect student work
- Teacher will evaluate student scenarios to check for understanding

APPENDIX F

PRE AND POSTASSESSMENT OF CONSTRUCTED RESPONSE QUESTIONS FOR
TREATMENT UNIT 1

Appendix F

Pre and Post-assessment of Constructed Response Questions for Treatment Unit 1

Use the diagram below to answer questions 1-3.

[Diagram has a map of the Galapagos Islands, with pictures of each tortoise species that inhabits the particular islands.]

1. What three differences are apparent in the bodies of the three tortoise species shown in Figure 1?
2. Vegetation on Hood Island is sparse and sometimes hard to reach. How might the vegetation have affected the evolution of the Hood Island tortoise shown in Figure 1?
3. Considering the body structures of the tortoises shown in Figure 1, which tortoises—a population from Pinta Island or a population from Isabela Island—might survive more successfully on Hood Island? Why?
4. Most of the plants in a population have leaves with no coating, but a few individuals have leaves with a thick, waxy coating. The area in which the population lives experiences three successive years of severe drought. Explain how the drought will affect the variation in the population.

Use the diagram to answer questions 5-6.

[Diagram depicts homologous species on a cladogram. At the bottom of the tree is a primitive fish. One branch on the tree above the primitive fish depicts a turtle, and an additional branch from the turtle that includes alligators and birds. A separate branch from the primitive fish has mammals.]

5. Homologous structures are structures that have different forms in mature adults but develop from the same structures in embryos (unborn offspring). The diagram above shows the limbs of four modern organisms. Based on the diagram, describe how the organisms are related to each other.

6. Which two modern organisms are most closely related to each other? Explain your answer.

APPENDIX G

PRE AND POSTASSESSMENT OF CONSTRUCTED RESPONSE QUESTIONS FOR
TREATMENT UNIT 2

Appendix G

Pre and Post-assessment of Constructed Response Questions for Treatment Unit 2

1. Within a fish species, variations exist in color, size, and the speed at which individuals can swim. Describe how each of these variations can lead to an increased chance of survival on the individual.
2. Many animals that live in forests or jungles have stripes or spots on their fur. How does an animal's pattern on its fur represent a successful adaptation?
3. A bear produces two offspring. One of the cubs is smaller than normal and has difficulty digesting food. What is likely to happen to the two bear cubs? Discuss their abilities to reach maturity and produce offspring.

Use the information and tables to answer question 4-5.

Peppered Moths

The British peppered moth, *Biston betularia*, occurs in two colorations: light (mixed black and white) and black. Black coloration was first seen in 18th-century moth collections as a rare, highly prized mutant. Black coloration is controlled primarily by a single, dominant gene.

Before 1850, the overwhelming majority of peppered moths in northern England were light. As the Industrial Revolution swept through northern England, however, light moth populations dwindled as black moth populations grew. Overall, the total peppered moth numbers remained steady.

Peppered Moths in England

Year	Black Moths (%)	Light Moths (%)
1850	10	90
1900	90	10
1996	8	92

In the same time period, the less industrialized rural England saw no such changes in moth populations. The only predators observed to prey on the moths were local birds. No migratory or population changes of birds occurred during that time.

British naturalist H.B.D. Kettlewell captured, marked and released known numbers of black and light-peppered moths in an unpolluted woodland and two similar groups in a polluted woodland. He later recaptured as many moths as possible. The following are some of Kettlewell's mark- and-recapture data.

Dorset, England (Unpolluted Woodland)

	Black Moths	Light Moths
Marked and Released	473	496
Recaptured	30	62
Percent Recaptured	6%	12%

Birmingham, England (Soot-blackened Woodland)

	Black Moths	Light Moths
Marked and Released	447	137
Recaptured	123	18
Percent Recaptured	27%	13%

- What is the most likely reason for the increased growth in populations of dark-colored variations of the peppered moth between 1850-1900? Use information from the tables above to support your answer.
- If you were to go outside and search for peppered moths today, which variation are you most likely to observe? Explain the reason for your answer, using information from the data above and your understanding of current environmental conditions.

6. Some species of disease-causing bacteria which could be killed by penicillin 50 years ago, today cannot be destroyed by this drug. Explain the mechanism that allows this to happen.

APPENDIX H

READING SKILLS ASSESSMENT SURVEY

Appendix H

Reading Skills Assessment Survey

Please rate the following statements. Use the scale below.

4=always

3=usually

2=sometimes

1=rarely

- | | 4 | 3 | 2 | 1 |
|--|---|---|---|---|
| 1. Before I begin reading, I create a reading goal and a plan of action
so I know what I intend to accomplish. | 4 | 3 | 2 | 1 |
| 2. I have one style of reading that I use with all reading materials. | 4 | 3 | 2 | 1 |
| 3. I skim through the chapter, read the chapter review questions,
and read the summary before I start reading the chapter. | 4 | 3 | 2 | 1 |
| 4. I examine or preview the front and back sections of new
textbooks before I begin using the textbook. | 4 | 3 | 2 | 1 |
| 5. Finding a main idea or topic sentence in paragraphs is
confusing or difficult for me to do. | 4 | 3 | 2 | 1 |
| 6. I use different kinds of clues in sentences to help me identify
the definitions or unfamiliar words. | 4 | 3 | 2 | 1 |
| 7. I am confident in my ability to use reading and vocabulary
to strengthen my reading skills. | 4 | 3 | 2 | 1 |
| 8. I go into “autopilot” when I read a textbook; I do not pay
enough attention to the details and do not monitor my understanding. | 4 | 3 | 2 | 1 |
| 9. I use a variety of strategies when I read, and I adjust my strategies
needed to comprehend difficult-to-understand passages.
Explain. | 4 | 3 | 2 | 1 |
| 10. I know how to interpret information on pie charts, flow charts,
tables bar graphs, and line graphs. | 4 | 3 | 2 | 1 |
| 11. I am aware of what I am reading and connect it to things I have
learned before. | 4 | 3 | 2 | 1 |
| 12. When reading science textbooks, I feel confident.
Explain. | 4 | 3 | 2 | 1 |
| 13. Describe the setting where you read your assignments. Include the noise level, your
access to electronic devices, your level of comfort, and your state of alertness. | | | | |

14. When my teacher assigns a reading assignment, my first thought is

APPENDIX I

LESSON PLAN TO EVALUATE HIGH-ORDER THINKING QUESTIONS

Appendix I
Lesson Plan to Evaluate High-Order Thinking Questions

What is a higher-order question? Place a check next to the questions your group thinks is a higher order question. Use the guide on the poster at the front of the class to help you determine.

1. Which science skill is a student using when she touches the soil in a plant pot to determine whether it is dry?
2. List five characteristics of living things.
3. Compare sexual reproduction with asexual reproduction.
4. What is genetic engineering?
5. Give an example of why it is advantageous that scientists test only one variable at a time during an experiment.
6. What is an ionic bond?
7. Draw a Lewis dot diagram to show how sodium and chlorine form an ionic bond.

[Graph demonstrates the effect on catalase activity under acidic, basic, and normal conditions]

8. Look at the graph above. What happens to the rate of the reaction in the presence of an acid?
9. Based on the graph above, determine the approximate pH of our blood.
10. What is the ultimate energy source for all living things?
11. How are lactic acid fermentation and alcoholic fermentation alike? How are they different? Create a Venn diagram to compare and contrast.
12. List the correct order of steps in mitosis.
13. During which step of meiosis is nondisjunction most likely to occur, and what is the result of nondisjunction?
14. Design a lab that would study the effects of sunlight on fungal growth in forests.
15. Predict what would happen if a society did not have the option of using fossil fuels. Explain your answer.

APPENDIX J

WHAT I KNOW(WIK) SHEET

Appendix J
What I Know Sheet¹

Reading Topic:

Purpose for Reading:

Column A	Column B	Column C
What I already knew:	What I now know:	What I still don't understand

Summary of reading assignment:

¹Adapted from Heller, M.F. (1986). How do you know what you know? Metacognitive modeling in the content area. *Journal of Reading*, 29(5), 415-422.

APPENDIX K

MODELING THE SQ3R TECHNIQUE

Appendix K
Modeling the SQ3R Technique

Ideas that Shaped Darwin's Thinking

Survey: *Record Key Concepts from Chapter 15-2.*

Question: *Change the section headings into questions.*

Read: *Write the answers to questions you created above.*

Recite: *Record key facts and page numbers to defend the answers you gave for each question as you read.*

Review: *Create a summary paragraph for each question you wrote.*

APPENDIX L

PRE AND POSTTREATMENT INTERVIEW QUESTIONS

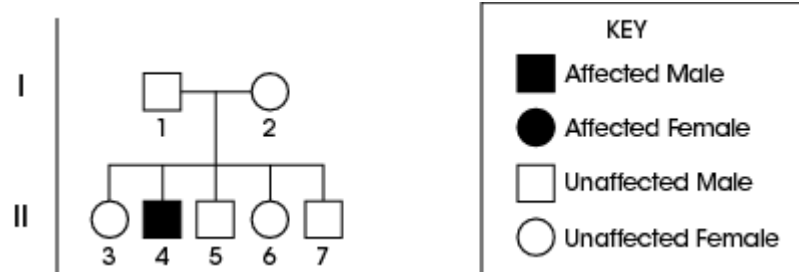
Appendix L
Pre and Post-treatment Interview Questions

1. How do you feel about using guided reading sheets during class? Explain
2. (Post-treatment only) How did your feelings change as we continued to use the reading sheets? Explain.
3. (Post-treatment only) At what point did your feelings change as we continued to use the reading sheets (what concept or lesson)? Explain.
4. (Pretreatment only) How does your understanding of biology concepts change after you use the guided worksheets? Explain.
5. (Post-treatment only) How did your understanding of biology concepts change from before using the reading sheets compared with now? Explain.
6. (Pretreatment only) Describe how you determine the purpose for reading an assigned text.
7. (Post-treatment only) How did your ability to develop a purpose question and answer that question change from the first time you used the reading sheets until the last time?
8. How important is reading to help you understand concepts in biology class?
9. (Post-treatment only) Which reading sheet worked the best for you? Why?
10. What was the best thing about using the reading sheets (or guided worksheet – pretreatment)?
11. What can I do differently next time we use the reading sheets (or guided worksheet – pretreatment)?
12. Is there any other question I should have asked you that I have not, and what is the answer to your question?

APPENDIX M

STUDENT INTERVIEW QUESTIONS – NONTREATMENT UNIT

Appendix M
Student Interview Questions – Non-treatment Unit



Ohio Department of Education. (2009). Ohio graduation tests – science. p. 23.

1. Describe what this diagram is showing.
2. Where are the parents in this pedigree?
3. What structure indicates the offspring?
4. What can you tell me about the individuals numbered 3-7?
5. What can you tell me about the genotypes of the following individuals: 1, 2, 4?

APPENDIX N

STUDENT INTERVIEW QUESTIONS – TREATMENT UNIT 1

Appendix N
Student Interview Questions – Treatment Unit 1

[Diagram has a map of the Galapagos Islands, with pictures of each tortoise species that inhabits the particular islands.]

1. What three differences are apparent in the bodies of the three tortoise species shown in Figure 1?
2. Define “adaptation” in the context of the Galapagos tortoises.
3. Considering the body structures of the tortoises shown in Figure 1, which tortoises—a population from Pinta Island or a population from Isabela Island—might survive more successfully on Hood Island? Why?
4. Which isolation mechanism was responsible for the changes between the tortoise species on the Galapagos Islands?
5. As a result of this isolation, are the different tortoise species able to successfully reproduce? Explain.

APPENDIX O

STUDENT INTERVIEW QUESTIONS – TREATMENT UNIT 2

Appendix O
Student Interview Questions – Treatment Unit 2

1. A bear produces two offspring. One of the cubs is smaller than normal and has difficulty digesting food. What is likely to happen to the two bear cubs?
2. Explain the ability of each cub to reach maturity and produce offspring.
3. Use your answer from number 2 to explain the long-term consequences of this species.

APPENDIX P

DETAILED PROJECT TIMELINE

Appendix P

Detailed Project Timeline

January 3 – Get parental permission
 January 5 – Non-treatment pre-assessment; non-treatment concept preinterviews
 January 6 – Non-treatment – components and structure of DNA
 January 9 – Lab – modeling DNA replication
 January 10 – Non-treatment reading – DNA replication
 January 11 – Non-treatment reading – RNA and protein synthesis; quick lab synthesis
 January 12 – Lab – modeling protein synthesis (use components of 1/9 lab)
 January 13 – Non-treatment reading – roles of DNA, RNA, genes and proteins; types of mutations; Venn diagram
 January 17 – Activity – selective breeding of dogs vs. natural selection of wolves; pedigrees
 January 18 – Non-treatment reading – genetic variation; cloning; transgenic organisms
 January 19 – Lab – karyotyping activity of human chromosomes
 January 20 – Non-treatment post-assessment; non-treatment reading about genetic diseases; non-treatment postinterviews and unit 1 preinterviews
 January 23 – Reading skills inventory; pre-assessment unit 1
 January 24 – Activity – what is a higher-order question?
 January 25 – Treatment reading – Darwin’s theory and ideas that shaped his thinking
 January 26 – Lab – adaptation
 January 27 – Treatment reading – Darwin presents his case and evidence for evolution
 January 30 – Treatment reading – Genes and variation
 January 31 – Treatment reading – Types of selection and genetic drift
 February 1 – Lab – computer lab to model selection
 February 2 – Treatment reading – Hardy-Weinberg principle
 February 3 – Treatment reading – Should antibiotics be restricted? (not textbook)
 February 6 – Treatment reading – Speciation
 February 7 – Treatment reading – The fossil record
 February 8 – Treatment reading – Patterns of evolution
 February 9 – Lab – modeling coevolution
 February 10 – Unit 1 Post-assessment; unit 1 postinterviews and unit 2 preinterviews
 February 13 – Treatment reading – What is ecology?
 February 14 – Treatment reading – energy flow
 February 15 – Lab – food webs and ecological pyramids
 February 16 – Treatment reading – cycles (water, nitrogen, carbon, phosphorus); limiting nutrients
 February 17 – Lab – energy cycles computer lab
 February 21 – Treatment reading – role of climate
 February 22 – Treatment reading – biotic/abiotic factors; Venn diagram

February 23 – Treatment reading – community interactions and ecological succession

February 24 – Lab – biomes

February 27 – Treatment reading – populations; quick lab – analyzing population trends

February 28 – Lab – peppered moth computer lab

February 29 – Treatment reading – limits to growth; renewable and nonrenewable
resources

March 1 – Post-assessment Unit 2; postinterviews

*Teacher reflection journal, teacher time-log, and teacher attitude survey daily
throughout End Project Implementation: March 1, 2012

APPENDIX Q

RUBRIC FOR EVALUATING STUDENT READING STRATEGY WORKSHEETS

Appendix Q
Rubric for Evaluating Student Reading Strategy Worksheets

Topic	2 points	1 point	0 points
Purpose for reading	Clearly defined	Not clearly defined	Absent
What I Already Know	Thoughtful	Sketchy	Absent
What I Know Now	Organized	Disorganized	Absent
What I Still Don't Understand		At least one question	No questions
Summary	Organized/Complete	Disorganized/Incomplete	Absent

APPENDIX R

PROMPTS FOR TRACKING STUDENT RESPONSES DURING PROJECT

Appendix R
Prompts for Tracking Student Responses During Project

Non-treatment:

1. What questions were asked during reading in the non-treatment phase of the project?

Treatment Unit 1:

2. What questions were explored on the reading sheets during Treatment Unit 1?
3. How are these questions different from those asked during non-treatment?

Treatment Unit 2:

4. What questions were explored on the reading sheets during Treatment Unit 2?
5. How are these questions different from those asked during non-treatment and Treatment Unit 1?

APPENDIX S

PROMPTS FOR SELF-REFLECTION DURING PROJECT

Appendix S
Prompts for Self-Reflection During Project

Non-treatment:

1. What behaviors do I see when students are reading and using the traditional guided worksheets? Explain.
2. What aspects do they struggle with using this method? Explain.
3. How well are students internalizing this information during the non-treatment unit? Explain.
4. What is my attitude toward teaching the material using this lesson plan? Explain.
5. What motivates me to keep or change this lesson plan? Explain.

Treatment Unit 1:

1. What behaviors do I see when students are reading and using the WIK and SQ3R sheets? Explain.
2. What aspects do they struggle with using this method? Explain.
3. How well are students internalizing this information during Treatment Unit 1? Explain.
4. What is my attitude toward teaching the material using this lesson plan? Explain.
5. What motivates me to keep or change this lesson plan? Explain.

Treatment Unit 2:

1. What behaviors do I see when students are reading and using the WIK and SQ3R sheets during this unit? Explain.
2. What aspects do they struggle with using this method? Explain.
3. How well are students internalizing this information during Treatment Unit 2? Explain.
4. What is my attitude toward teaching the material using this lesson plan? Explain.
5. What motivates me to keep or change this lesson plan? Explain.

APPENDIX T

PROMPTS FOR PEER OBSERVATION DURING NONTREATMENT AND
TREATMENT

Appendix T
Prompts for Peer Observation during Non-treatment and Treatment

Non-treatment:

1. What behaviors do I see when students are reading and using the traditional guided worksheets?
2. What aspects do they struggle with using this method?
3. What specific strategies does the teacher employ when responding to students during non-treatment?
4. Other comments—include other things that you have observed that are of interest.

Treatment Unit 1:

1. What behaviors do I see when students are reading and using the WIK and SQ3R sheets?
2. What aspects do they struggle with using this method?
3. How is the teacher responding to students during Treatment Unit 1?
4. What can the teacher improve upon to make this technique more useable to her students?
5. Describe the difference in teacher behavior now compared to non-treatment

Treatment Unit 2:

1. What behaviors do I see when students are reading and using the WIK and SQ3R sheets during this unit?
2. What aspects do they struggle with using this method?
3. How is the teacher responding to students during Treatment Unit 1?
4. How are the teacher's behaviors different now compared to non-treatment and Treatment Unit 1?

APPENDIX U

DETAILED RESULTS FOR PRETREATMENT AND POSTTREATMENT READING
SURVEY ON STUDENT ATTITUDES

Appendix U
Detailed Results for Pretreatment and Post-treatment Likert Scale Reading Survey on
Student Attitudes

	Pretreatment	Post-treatment	% Change
Difficulty finding the main idea of a passage	1.77	1.73	-2.26
Confident using vocabulary	2.94	3.00	2.04
Go into autopilot when reading	2.35	2.31	2.04
Ability to interpret charts and graphs	3.09	3.23	4.53
Confident when reading the science textbook	2.2	2.44	10.9

Note. Likert scale 4=always, 3=usually, 2=sometimes, 1=rarely.

APPENDIX V

DETAILED RESULTS FOR PRETREATMENT AND POSTTREATMENT READING
SURVEY ON STUDENT MOTIVATIONS

Appendix V
Detailed Results For Pretreatment And Post-treatment Reading Survey On Student
Motivations

	Pretreatment	Post-treatment	% Change
Create a reading plan before reading	1.74	1.92	10.34
Preread the section of text	2.2	2.28	3.64
Use context clues when reading	2.85	3.05	7.02
Use a variety of reading strategies	2.51	2.44	-2.79
Connect reading with prior knowledge	2.82	2.85	1.06

Note. Likert scale 4=always, 3=usually, 2=sometimes, 1=rarely.