Spring 2016

Effectiveness of the QAR Reading Strategy on Science Reading

Courtney Anne Broser

EFFECTIVENESS OF THE QAR READING STRATEGY ON SCIENCE READING

A Masters Thesis

Presented to

The Graduate College of

Missouri State University

In Partial Fulfillment

Of the Requirements for the Degree

Master of Science, Biology

By

Courtney Anne Broser

May 2016

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Biology

Missouri State University, May 2016

Master of Science

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ABSTRACT

The Questions-Answer Relationship (QAR) is a reading strategy that guides student comprehension by allowing the student to demonstrate their ability to determine importance, make inferences, and monitor comprehension through questions. The study was conducted on high school students in physical science to determine if the implementation of the QAR would improve content area literacy knowledge and confidence from pre-test and post-test data. Pedagogies included modeling, collaboration, independent work, guided practice, direct instruction, and inquiry laboratories. Through the implementation of the QAR method, the researcher found that students that learned new reading strategies gained confidence and were more engaged in the content reading. Though the treatment group had more significant gains on specific questions, there were significant improvements on specific questions in regards to both groups, although no significance was found in total scores.

KEYWORDS: question-answer relationship, reading strategy, reading comprehension, science, reading, science, teaching, science classroom, teaching science, science literacy

This abstract is approved as to form and content

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INTRODUCTION

As students in public education advance in grade-level, the required reading material becomes more rigorous and content-specific. While reading, students are required to think creatively and critically to improve their individual performance and achievement scores. Development of these types of thinking allows students to improve their ability to generate ideas, evaluate the value of ideas, and reflect on their ideas. Students are responsible for thinking, reflecting, and extending their comprehension from literal to deeper levels of thinking on their own (Stein, 2009). Without proper instruction and opportunity to perform, students leave high school without the fundamental skills of how to comprehend their texts.

According to a study done by Susan Carlson on 305 Pittsburg State University (PSU) students, over half of the students read only 50% or less of the required readings in their classes. Of the PSU students surveyed, 27% used active reading strategies (strategies that require a student to interact with the text) for required classes in their major, and only 9% of students used active reading strategies in their general education courses (Carlson, 2007). Helping high school students develop active reading strategies and develop confidence in the strategies may help them in high school and college.

Active Reading in the Classroom

Students are engaged in active reading when they are using certain techniques or strategies to more fully engage with a text (Starros, 2012), such as Reciprocal Teaching, Question-Answer Relationships, and Bloom's Taxonomy (Stein, 2009). These strategies,

when taught effectively, can guide students to take control of their own learning and become active readers (Stein, 2009). When students are actively reading, they are monitoring their comprehension and thus are able to ask themselves if they understand the material.

For students to read and comprehend proficiently, it is necessary for teachers to give students support through modeling different strategies on how their thinking should change with new knowledge (Tovani, 2004). Minimal comprehension of the material occurs when students do not actively think about what they are reading (Tovani, 2000). Students who do not comprehend or are confused by the material must change their behavior and try cognitive strategies in order to increase their learning (Gier et al., 2010). By supporting students with reading strategies, teachers can give students an idea of what effective readers do (Stein, 2009).

A Purpose for Active Reading

As students become more comfortable and effective with the strategies, they begin to set their own purpose for learning while monitoring their comprehension (Stein, 2009). Students need processing time to construct an understanding from their assigned text; however, if a student is not given a purpose for reading, they may feel overwhelmed. "Recognizing that purpose often determines what is important and what a reader remembers has major implications for content instruction. It means that teachers have to be clear in their reasons for assigning the reading" (Tovani, 2004).

To construct an understanding of a text, students first need a place to write down their brainstorming and track ideas while they are deciphering the text. Students are then

able to refer back to that material and make connections to the text with their personal lives (Tovani, 2004). Unless a student is constructing meaning, the student is not comprehending (Tovani, 2000).

Active Reading through Question-Answer Relationship Reading Strategy

The Question-Answer Relationship (QAR) is a reading strategy that guides student comprehension by allowing them to demonstrate their ability to determine importance, make inferences, and monitor their comprehension through questions that arise before, during, and after reading a text (Fenty et al., 2012). Having a purpose allows students to determine what is important and is often determined first by the teacher through learning objectives (Tovani, 2000). After the purpose is established, the instructor develops guiding questions that students answer throughout the reading. The students then sort the questions into two categories and then place the answers in conjunction with the question from the reading so that every question will have an answer.

The first category is *author,* which means that the student will be able to find the answers directly from the text. These answers may be direct quotes from the text or paraphrases. The second category is the *author and I,* which requires the student to rely on their background knowledge and the communication through the text to derive at the answer (Fenty et al., 2012). These types of questions may be answered by inferring or using their background knowledge of the content in the text to create a new example or form relationships to another topic. Some answers may be more abstract in this category.

Research has found that the use of QAR increases one's ability to decipher and answer questions, as well as, the ability to comprehend texts. The QAR is a simple instructional strategy, and its consistent use across content areas can help increase content acquisition and student successes in different content areas (Fenty et al., 2012). Most statistics show that 4th and 5th grade students' achievement across content areas in reading could be greatly improved by using the QAR strategy. Students can develop their own relationship with the text and make real-world connections to improve comprehension (Neufeild, 2005).

Previous studies have used the QAR reading comprehension strategy with various grade levels and courses. Leah H. Kinniburgh and Abigail Baxter (2012) found that the QAR can be effectively implemented within the science classroom of struggling 4th grade readers. The instructor, with limited professional development of the strategy, was able to aid struggling readers using QAR. The study concluded that teachers too, need to gain confidence so that they can assist students to be successful. Another study done showed an increase in comprehension among 8th grade students after using QAR (Becker, 2012). When students are shown specific strategies, they can achieve success (Kinniburgh and Baxter, 2012).

Reading Comprehension Standards and the Influence in Classrooms

The College and Career Readiness Standards (CCRS), Common Core State Standards (CCSS), and the implementation of the required testing of all 11th grade students in the state of Missouri for the ACT have made an impact on teacher-driven instruction over the past few years. Public educators are to prepare students to read at a

higher level within their content area. Standard 10 of the Common Core State Standards for English Language Arts states that students must be able to read and comprehend complex literary and informational texts independently and proficiently (Smith III, 2015). Should science teachers be responsible for improving Lexile scores? Are science teachers responsible for teaching reading? Should this not be the responsibility of the English/Language Arts (ELA) teachers? These are the questions I ask myself.

Teachers have been trained in their specific content area and are uncomfortable with stepping into the role of a reading specialist (Tovani, 2000). It is important that comprehension strategies are not left exclusively to the language arts teachers and reading specialists, or taught only within the language arts classrooms; reading strategies should be taught in other content classrooms (Neufeild, 2005). Comprehension strategy instruction is necessary for developing adolescent readers and writers. Struggling readers need high-quality instruction each day in every class (Allington, 2007). Effectively incorporating reading comprehension skills into science instruction amongst 4th grade struggling readers and students diagnosed with reading disabilities led to improved test scores in both reading and science. Studies have shown that the QAR improves student's reading comprehension not only in upper elementary, but in middle and high school levels as well (Kinniburgh and Shaw, 2009).

Standardized tests, such as Missouri End-of-Course exams, the ACT, and SAT, require students to read narrative and expository passages and answer the questions that follow (Kinniburgh and Shaw, 2009). Expository texts may have unknown, content-specific vocabulary that has not been given enough background information for the reader to make sense of the terminology (Hall, 2004). This can cause readers of all

abilities to struggle due to the answers not being given directly in the text, word-for-word. Students have to derive their answers from their own understanding of what they have read. Failure to comprehend these difficult texts could lead to confusion in the content and failing to achieve a preferred score on a high-stakes exam, like the ACT, could lead to a missed scholarship for some students (Hall, 2004)

Scientific Literacy

Many secondary school students struggle to read science textbooks due to the terminology, the non-technical words that have both vernacular and specialized scientific meanings, the grammar, and the ability to read charts, graphs, tables, and diagrams (Roberts et al., 2012). In the classroom, science teachers are expected to be the experts of the content and thus responsible for helping students comprehend the text. High school textbooks are measured at 1150 - 1385 on the Text Complexity Grade Bands and Associated Lexile Ranges, which is a measurement of how difficult the texts are (Smith III, 2015). The Lexile Ranges are based on the Lexile Framework, which is a systematic way to match reader with text using numerical scales (Lexile, 2015).

While content teachers readily grasp the content, there are struggles in providing basic reading strategies to help students comprehend the content. Struggling readers in need of supplemental material are often left behind, still stressed to comprehend the basic necessities of the content. By making connections to the reading, students have a richer experience. The more connections a student is able to make to the text, the better he or she will comprehend (Tovani, 2000).

Study Purpose

In my six years of teaching, I have often wondered how teachers can make science texts more comprehensible to students. If high school students are expected to be able to dissect a high school text by the time they graduate, how can I help them? The purpose of the study is to evaluate the effectiveness of the QAR reading comprehension strategy among ninth through twelfth grade physical science students. The main goal was to document the knowledge gained by the treatment group after the unit had been presented compared to the knowledge prior to the unit in order to determine if the reading strategy was effective among my high school students. If found effective, I would implement the reading comprehension strategy in all of my classrooms. I also compared the confidence from the beginning to end of the unit for my own personal interest through a short survey that has been modified (Confidence Questionnaire). According to Maryann Manning at the University of Alabama at Birmingham, teachers work to build reading-confidence at the primary grade levels. During middle school students have varying levels of confidence and each time a students has a negative interaction with unsuccessful reading, their confidence decreases. By the time students reach high school students could potentially be discouraged and refuse to read (Manning).

I hypothesized that implementing the QAR reading comprehension strategy within my classroom would increase my students' overall improvement in content knowledge and confidence in their reading of the content text. The null hypotheses for the study were (1) there would be no significant differences in the knowledge gained of the chemistry unit content and (2) there would be no significant difference in the confidence levels before and after the unit was presented.

METHODS

The study was conducted at a high school in Southwest Missouri during spring 2015. Approval of this project was granted by the Institutional Review Board at Missouri State University, Springfield, Missouri (#15-0436, April 23, 2015), and the school district prior to the beginning of data collection (Appendix A). Student participation was voluntary in pre- and post-test surveys and took place within the normal classroom instruction (Appendix B).

This was a quasi-experimental study due to the need to base treatment and control groups on the entire class section rather than a random assignment of individuals. Student participants were divided into treatment and control groups based on the section of day they were enrolled in physical science. Of the three sections of physical science, one section was used as the treatment group and two sections were used as the control group. The students in the treatment group totaled 13 while the control group totaled 26 for both the pre-test and the post-test. The control group was composed of two different class sections. Twelve students were in the first control group and 14 were in the second control group.

Classroom Demographics

The participating students in the treatment classroom, grades 9-11, averaged a Lexile score of 917, just below the reading levels of grades 6-8 science textbooks according to the Text Complexity Grade Bands and Associated Lexile Ranges (Smith III, 2015). Five of the 13 students receive special services within the classroom. Of the

students in the treatment group, only six of the 13 read at a high school grade level. The remainder of the students are reading at an eighth grade level or below. One student in the treatment group is below a second grade reading level.

The participating students in the control group, grades 9-11, average a Lexile score of 1053, which is within the ninth to tenth grade reading level (Smith III, 2015). Three of the 26 students receive special services within the classroom. All students within the control group read at the eighth grade level or higher. All student participants, both treatment and control, spoke English as their primary language.

Instructional Development

The pre- and post-test used in this study were written by the researcher for this unit (Appendix C and D, respectively). Students were asked to write their multiple choice and matching answers on the answer sheet provided and their short answer responses directly on the test, as in normal classroom procedures for exams. The pre-test was administered at the beginning of the unit, and the post-test was given at the end of the unit following the last day of instruction. Both tests took students approximately 45 minutes to complete. There were 66 questions on the chemistry unit test and 11 questions on the QAR Questionnaire regarding confidence (Appendix E).

A variety of question types were used on the knowledge section including multiple choice, matching, short answer, and completion. Each student received an individual score for each question and a composite score for all correct post-test answers. Post-test scores were applied towards the students' overall classroom grade. The pre-test

was scored individually for correctness of each question along with a composite score; however, the score did not apply to their overall classroom grade.

Knowledge questions included topics such as physical versus chemical changes, solvents, solutes, solution and mixtures, and states of matter. The knowledge questions (numbers one through 63 on pre-test and questions one through on through 22 and 26-66 on post-test) were worth one point each if correct and zero points if incorrect. Pre-test question #64/post-test #24 was worth four points and scored with a rubric (Figure 1); pre-test #65/post-test question #23 was worth one point (correct), one-half point (partial correctness), and zero points (incorrect; Figure 2); pre-test question #66/post-test questions #25 was worth ten points where partial credit was given based on correctness from the rubric (Figure 3).

Program Development and Implementation

The students in the treatment classroom experienced the unit (Table 1) with the reading strategy instruction over the course of 15 days with 53-minute class periods. Normal classroom instruction included a mixture of lecture, reading assignments, and inquiry laboratory assignments. Each day, information was presented to the students and reinforced with inquiry laboratory assignments. The treatment group received the pre-test, normal classroom instruction, and post-test, with a reading strategy implemented to encourage growth in confidence. The control group received the pre-test, normal classroom instruction without the QAR reading strategy, and a post-test. The same amount of time was allocated for the control group, 15 days with 53-minute class periods.

The pre-test and post-test were developed prior to teaching the unit and included questions regarding the Course Level Expectations for Missouri (Science Course Level Expectations) , the Next Generation Science Standards (HS-PS1), and various information that important to know to prepare students for Chemistry I in which students enroll in for the next school year. The tests consisted of the same 41 multiple choice, 22 matching and three short answer questions, only in different orders for each test. Their overall change in knowledge and confidence were assessed.

For the treatment group, the QAR reading comprehension strategy was completed a total of five times, but only four times during the instructional unit. Prior to the beginning of the unit, students in the treatment group assembled their QAR folder based off of the instructional sheet (Appendix F). Students were then asked to read an article not related to the subject matter and the teachers both modeled the strategy. The students were then allowed to practice completing the strategy with assistance from the teacher within the classroom.

The work was reviewed and discussed prior to completing the questions for the strategy during the unit of instruction. For each time the QAR was implemented, a set of questions were handed out to each students to either cut-and-paste into their folder or they could write the questions instead (Appendix G and H). While not all topics tested on were covered through the QAR, all test material was covered through instructional methods and some reading correlated directly to inquiry labs (Table 1).

Analysis

Descriptive statistics, such as the mean and standard deviation, were used to directly compare all questions on the pre-test to the corresponding questions on the post-test. A paired T-test was used to analyze the individual knowledge questions. The paired T-test evaluates the significant change due to treatment when the same individuals are tested twice.

The short answer section was analyzed separately using the rubrics in Figures 1, 2 and 3. All individual knowledge questions were compiled for total knowledge scores for each student. The total knowledge scores and the QAR questionnaire were then analyzed using the Wilcoxon Signed Rank test. The test analyzes the means of the two sets of scores. An increase in the score, from the pre-test to the post-test, indicated positive change. All analyses were completed using Microsoft Excel 2013.

Question 64/24	During Mr. Morton's chemistry class, he decided to show off gas laws in a demonstration. He filled a coke can with 25 mL of water and brought it to a boil. He then took the can and flipped it upside down in an ice bath. When he did this, the can crushed together. Why did this happen? Explain your answer using the following terms: - temperature, - pressure, - distance of gas molecules, - speed of gas molecules				
Possible Score Received	**0**	**1**	**2**	**3**	**4**
	0/4 of the terms were correctly explained	1/4 of the terms was correctly explained	2/4 of the terms was correctly explained	3/4 of the terms was correctly explained	4/4 of the terms was correctly explained

Figure 1. Scoring rubric for short answer question pre-test 64 and post-test 24.

Question 65/23	Describe the size and scale of an atom. Explain the relative size of the nucleus in relation to the size of the entire atom.		
Possible Score Received	**0**	**0.5**	**1**
	No correct size and scale listed. No comparison of the nucleus to the entire atom.	Correct size and scale of an atom -or- The nucleus was compared to the entire atom.	Correct size and scale of the atom was listed – and- Nucleus was compared to the entire atom.

Figure 2. Scoring rubric for short answer question pre-test 65 and post-test 23.

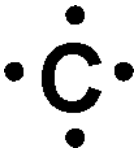
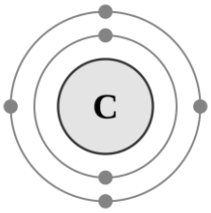
Element	**Hydrogen**	**Carbon**
Symbol	H (0.5 points)	C (0.5 points)
Atomic Number	1 (0.5 points)	6 (0.5 points)
Atomic Mass	1.01 (0.5 points)	12.01 (0.5 points)
# of Protons	1 (0.5 points)	6 (0.5 points)
# of Neutrons	0 (0.5 points)	6 (0.5 points)
# of Electrons	1 (0.5 points)	6 (0.5 points)
Valence Electrons	1 (0.5 points)	4 (0.5 points)
Lewis Dot Structure	(0.5 points) 	(0.5 points) 
Energy Shell Diagram	(1 point) 	(1 point) 

Figure 3. Scoring rubric for short answer question pre-test 66 and post-test 25.

Table 1. Overview of chemistry unit for the treatment group.

Day	Topics Covered	Method of Instruction
1	Pre-test and QAR Questionnaire administered	Written test
2	Framing Questions, Physical vs. Chemical Changes	Anticipatory set to unit, Inquiry Lab
3	Reading Page – Chemical vs. Physical Changes (QAR Strategy for Treatment)	Reading Strategy
4	Ink Pen Chromatography Lab	Inquiry Lab
5	Classification of Matter	Guided Practice
6	Reading Page – Solvents, Solutes, Solutions, and Mixtures (QAR Strategy for Treatment)	Reading Strategy
7	Reading Page - States of Matter (QAR Strategy for Treatment)	Reading Strategy
8	Adventures in Density Lab	Inquiry Lab
9	Chemical Elements, the Atom, and the Periodic Table (QAR Strategy for Treatment)	Reading Strategy
10-11	Practice Questions – Just How Small is an Atom?	Guided Practice
12	The Periodic Table PowerPoint	Direct Instruction
13	The Periodic Table PowerPoint and Practice Questions – The Periodic Table	Direct Instruction, Guided Practice
14	Unit Review	Guided Practice
15	Post-test administered and QAR Questionnaire administered	Written test

RESULTS

The purpose of the study was to evaluate the effectiveness of the QAR reading comprehension strategy among ninth through twelfth grade physical science students. I hypothesized that implementing the QAR reading comprehension strategy within my classroom would increase my students' overall improvement in content knowledge and confidence in their reading of the content text. The null hypotheses for the study were (1) there would be no significant differences in the knowledge gained of the chemistry unit content and (2) there would be no significant difference in the confidence levels before and after the unit was presented. The results are discussed in two major sections, knowledge scores and confidence scores. The knowledge scores results were broken down further into content topics that were discussed.

Knowledge Scores

The students in the treatment group and the control group showed an overall increase in knowledge from the pre-test to the post-test but the results were not significant ($p < 0.05$; Table 2). For both the treatment group and control group, scores improved on all of the matching questions, but not significantly. Scores significantly improved on seven of the 22 questions for the treatment group and the control group significantly improved on 13 of 22 questions ($p < 0.05$). Knowledge scores for the treatment group improved on 36 of 40 multiple-choice questions and the control group improved on 38 of 40 multiple-choice questions, although the improvements were not

significant. The treatment group significantly improved on eight of 40 questions and the control group significantly improved on 19 of 40 questions ($p > 0.05$).

The mean rank knowledge scores for the pre-test and post-test approached significance groups for the pre-test ($p = 0.07$) and post-test ($p = 0.08$; Table 2). Pre-test question #41 (post-test #50) showed the greatest increase in scores from the pre-test to post-test (85%) for the treatment groups, while pre-test question #31 (post-test #60) showed a 31% decrease from the pre-test to post-test. The mean total knowledge scores for the pre-test treatment and control groups were 37.2% and 38.5% respectively ($p = 0.07$). The total mean percent correct knowledge scores for the post-test treatment and control groups were 67.1% and 65.2%, respectively ($p = 0.09$), approaching significance.

Knowledge Scores by Topic

The students in the treatment group showed an overall gain in knowledge on 19 of the 21 content questions and showed significant improvement on six out of 21 questions, three of the 21 questions approached significance on the topic of physical versus chemical changes. For the control group, the students increased their mean scores on 20 of the 21 questions but significantly improved on only nine of the 21 questions while two of the 21 questions approached significance (Table 3).

On the topic of solvents, solutes, solutions, and mixtures, the students in the treatment group showed an overall gain in knowledge (but not significant) on all of the 11 questions but only significantly improved on one of the 11 questions. Two of the 11 questions approached significance. The control group showed an overall gain in

knowledge (but not significant) on all 11 questions but significantly improved on seven of the 11 while two of the 11 approached significance (Table 4).

For the topic of states of matter, the students in the treatment group showed an overall gain in knowledge, but not significant, on 29 of 31 questions and significantly improved on nine of the 31 questions, while six of the 31 questions approached significance. The control group showed an overall gain in knowledge, but not significant, on all 31 questions, significantly improved on 16 of the 31 questions, and approach significance on two of the 31 questions (Table 5).

Confidence Scores

The treatment group showed an overall increase, but not a significant increase, in reading confidence, increasing on nine of the 11 questions and significantly increasing on two of the 11 questions while the control group increased on four of the 11 questions but significantly increased on one of the 11 questions. The mean confidence score for the treatment pre-test was 17.6 while the total mean confidence score for the post-test was higher at 19.9 but was not significant ($p = 0.12$). The mean rank scores were not significantly different between groups for the pre-test ($p = 0.87$) or the post-test ($p = 0.76$; Table 6).

Question nine, on the QAR asked the students the following:, "I am engaged when I am reading outside of the science classroom (library book)." The question showed the most positive confidence score for the pre-test. Alternatively, question one asked, "I comprehend what I read (as I am reading, I understand what the text is talking about)." This question showed the highest score for the post-test (Table 7). The most significant

increase in mean confidence scores for the treatment group was question six, "I am familiar and use QAR's to help me when I am struggling (i.e. get confused) with the text" (Table 7). For the control group, question one, "I comprehend what I read (as I am reading, I understand what the text is talking about)" showed the highest confidence score from the pre-test to the post-test (Table 7).

Table 2. Comparison of total confidence and knowledge scores between the control group and the treatment group for the pre-test and post-test.

	Confidence Scores		**Knowledge Scores**	
	Mean Rank Pre-Test	Mean Rank Post-Test	Mean Rank Pre-Test	Mean Rank Post-Test
Control Group	19.77	19.15	38.5	65.2
Treatment Group	17.62	19.92	37.2	67.1
P-Value	0.87	0.76	0.07	0.08

**Denotes significant difference at p < 0.05*

Table 3. Analysis of matching and multiple choice questions regarding physical versus chemical changes pre-test versus post-test.

	Treatment Group			**Control Group**		
Post-/ Pre- #	% Correct Pre-	% Correct Post-	*P-Value*	% Correct Pre-	% Correct Post-	*P-Value*
2/50	31	85	0.01*	69	92	0.03*
4/49	77	100	0.17	85	96	0.18
13/47	38	62	0.34	46	92	<0.01*
15/42	54	62	0.08	35	85	<0.01*
26/24	0	31	0.04*	19	15	0.66
27/25	31	38	<0.67	27	62	0.02*
29/12	54	92	0.10	62	77	0.10
31/14	38	92	<0.01*	73	96	0.01*
32/19	15	54	0.10	42	46	0.79
33/15	15	54	0.05	23	62	< 0.01*
37/13	23	85	<0.01*	54	88	< 0.01*
38/22	77	62	0.08	65	73	0.57

Table 3 continued

40/18	23	62	0.05	58	62	0.74
41/1	38	69	0.04	46	73	0.05
43/21	15	23	0.67	23	23	1
44/26	38	92	0.03*	62	88	0.02*
45/16	62	85	0.33	88	92	0.57
51/20	54	54	0.67	54	73	0.10
52/2	31	38	0.72	19	62	< 0.01*
54/11	54	85	0.19	73	81	0.49
58/17	38	62	0.19	62	85	0.06

**Denotes significant difference at p < 0.05*

Table 4. Analysis of matching and multiple choice questions regarding Solvent, Solutes, Solutions, and Mixtures pre-test versus post-test.

	Treatment Group			**Control Group**		
Post-/ Pre- #	% Correct Pre	% Correct Post	*P-Value*	% Correct Pre	% Correct Post	*P-Value*
14/43	38	62	0.27	35	77	<0.01*
16/46	46	92	<0.01*	73	96	0.01*
17/44	23	62	0.10	35	77	<0.01*
18/45	46	85	0.10	65	96	<0.01*
35/5	54	77	0.44	50	54	0.79
36/6	31	62	0.10	35	58	0.08
48/3	23	38	0.43	42	65	0.03*
56/23	15	54	0.05	23	50	0.07
57/4	8	38	0.10	31	69	<0.01*
62/8	38	62	0.19	38	62	0.14
63/7	8	31	0.08	58	77	0.02*

**Denotes significant difference at p < 0.05*

Table 5. Analysis of matching and multiple choice questions regarding States of Matter pre-test versus post-test.

	Treatment Group			Control Group		
Post-/ Pre- #	% Correct Pre-	% Correct Post-	*P-Value*	% Correct Pre-	% Correct Post-	*P-Value*
1/51	69	100	0.08	81	96	0.10
3/48	38	85	0.02*	69	92	0.03*
5/60	23	85	<0.01*	62	92	<0.01*
6/61	38	92	<0.01*	65	81	0.16
7/59	31	46	0.17	42	62	0.20
8/58	31	62	0.21	31	48	0.07
9/57	8	46	0.17	31	46	0.26
10/56	23	54	0.10	15	54	<0.01*
11/63	31	92	<0.01*	4	81	<0.01*
12/62	31	77	0.10	38	81	<0.01*
19/53	38	77	0.05	54	81	0.02*
20/55	69	92	0.17	88	96	0.33
21/52	62	85	0.27	81	96	0.10
22/54	46	85	0.01*	65	81	0.21
28/9	69	100	<0.04*	88	92	0.66
30/10	62	77	0.58	92	100	0.16
34/37	46	85	0.10	62	65	0.75
39/33	69	85	0.58	62	100	< 0.01*
42/30	77	62	0.08	35	88	< 0.01*
46/28	31	38	0.67	23	50	0.03*
47/38	54	77	0.43	31	88	< 0.01*
49/27	69	77	0.67	69	92	0.01*
50/41	8	92	<0.01*	12	85	< 0.01*
55/35	0	8	0.33	19	38	0.20
59/40	8	46	0.02*	38	50	0.42
60/31	62	31	0.02*	54	65	0.42
61/32	23	69	0.05	23	62	< 0.01*
64/36	15	54	0.05	31	77	< 0.01*
65/29	31	54	0.19	35	69	< 0.01*
66/34	38	62	0.19	38	65	0.07

**Denotes significant difference at p < 0.05*

Table 6. Treatment versus control groups pre-test and post-test scores for QAR Questionnaire.

	Pre-Test	Post-Test
Treatment	17.6	19.9
Control	19.8	19.2
P-Value	0.12	0.36

Table 7. Pre- and post-test mean scores for confidence questions 1-11 (0 is the lowest and 3 is the highest score)

Question	**Treatment Group**			**Control Group**		
	Mean Pre	Mean Post	*P* – Value	Mean Pre	Mean Post	*P* – Value
1. I comprehend what I read (as I am reading, I understand what the text is talking about).	1.69	2.23	0.01*	1.81	2.27	< 0.05*
2. I like to read in the science classroom.	0.76	1	0.33	1.15	1.35	0.31
3. I like to read outside of class (library book).	1.92	1.93	1	2.15	1.96	0.28
4. I maintain my focus on the text while I read.	2.08	2.23	0.44	2.15	2.19	0.83
5. I know how and am able to use the question-answer relationship (QAR) reading strategy.	1.31	1.92	0.17	1.73	1.73	1
6. I am familiar and use QAR's to help me when I am struggling (i.e. get confused) with the text.	0.92	1.61	0.03*	1.46	1.35	0.68
7. I like help (through a reading strategy like QAR) to comprehend what I have read.	1.62	1.54	0.83	1.85	1.58	0.27

Table 7 continued

8. I am engaged when I am reading my science text.	1.69	1.85	0.43	1.5	1.54	0.81
9. I am engaged when I am reading outside of the science classroom (library book).	2.31	2	0.17	2.31	2.23	0.68
10. Reading strategy (QAR) increases my confidence in the content.	1.54	1.85	0.10	1.81	1.50	0.25
11. Reading strategy (QAR) increases my knowledge of the content.	1.76	1.77	1	1.84	1.46	0.08

DISCUSSION

With the expectation that high school students are expected to be able to dissect a high school text by the time they graduate, it was important to me to determine if the QAR reading comprehension strategy was effective among ninth through twelfth grade physical science students. I was also interested in determining if the treatment group gained confidence

I reject the null hypotheses that (1) there would be no significant difference in the knowledge gained of the chemistry unit content and (2) there would be no significant difference in the confidence levels before and after the unit was presented as the data indicates that the students that learned new reading strategies gained confidence and were more engaged in the content reading. There were significant improvements on specific questions although no significance was found in total scores. In addition, students in the treatment group had more significant gains on specific questions.

Knowledge Scores

The QAR reading strategy allows students a place to hold thinking while reading an assigned text. While both groups of students showed an increase in knowledge, the ones exposed to the QAR reading comprehension strategy did show increased confidence in comprehending what they had read compared to those not exposed to the reading strategy. The students in the treatment specifically showed an increase in maintaining focus while reading, using the QAR to aide when struggling with the text, engagement, and confidence. This agrees with a study done on a small group of fourth graders in

which the instructor had found success with the reading strategy and noted that a particular student who had great difficulty in reading comprehension prior to the study, grasped the different types of questions, gained independence and confidence in knowing how to find the answers to the questions (Stein, 2009). The students in the study I conducted were more engaged when using the QAR because the questions required them to search or make meaning of the content. The study indicated that the students in the treatment group did not like to read in or out of class, but liked to use the QAR in the classroom to help them because they QAR gave them confidence when reading the text.

The highest score on the pre-test and post-test for the treatment and control groups was on the topic of matter. Even though numerous students did answer the question correctly, more students answered it correctly after the unit was complete. It is uncertain if the QAR aided in this "gain in knowledge" or if it was recalled from previous studies in 8th grade, which was unknown to the researcher prior to the study.

The treatment and control groups also scored highest overall concerning atoms and the particles of atoms compared to other topics. The question, "What is between the nucleus and the electrons in an atom?," showed that greatest gain by both groups. This question was addressed with all students, regardless of their group title; however, the treatment group had a greater increase from the pre-test to the post-test in comparison to the control group on the question (Table 5). I believe that the students in the treatment group scored higher than the control group because the students in the treatment group were exposed to numerous questions in their QAR that addressed this topic.

The lowest scoring question, which asked students to identify which statement was true about compounds, was the same for the pre-test and post-test for both groups.

The treatment group showed a significant gain in knowledge (31%) while the control group did not show an increase. The students in the treatment group answered the question, "what are the characteristics of compounds", which led the students to know what is true and not true about regarding the topic. No further discussion, other than the QAR was completed on this topic. The control group was not asked this question during normal classroom instruction nor was there a discussion. I believe that the result for the treatment group may have been directly connected to the QAR reading strategy (Table 3).

The total knowledge scores between the treatment and control group for the pre-test scores were similar in that there was no significant difference as expected, meaning the students were at similar knowledge levels (regarding the content) when the pre-test was administered; however, there was also no significant difference between the post-test scores for the groups as well. For the knowledge questions, the treatment group mean scores were 3.2% higher than the control group. This did not follow a similar study done on eighth-grade students in which a reading comprehension strategy was taught versus a traditional classroom setting. The study found that the students that were taught the comprehension strategy outperformed the students in the traditional setting. Student were better able to recall information, transfer, and apply the information found in the science text (Hall, 2004).

I did expect that scores would increase with instruction; however, the level of increase was not substantial. The results for the treatment group may have been due to the difference in the number of lower-achieving and special education students when compared to the control groups; however, the study completed on eighth-grade students, as mentioned above, does go further in mentioning that both struggling readers and

students with reading disabilities increased the ability to comprehend the material when they were explicitly taught how to apply the reading comprehension skill to the science text (Hall, 2004). Also, in a study done on fourth-grade students, the results showed an increase in the ability to comprehend the material among struggling readers, but remarkably showed that students made the greatest advances in higher-order thinking types of questions (Kinniburgh and Baxter, 2012). I do believe that regular education students can benefit from the reading comprehension strategies too.

What I later realized was my introductory, or earlier hour was a warm-up to the rest of my day of teaching. As the day went on, the objectives were stuck in my head and I made sure that my other classes knew them just as well, regardless if they did not have the QAR to help them with the in class reading assignment. The control group may have received more instruction and a clearer meaning of the objectives than the treatment group due to my direct instruction. This "bleeding over" could potentially be why my knowledge scores were not significant between my treatment and control group.

Confidence Scores

The highest confidence score on the pre-test and post-test for the control group evaluated their level of engagement while reading outside of the science classroom, as in a library book. While the study was taking place, students within the study, both treatment and control, were required to read texts from various genres for their assigned reading in English. Students were allowed to pick the text of choice from a specific genre, thus, enabling the student to have a purpose for reading, i.e., the report regarding the specific text. Students within the control group showed lower scores than the

treatment group regarding engagement of reading of the science text. Students are not given choice in their reading within the science classroom.

The highest confidence score of the treatment group regarded maintaining focus while reading a text, regardless of the content. Students not only increased in their confidence for focus, they also increased confidence regarding comprehension, how to use the QAR, using the QAR when struggling with a text, and engagement in reading within the science classroom. Perhaps the most intriguing was the notable increase in confidence regarding the students' usage of the QAR to help them when they are struggling with the content text (Table 7). This supported the study done by Johnson (2014) when dealing with struggling readers in a 5th grade classroom. The students in both the Johnson study and this one, engaged in active reading and demonstrated their knowledge and confidence of the strategy by helping other students during peer collaboration.

Although students showed increased confidence among several questions, students indicated that they did not like help, via the QAR reading comprehension strategy, to comprehend what they read. This could be due to the extra work of writing and thinking the students had to do to increase their knowledge and confidence. Throughout the unit, questions arose regarding why the group was chosen as the treatment group as students became frustrated with the idea of the extra work and writing. However, some students took the QAR as an opportunity to have an extra study review for the post-test.

While there was a gain in confidence among the treatment group, there was no significant difference between the control and treatment groups pre- and post-QAR

questionnaire. The students were at similar levels regarding confidence in their reading and engagement as measured by this study; however, during the strategy students in the treatment group were engaged in the lesson and when called upon to answer, the treatment group could both reiterate what the reading stated and then provide an example that was not in the reading. By being able to have the correct answer and rise to the next level of thinking, students gained the confidence they needed to complete all of the QARs. In my opinion, improving just one individual's confidence is worth teaching the QAR.

Conclusions

The results of the QAR questionnaire indicated that there was no overall significant difference from the pre- to the post-test survey when implemented in a high school physical science class, although it approached significance. The content knowledge of both the treatment and control group increased, but the results were not significantly different when comparing the treatment to the control. There was a gain in confidence levels among the treatment group in terms of engagement and likelihood to read a science text. Although I didn't get as significant results as I hoped, there were still improvements on specific topics and especially in the reading confidence levels.

This research did not indicate that it is essential to implement the QAR within the science classroom; however, I do personally feel that it is necessary to allow students opportunities to learn through texts in various ways. This strategy does aid in comprehension by allowing for a place for students to hold their thinking as observed in the classroom during instruction. Students were then able to look back at these questions

and review them when needed. This strategy could be used in *any* class across the curriculum.

The QAR was chosen for this research but various types of reading strategies could be implemented within the science classroom. Limiting students to one specific strategy could cause them to become frustrated and disengaged as was witnessed during the research. An important idea learned from this research is that all students do not engage or want to use the same reading strategy; however, learning a new reading strategy did raise confidence levels and did engage students to become active readers. Student felt more comfortable when reading and helping other students find or develop the answers. Educating students about reading strategies will allow students to become active readers and engage in the content, regardless of their preferred course of study.

Implications for Professional Practice

Future studies should pay attention to the balance of struggling readers with IEPs and/or 504s versus regular education students. Ideally, a larger group of students would provide a more powerful comparison group for the study; however, research was limited within the researcher's classroom of students and parents of the students that were willing to participate. Perhaps a future study could be done to compare students with IEPs and/or 504s to each other while regular education students could be compared to each other. More research should be done on this strategy to better understand whether the QAR would be beneficial specifically to readers in need of support or accelerated/advanced readers. Regardless, future studies should include more students and more teachers with more time devoted to the unit of study.

Prior to repeating this study, it would be wise to seek professional development regarding reading strategies. While researching this topic, I was able to attend a multi-day workshop over a span of a semester regarding a variety of reading comprehension strategies provided by my school district. We were required to attempt the most recent strategy on our own and then with our students. As I was trying to determine what article I would use to implement the strategy, I would attempt the strategy on my own, while reading about reading comprehension strategies. This gave me the confidence to be able to teach my students and know when they will struggle, because I struggled first.

When trying to repeat this study, please be aware that once students identify themselves as the treatment group, some become less engaged in their daily effort. I witnessed this in my treatment classroom of students. The students became frustrated with me and the QAR. Some students refused to complete the QAR. For future studies, I would recommend taking the QAR for a grade. This way, students are held accountable for the reading strategy.

I would also caution the timing when teaching your treatment group and control group. I planned for my treatment group to be before my control group in the day so that I would remember to complete the QAR and follow through with the specific instruction for my study and not get caught up in the day-to-day routines.

I would also encourage students to create their own questions or select their own reading. For some students, this could be very difficult. Perhaps for those students, teachers could let them extend upon the teacher created questions or guide them to select pieces of literature that are both appropriate for Lexile level and content. This could aid them in setting their own purpose for their reading. Through classroom discussion,

students asked wonderful questions and wanted more information from me than the reading provided. I encouraged my students to research the questions that we did not have time for on their own.

I continue to use the QAR reading comprehension strategy in my classroom today. I do not require students to create the folder; however, I do require that student have a composition notebook to record their questions and answers. I conducted this study with students in the spring of 2015 and I have already witnessed students from that study who are now tenth graders in my current classroom use the QAR with the content reading. What is more empowering is that students from the treatment group help other students dissect the text.

Since this study, I have branched out with other reading comprehension strategies and try to model various reading strategies with my current students, including story maps, anticipation guides, summarizing, graphic organizers and guided practice. This is based on a study done in 1997 on a group of eighth grade science students that concluded students who were taught multiple comprehension strategies were able to show a significant increase in their comprehension of science text (Hall, 2004). I have been specifically working with my student that is reading at a second grade level on these strategies. This student's improvement has impressed me beyond words.

In the future, I would like to retry this study with my struggling readers in class and students with lower Lexile scores. I would like to compare their data to students with grade level Lexile scores and students with higher Lexile scores to see if there was a significant gain in knowledge. The more students I could sample, the better since my sample size was so small.

In this study, I learned three invaluable lessons. First, students are truly not willing to ask for help when struggling with the content. The QAR, among other reading strategies are necessary to help students like this. Two, the students wanted to learn the content. Using the QAR was a way for them to become more independent and take charge of their learning. And last, but certainly not least, my students actually cared, regardless if the treatment group thought I was "picking on them". I have witnessed some of my students return to me the next year and use the reading strategies in a different science class. The feeling of joy was overwhelming. The strategies I taught, including the QAR are still being used to help my students decode a text.

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APPENDICES

Appendix A. IRB Approval

Date	4/23/2015
RE:	Notice of IRB Exemption
Exemption Category	1. Educational setting
Study #	15-0436
Study Title	Effectiveness of the QAR Reading Strategy on Science Reading

This submission has been reviewed by the Missouri State University IRB and was determined to be exempt from further review according to the regulatory category cited above under 45 CFR 46.101(b).

Investigator's Responsibilities	If your study protocol changes in such a way that exempt status would no longer apply, you should contact the above IRB before making the changes.

Appendix B. Consent Form

Effectiveness of the QAR Reading Strategy on Science Reading

Conducted by: Courtney Broser

You are being asked to take part in a research study on how reading strategies can affect overall comprehension of the content and confidence levels. You are being asked because you are currently enrolled in one of Ms. Courtney Broser's physical science classes.

The purpose of this study is to learn how the question-answer reading comprehension strategy will help students gain confidence and knowledge of the content area in chemistry.

If you agree to be in this study, you will take a pre-test, complete the questions-answer relationship reading comprehension strategy, and take a post-test to determine overall gain in knowledge and confidence. Other than the reading strategy, the classroom atmosphere will in no way be altered. We will still be completing laboratory assignments.

There are no imminent risks associated with this research. The benefits could include an increase in overall scores and confidence in active reading strategies. Precautions will be taken for conceal and protect identifiable data. Your answers will be confidential. The records of this study will be kept private. In any sort of report we make public we will not include any information that will make it possible to identify you. Research records will be kept in a locked and encrypted file; only the researchers will have access to the records. Any hard copy, identifiable data will be shredded and disposed of.

Taking part in this study is completely voluntary. You will still be responsible for completing your work in and out of class; however, your data will not be included in the research. If you decide to take part, you are free to withdraw at any time. You will be given a copy of this form to keep for your records.

Statement of Consent: I have read the above information, and have received answers to any questions I asked. I consent to take part in the study.

Your Signature _____ Date _____

Your Name (printed) _____

Parent Signature _____ Date_____

Parent Name (printed) _____

Thank you,

Courtney Broser

Appendix C. Unit Pre-Test

Chemistry Pre-Test
Multiple Choice
Identify the choice that best completes the statement or answers the question.

1. Which of the following best represents a physical property?
   a. Explosive
   b. Combustible
   c. melting point
   d. ability to rust

2. Which of the following best represents a physical change?
   a. corrosion
   b. explosion
   c. evaporation
   d. rotting of food

3. Which of the following can be classified as a mixture?
   a. pure water
   b. pure air
   c. pure nitrogen
   d. pure gold

4. Which of the following is a heterogeneous mixture?
   a. Air
   b. salt water
   c. steel
   d. soil

5. Which of the following is a heterogeneous mixture?
   a. vinegar in water
   b. Milk
   c. oil and vinegar
   d. air

6. Which of the following is a homogeneous mixture?
   a. salt water
   b. beef stew
   c. sand and water
   d. soil

7. Separating a solid from a liquid by evaporating the liquid is called _____.
   a. Filtration
   b. condensation
   c. solution
   d. distillation

8. A substance that can be separated into two or more substances only by a chemical change is a(n) _____.
   a. Solution
   b. homogeneous mixture
   c. heterogeneous mixture
   d. compound

9. The first letter in a properly written chemical symbol is always
   a. bold faced
   b. Capitalized
   c. italicized
   d. underlined

10. The chemical symbol for iron is _____.
   a. Fe
   b. *FE*
   c. Fe
   d. Ir

11. Which of the following represents a compound?
a. H
b. H-3
c. H_2O
d. O-16

12. Which of the following is a chemical property?
a. Color
b. hardness
c. freezing point
d. ability to react to oxygen

13. Which of the following is a chemical change?
a. grating cheese
b. melting cheese
c. fermenting cheese
d. mixing two cheeses in a bowl

14. Which of the following is a chemical change to a metal?
a. Bending
b. Melting
c. rusting
d. polishing

15. Which of the following processes involves a change in physical properties?
a. rusting
b. Decomposing
c. boiling
d. burning

16. A chemical change occurs when a piece of wood
a. splits.
b. is painted.
c. decays.
d. is cut.

17. What happens to matter during a chemical reaction?
a. Matter is neither destroyed of created.
b. Some matter is destroyed.
c. Some matter is created.
d. Some matter is destroyed and some is created.

18. Which of following is true for all chemical reactions?
a. The total mass of the reactants increases.
b. The total mass of the products is greater than the total mass of the reactants.
c. The total mass of the products is less than the total mass of the reactants.
d. The total mass of the reactants equals the total mass of the products.

19. Which of the following is a physical property of water?
a. It acts as a universal solvent.
b. It is composed of hydrogen and oxygen that are bound covalently.
c. It “sticks” to itself.
d. All of the above.
e. None of the above.

20. What is one difference between a mixture and a compound?
a. A compound consists of more than one phase.
b. A compound can only be separated into its components by chemical means.
c. A mixture can only be separated into its components by chemical means.
d. A mixture must be uniform in composition.

21. The chemical formula of a compound indicates
a. the source of the elements in the compound.
b. how elements are joined in the compound.
c. the alchemy symbols for the elements in the compound.
d. the relative proportions of the elements in the compound.

22. What must occur for a change to be a chemical reaction?
a. There must be a change in chemical properties.
b. There must be a change in physical properties.
c. The change must involve a change in mass.
d. The change must involve a change in volume.

23. Which of the following is true about homogeneous mixtures?
a. They are known as solutions.
b. They consist of two or more phases.
c. They have compositions that never vary.
d. They are always liquids.

24. Which of the following is true about compounds?
a. They can be physically separated into their component elements.
b. They have compositions that vary.
c. They are substances.
d. They have properties similar to those of their component elements.

25. In the chemical reaction in which sucrose is heated and decomposes to form carbon dioxide and water, which of the follow is a reactant?
a. Sucrose
b. carbon dioxide
c. water
d. heat

26. What is the difference between an atom and a compound?
a. An atom is a single unit particle; whereas, a compound is made up of more than one unit.
b. An atom is made up more than one unit; whereas, a compound is a single unit.
c. An atom is made up of three or more units; whereas, a compound is made up of six units.
d. An atom is made up of zero units; whereas, a compound is made up of one unit.

27. The smallest particle of an element that retains the properties of that element is a(n)
a. Atom
b. electron
c. proton
d. neutron

28. Which of the following is true about subatomic particles?
a. Electrons are negatively charged and are the heaviest subatomic particle.
b. Protons are positively charged and the lightest subatomic particle.
c. Neutrons have no charge and are the lightest subatomic particle.
d. The mass of a neutron nearly equals the mass of a proton.

29. All atoms are
a. positively charged, with the number of protons exceeding the number of electron.
b. negatively charged, with the number of electrons exceeding the number of protons.
c. neutral, with the number of protons equaling the number of electrons.
d. neutral, with the number of protons equaling the number of electrons, which is equal to the number of neutrons.

30. The particles that are found in the nucleus of an atom are _____.
a. neutrons and electrons
b. electrons only
c. protons and neutrons
d. protons and electrons

31. In Bohr's model of the atom, where are the electrons and protons located?
a. The electrons move around the protons, which are at the center of the atom.
b. The electrons and protons move through the atom.
c. The electrons travel in circular orbits around the protons, which are at the center of the atom.
d. The electrons are located throughout the atom, but they are not free to move.

32. What is the number of electrons in the outermost energy level of an oxygen atom?
a. 2
b. 4
c. 6
d. 8

33. The modern periodic table is arranged in order of increasing atomic _____.
a. shape
b. charge
c. number
d. radius

34. Dmitri Mendeleev arranged elements according to the _____ and used the arrangement to predict the properties of missing elements.
a. atomic mass
b. atomic number
c. atomic radius
d. atomic color

35. Which of the following categories includes the majority of the elements?
a. metalloids
b. liquids
c. metals
d. nonmetals

36. Of the elements Pt, V, Li, and Kr, which is a nonmetal?
a. Pt
b. V
c. Li
d. Kr

37. To what category of elements does an element belong to if it is a poor conductor of electricity?

a. transition metals
b. Metalloids
c. nonmetals
d. metals

38. Which of the following elements is a transition metal?

a. Cesium
b. Copper
c. tellurium
d. tin

39. What is the charge of a cation?

a. positive
b. Zero
c. negative
d. neutral

40. Which of the following statements is true about ions?

a. Cations form when an atom gains electrons.
b. Cations form when an atom loses electrons.
c. Anions form when the gain protons.
d. Anions form when the lose protons.

41. What is between the nucleus and the electrons in an atom?

a. A gelatin-like substance
b. Protons and neutrons
c. A pudding-like substance
d. Empty space

Matching: *Match each item with the correct statement below.*

a. mixture
b. product
c. heterogeneous mixture
d. reactant
e. homogeneous mixture
f. chemical reaction

____42. a substance formed in a chemical reaction
____43. not uniform composition (can see different pieces)
____44. uniform composition (cannot see different pieces)
____45. a physical blend of two or more compounds
____46. process in which substances are changed into different substance
____47. starting substance in a chemical reaction

a. Mass
b. compound
c. element
d. atom

____48. substance that cannot be changed into simpler substances by chemical means
____49. amount of matter an object contains
____50. composed of two or more substances chemically combined in a fixed proportion
____51. the smallest particle that has the properties of an element

a. Proton
b. nucleus
c. electron
d. neutron

____52. A positively charged subatomic particle.
____53. A negatively charged subatomic particle.
____54. A subatomic particle with no charge.
____55. The central part of the atom, containing protons and neutrons.

a. Alkali metals
b. Transition metals
c. Noble Gases
d. Halogens

____56. A class of elements that will easily gain on valence electron.
____57. A class of elements that is highly reactive with water.
____58. A class of elements that is unreactive with a full valence shell.
____59. A class of elements that are great conductors, malleable, ductile, and have a luster.
____60. He
____61. Cu
____62. Cl
____63. Na

Short Answer

64. During Mr. Morton's chemistry class, he decided to show off gas laws in a demonstration. He filled a coke can with 25 mL of water and brought it to a boil. He then took the can and flipped it upside down in an ice bath. When he did this, the can crushed together. Why did this happen? Explain your answer using the following terms:
- temperature
- pressure
- distance of gas molecules
- speed of gas molecules

65. Describe the size and scale of an atom. Explain the relative size of the nucleus in relation to the size of the entire atom.

66.**Element Table:** *Properly fill the appropriate blanks that best completes the table.*

Element	**Hydrogen**	**Carbon**
Symbol		
Atomic Number		
Atomic Mass		
# of Protons		
# of Neutrons		
# of Electrons		

Valence Electrons		
Lewis Dot Structure		
Energy Shell Diagram		

Appendix D. Unit Post-Test

Chemistry Post-Test
Matching

Match each item with the correct statement below.

a. Mass
b. Compound
c. element
d. atom

____1. the smallest particle that has the properties of an element
____2. composed of two or more substances chemically combined in a fixed proportion
____3. substance that cannot be changed into simpler substances by chemical means
____4. amount of matter an object contains

a. Alkali metals
b. Transition metals
c. Noble Gases
d. Halogens

____5. He
____6. Cu
____7. A class of elements that are great conductors, malleable, ductile, and have a luster.
____8. A class of elements that is unreactive with a full valence shell.
____9. A class of elements that is highly reactive with water.
____10. A class of elements that will easily gain on valence electron.
____11. Na
____12. Cl

a. Mixture
b. Product
c. heterogeneous mixture
d. reactant
e. homogeneous mixture
f. chemical reaction

____13. starting substance in a chemical reaction
____14. not uniform composition (can see different pieces)
____15. a substance formed in a chemical reaction
____16. process in which substances are changed into different substance
____17. uniform composition (cannot see different pieces)
____18. a physical blend of two or more compounds

a. Proton
b. Nucleus
c. electron
d. neutron

____19. A negatively charged subatomic particle.
____20. The central part of the atom, containing protons and neutrons.
____21. A positively charged subatomic particle.
____22. A subatomic particle with no charge.

Short Answer

23. Describe the size and scale of an atom. Explain the relative size of the nucleus in relation to the size of the entire atom.

24. During Mr. Morton's chemistry class, he decided to show off gas laws in a demonstration. He filled a coke can with 25 mL of water and brought it to a boil. He then took the can and flipped it upside down in an ice bath. When he did this, the can crushed together. Why did this happen? Explain your answer using the following terms:
- temperature
- pressure
- distance of gas molecules
- speed of gas molecules

25.**Element Table**: *Properly fill the appropriate blanks that best completes the table.*

Element	**Hydrogen**	**Carbon**
Symbol		
Atomic Number		
Atomic Mass		
# of Protons		
# of Neutrons		
# of Electrons		
Valence Electrons		
Lewis Dot Structure		
Energy Shell Diagram		

Multiple Choice
Identify the choice that best completes the statement or answers the question.
26. Which of the following is true about compounds?
a. They can be physically separated into their component elements.
b. They have compositions that vary.
c. They are substances.
d. They have properties similar to those of their component elements.

27. In the chemical reaction in which sucrose is heated and decomposes to form carbon dioxide and water, which of the follow is a reactant?
a. Sucrose
b. carbon dioxide
c. water
d. heat

28. The first letter in a properly written chemical symbol is always
a. bold faced
b. capitalized
c. italicized
d. underlined

29. Which of the following is a chemical property?
a. Color
b. hardness
c. freezing point
d. ability to react to oxygen

30. The chemical symbol for iron is _____.
a. Fe
b. *FE*
c. Fe
d. Ir

31. Which of the following is a chemical change to a metal?
a. bending
b. melting
c. rusting
d. polishing

32. Which of the following is a physical property of water?
a. It acts as a universal solvent.
b. It is composed of hydrogen and oxygen that are bound covalently.
c. It "sticks" to itself.
d. All of the above.
e. None of the above.

33. Which of the following processes involves a change in physical properties?
a. rusting
b. decomposing
c. boiling
d. burning

34. To what category of elements does an element belong to if it is a poor conductor of electricity?
a. transition metals
b. metalloids
c. nonmetals
d. metals

35. Which of the following is a heterogeneous mixture?
a. vinegar in water
b. Milk
c. oil and vinegar
d. air

36. Which of the following is a homogeneous mixture?
a. salt water
b. beef stew
c. sand and water
d. soil

37. Which of the following is a chemical change?
a. grating cheese
b. melting cheese
c. fermenting cheese
d. mixing two cheeses in a bowl

38. What must occur for a change to be a chemical reaction?
a. There must be a change in chemical properties.
b. There must be a change in physical properties.
c. The change must involve a change in mass.
d. The change must involve a change in volume.

39. The modern periodic table is arranged in order of increasing atomic _____.
a. Shape
b. Charge
c. number
d. radius

40. Which of following is true for all chemical reactions?
a. The total mass of the reactants increases.
b. The total mass of the products is greater than the total mass of the reactants.
c. The total mass of the products is less than the total mass of the reactants.
d. The total mass of the reactants equals the total mass of the products.

41. Which of the following best represents a physical property?
a. Explosive
b. combustible
c. melting point
d. ability to rust

42. The particles that are found in the nucleus of an atom are _____.
a. neutrons and electrons
b. electrons only
c. protons and neutrons
d. protons and electrons

43. The chemical formula of a compound indicates
a. the source of the elements in the compound.
b. how elements are joined in the compound.
c. the alchemy symbols for the elements in the compound.
d. the relative proportions of the elements in the compound.

44. What is the difference between an atom and a compound?
a. An atom is a single unit particle; whereas, a compound is made up of more than one unit.
b. An atom is made up more than one unit; whereas, a compound is a single unit.
c. An atom is made up of three or more units; whereas, a compound is made up of six units.
d. An atom is made up of zero units; whereas, a compound is made up of one unit.

45. A chemical change occurs when a piece of wood
a. splits.
b. is painted.
c. decays.
d. is cut.

46. Which of the following is true about subatomic particles?
a. Electrons are negatively charged and are the heaviest subatomic particle.
b. Protons are positively charged and the lightest subatomic particle.
c. Neutrons have no charge and are the lightest subatomic particle.
d. The mass of a neutron nearly equals the mass of a proton.

47. Which of the following elements is a transition metal?
a. cesium
b. copper
c. tellurium
d. tin

48. Which of the following can be classified as a mixture?
a. pure water
b. pure air
c. pure nitrogen
d. pure gold

49. The smallest particle of an element that retains the properties of that element is a(n)
a. Atom
b. Electron
c. proton
d. neutron

50. What is between the nucleus and the electrons in an atom?
a. A gelatin-like substance
b. Protons and neutrons
c. A pudding-like substance
d. Empty space

51. What is one difference between a mixture and a compound?
a. A compound consists of more than one phase.
b. A compound can only be separated into its components by chemical means.
c. A mixture can only be separated into its components by chemical means.
d. A mixture must be uniform in composition.

52. Which of the following best represents a physical change?
a. corrosion
b. explosion
c. evaporation
d. rotting of food

53. What is the charge of a cation?
a. Positive
b. Zero
c. negative
d. neutral

54. Which of the following represents a compound?
a. H
b. H-3
c. H_2O
d. O-16

55. Which of the following categories includes the majority of the elements?
a. metalloids
b. Liquids
c. metals
d. nonmetals

56. Which of the following is true about homogeneous mixtures?
a. They are known as solutions.
b. They consist of two or more phases.
c. They have compositions that never vary.
d. They are always liquids.

57. Which of the following is a heterogeneous mixture?
a. Air
b. salt water
c. steel
d. soil

58. What happens to matter during a chemical reaction?
a. Matter is neither destroyed of created.
b. Some matter is destroyed.
c. Some matter is created.
d. Some matter is destroyed and some is created.

59. Which of the following statements is true about ions?
a. Cations form when an atom gains electrons.
b. Cations form when an atom lose electrons.
c. Anions form when the gain protons.
d. Anions form when the lose protons.

60. In Bohr's model of the atom, where are the electrons and protons located?
a. The electrons move around the protons, which are at the center of the atom.
b. The electrons and protons move through the atom.
c. The electrons travel in circular orbits around the protons, which are at the center of the atom.
d. The electrons are located throughout the atom, but they are not free to move.

61. What is the number of electrons in the outermost energy level of an oxygen atom?
a. 2
b. 4
c. 6
d. 8

62. A substance that can be separated into two or more substances only by a chemical change is a(n) _____.
a. Solution
b. homogeneous mixture
c. heterogeneous mixture
d. compound

63. Separating a solid from a liquid by evaporating the liquid is called _____.
a. Filtration
b. Condensation
c. solution
d. distillation

64. Of the elements Pt, V, Li, and Kr, which is a nonmetal?
a. Pt
b. V
c. Li
d. Kr

65. All atoms are
a. positively charged, with the number of protons exceeding the number of electron.
b. negatively charged, with the number of electrons exceeding the number of protons.
c. neutral, with the number of protons equaling the number of electrons.
d. neutral, with the number of protons equaling the number of electrons, which is equal to the number of neutrons.

66. Dmitri Mendeleev arranged elements according to the _____ and used the arrangement to predict the properties of missing elements.

a. atomic mass
b. atomic number
c. atomic radius
d. atomic color

Appendix E. QAR Questionnaire

QAR Questionnaire

Please complete the questionnaire by circling the numbers that correspond to your answers to each question. Your honest answers are greatly appreciated and will not count against your overall grade. 3 represents being 100% confident and 0 represents being 0% confident. Survey modified from: https://www.ecu.edu/cs-educ/opd/upload/ConfidenceQuestionnaire.pdf

	I am not confident	**I'm not very confident**	**I'm somewhat confident**	**I'm very confident**
I comprehend what I read (as I am reading, I understand what the text is talking about).	0	1	2	3
I like to read in the science classroom.	0	1	2	3
I like to read outside of class (library book).	0	1	2	3
I maintain my focus on the text while I read.	0	1	2	3
I know how and am able to use the question-answer relationship (QAR) reading strategy.	0	1	2	3
I am familiar and use QAR's to help me when I am struggling (i.e. get confused) with the text.	0	1	2	3
I like help (through a reading strategy like QAR) to comprehend what I have read.	0	1	2	3
I am engaged when I am reading my science text.	0	1	2	3
I am engaged when I am reading outside of the science classroom (library book).	0	1	2	3
Reading strategy (QAR) increases my confidence in the content.	0	1	2	3
Reading strategy (QAR) increases my knowledge of the content.	0	1	2	3

Appendix F. QAR Student Instruction Sheet

Question-Answer Relationship (QAR) Reading Comprehension Strategy Student Instruction Page

Purpose: To help you understand the relationship between questions and answers.

Materials:
One file folder, paper, stapler, two markers, sentence strips, reading page

Procedure:

Set-up

1. Obtain a file folder.
2. Write your name on the front of the file folder (you will be able to go back and decorate later).
3. Open the file folder and obtain 20 pieces of notebook paper.
4. Staple ten pieces of paper to one side and ten pieces of paper to the other side.
5. At the top of the paper (on the left-hand side) write "Author".
6. At the top of the paper (on the right-hand side) write "Author and I".

Execution

7. Obtain the set of questions regarding the reading page.

8. Sort questions based on:

    a. Author: questions can be answered directly from the reading. No background knowledge of the topic is required.

    b. Author and I: questions can only be answered through knowledge gained from the author and by use of background knowledge.

9. Once questions are sorted, obtain a reading page.

10. Reading the article with questions in mind.

11. After reading the article, resort the questions into the categories.

12. Once questions have been checked by instructor, paste the questions on the notebook paper (or write them in). Be sure to leave enough space for your answer.
13. Answer the questions below each question.

Completion

14. Please place these set of instructions in your folder and close your folder.

15. When finished, place your file folders in the collection tray for safe keeping with your name up.

16. Next time you come to class, please grab your file folder.

Appendix G. QAR Sample Questions

The questions are categorized based on where they should be placed. Students would not receive questions that are already categorized.

Author:

- What is an atom made up of?
- What does "universal solvent" mean?
- Does every material act as a solvent? If not, what are some examples?
- Explain the difference between homogeneously and heterogeneously.

Author and I:

- Draw an atom (use three different colors to represent the protons, neutrons, and electrons).
- In your own words, what does insoluble mean?
- Provide an example of a heterogeneous and homogeneous mixture in real life (not one provided in your reading page).
- Why is water considered a universal solvent (please use specific information from the text to justify your answers)?

Appendix H. Sample of student work.