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Using Question Answer Relationships in Science Instruction to Increase the Reading Achievement of Struggling Readers and Students with Reading Disabilities

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The Question Answer Relationship (QAR) literacy strategy was integrated into science instruction in a fourth grade classroom. Ten students who struggled with reading, including some who were diagnosed with a reading disability, participated in this study. Significant gains were made in reading by the 10 student participants in comprehending science expository text after a 4- week implementation period. The general education teacher showed an increase in her ability to assist these struggling students after receiving training and constant support over the 4-week instructional period.

Keywords: reading in the content areas, question answer relationships, assisting struggling readers

In 2007-2008, standardized testing in science became mandatory in the United States. The 2009 results of the National Assessment of Educational Progress (NAEP) science assessment were very discouraging regarding the progress students were making in this content area. The majority of students in 4th and 8th grades scored at or above basic, and only 30% scored at or above proficient at both grade levels (National Center for Educational Statistics, 2011).

This lack of progress should not be surprising. The No Child Left Behind Act of 2001 has left schools and districts little choice but to place the strongest instructional emphasis for student achievement on reading; therefore, reading instruction is the main focus in most primary classrooms. Science has been omitted from many children's early school experiences resulting in students moving into the upper elementary grades with large deficits in reading the technical language of the science textbook (Cunningham & Allington, 2007).

The integration of reading strategies into science instruction provides a means for increasing student achievement in both content areas. Integrating reading strategies into science could prove especially beneficial for students who struggle in reading and students in special education who have been diagnosed with a reading disability. A review of the literature indicates that very few studies have been conducted in this area.

In 2004, Hall published a meta-analysis of studies conducted between 1940 and 2004 that identified promising strategies for students who were experiencing problems in comprehending expository texts. Results indicated that few studies focused upon reading and comprehending science text. None of the studies focused upon elementary-aged students, and many of the studies involving middle school students included a minimal number of students who had been diagnosed with reading disabilities. This indicates a need for research in the area of the identification of reading strategies that improve

students' ability to comprehend science material. By teaching students to apply strategies that will assist them in understanding science content area materials, standardized test scores may increase in the areas of reading and science.

This study focused upon increasing the reading achievement of struggling readers and students in special education had been diagnosed with reading disabilities through the integration of a reading comprehension strategy into science instruction. It was conducted in a fourth grade classroom. Fourth grade was selected because at this grade level the science textbook becomes increasingly difficult to read and comprehend.

The Question Answer Relationship (QAR) comprehension strategy was integrated into science instruction. This literacy strategy was selected because it has proven to lead to achievement gains for struggling readers and students who have been diagnosed with disabilities in the area of reading (Raphael, 1982).

The term *students with reading disabilities* was defined in this study as students who showed a discrepancy between their reading ability and achievement and read 3 to 7 years below grade level (Bakken, Mastropieri, & Scruggs, 1997; Bos, Anders, Filip, & Jaffe, 1989). These students were all enrolled in special education. The term *struggling readers* referred to "readers who have average to above average intelligence with reading skills that fall two or more years below their intellectual level, but have not been identified as having a learning disability" (Zecker & Zinner, 1987, as cited in Hall, 2004, p.77). These students were not enrolled in special education. Ten fourth grade students all of whom were either struggling readers or students enrolled in special education who had been diagnosed with a reading disability received this integrated instruction. They were provided their science instruction by a general education teacher. The teacher taught three sections of science; all classes were ability grouped. The special education teacher came into the classroom to assist the students with special needs during this instructional period.

Reading Strategy Instruction in Science

Gunning (2003) defines strategies as "deliberate, planned procedures designed to help us reach a goal" (p. 279). Anderson and Roit (1993) give a more detailed definition of the term which stresses the role of existing mental abilities used to form new strategies. They define strategy as "a thoughtful and effortful mental act designed to maintain existing mental competencies when those competencies are taxed" (p. 126). Pressley (2002) contends that many teachers provide students with opportunities to practice comprehension strategies, but do not actually teach students the strategies or how to apply them.

Research has indicated that all students, especially those with deficits in reading, need explicit instruction in applying reading comprehension strategies while reading science text (Neufield, 2005; Radcliffe, Caverly, Peterson, & Emmons, 2004). Science texts are predominantly expository in nature whereas most of the students' reading instruction is focused on narrative text. Many upper elementary teachers have not been trained in how to infuse explicit reading comprehension strategy instruction into other content areas. They are unaware that literacy strategies that have been proven effective in increasing students' reading comprehension can be easily integrated into content areas such as science. Many upper elementary teachers need training in effective implementation of specific reading comprehension strategies. This is especially important for those teach students with learning disabilities who are included in the general education classroom. In many instances, teachers may be aware of the strategies, yet they have not been provided with support in strategy implementation with struggling readers and feel inadequate in using the strategies effectively.

"In the upper elementary grades, reading comprehension, or the ability to construct meaning from a variety of texts, can be the key to academic success" (Mason, Meadan, Hedin, & Corso, 2006, p. 47). Students must learn that reading expository text is much different from reading narrative text, which is what most students have been exposed to in the primary grades in elementary school (Bakken et al., 1997; Frey & Fisher, 2007). While commercial reading programs have integrated more science material into basal readers (Norris et al., 2008), comprehension strategies to assist students in comprehending the material may not be included with the teacher directions.

Struggling readers and students who have been diagnosed with reading disabilities who have been taught comprehension strategies in the primary grades are likely to show difficulties in transferring the specific strategies and skills to expository text in the content area reading materials (Anderson & Roit, 1993). These students must have assistance in making this transfer in order to improve in their reading abilities. Teaching students to apply these specific comprehension strategies must not be left just to the language arts teachers, or within the domain of language arts. They should be taught in other content areas as well (Neufield, 2005). The QAR strategy can easily be applied in all content areas.

QAR Comprehension Strategy

Raphael (1982, 1986) devised the QAR strategy as a way for students to understand that the answer to a question is directly related to the type of question that is asked. QAR assists students in differentiating among questions based on where the answer can be found: either *In the Book* or *In My Head* (Caldwell & Leslie, 2005). If answers are In the Book, the questions will be of a literal type because the answers are "right there" in the text. If the questions are *In My Head*, inferential questions have been posed, and readers must use their own background

knowledge to compose answers that require information not found in the text (Tompkins, 2004).

The two categories of questions, *In the Book* and *In My Head* can be further delineated into four subcategories. When questions are posed whose answers can be found *In the Book*, students will find them either *Right There* in one place in the text, or they will have to *Think and Search*. This means that students will need to look in several places in the text to find the answer. Questions that fall under the heading of *In My Head* are going to be deemed either *Author and You* or *On My Own* questions. For answers to *In My Head* questions, students will need to use their own background knowledge and experiences in addition to the textual information to answer the question. If the answers to the questions are found *On my Own*, students must rely solely on background experiences and knowledge to answer the question (Frank, Grossi, & Stanfield, 2006).

In addition to assisting students in knowing how to relate the questions to their answers, the QAR provides a framework for comprehension strategy instruction. The questions posed before, during, and after reading require students to use multiple comprehension strategies as they formulate their answers (Raphael, Highfield, & Au 2006). For example, students will recall information, make predictions, synthesize information, make connections, and use text structures when answering the questions. They learn that good readers use multiple strategies, and, in many cases, strategies are used simultaneously, when reading a text to find information.

Many research studies have been conducted in the upper elementary grades, (grades 3-6), and in middle and high school, (Ezell, Hunsicker, & Quinque, 1997; Ezell, Hunsicker, Quinque, & Randolph, 1996; Ezell, Kohler, Jarzynka, & Strain, 1992; Graham & Wong, 1993; Raphael & McKinney, 1983; Raphael & Pearson, 1982; Raphael & Pearson, 1985; Raphael & Wonnacutt, 1985) which prove that QAR improves students' reading comprehension. Therefore, it would seem logical that integrating the QAR into science instruction would increase students' reading comprehension of science materials.

Method

Participants

Participants in this study were 10 fourth grade students in a science class in a rural elementary K-5 school in a large public school district located in the southeastern United States. All of the participants had either been diagnosed with a reading disability and were in the special education program, or were classified as struggling readers. Half (five) of the participants were boys and half (five) were girls. Four of the boys were white and one was African-American. Three white girls and two African-American girls participated. These students were homogeneously grouped by ability and changed classes throughout the day. This was strictly a study to compare the pretest and posttest results of this one small group of students. No control group was used for comparison because the students were grouped for science in homogeneous groups. This was the only group of students in the fourth grade who had been diagnosed with a reading disability or who struggled in reading. There was no other like group with whom to compare the scores. In addition, the study was primarily undertaken to see if the general education teacher could implement QAR instruction and whether there would be preliminary evidence of its influence on students' reading abilities.

One general education classroom teacher with 4 years of teaching experience provided science instruction to the student participants. This teacher had three sections of ability grouped students who came to her classroom specifically for science instruction. She used QAR with one of these sections of students for this study. She was chosen to participate based on her interest in improving these students' reading abilities. She was unfamiliar with the QAR strategy prior to this study, and but had no knowledge of ways to integrate reading strategies into content area instruction. This teacher provided direct instruction in science using QAR during a four 4 week implementation period. She designed and taught lessons each week that integrated the strategy.

A special education resource teacher came into the classroom during science and lent support to the special education students who had been identified with a reading disability. The special education teacher did not provide any instruction related to the QAR strategy. Her role as a participant in this study was to administer an informal reading inventory to each student participant. The informal reading inventory was administered before and after the implementation period and served as a pretest and posttest.

Measures

The Analytical Reading Inventory, (ARI, 8th ed., Wood & Moe, 2007), an informal reading assessment tool, was administered as a pretest and posttest in this study. This informal reading inventory was chosen because the questions posed for selections correspond with the question types in the QAR strategy. The question types included in the inventory and their correlation to QAR question types are:

ARI Question Type	QAR Question Type
Retells in Fact (RIF)	Right There
Puts Information Together (PIT)	Think and Search
Connects Author and Reader (CAR)	Author and Me
Evaluates and Substantiates (EAS)	On My Own

Sample questions from the ARI for the first grade passage on the topic of the five senses were:

1. How many senses do we have? (RIF/Right There)
2. What do you know about the phrase the five senses? What does the five senses have to do with this text? (CAR/Author and Me)
3. What did the text say we can learn about when we see? (RIF/Right There)
4. Why can we hear our name called out? (PIT/Think and Search)
5. What sense helps us know how soft a kitten feels? (RIF/Right There)
6. In your opinion, what would life be like without all five senses? You think this because… (EAS/On My Own).

An additional reason for selection of the ARI was because it contains specific content related passages that can be used to assess reading comprehension in those areas. Science text passages were used to determine each student's reading level (pretest) and the progress made over the four week period (posttest).

A dependent samples *t* test was used to analyze pretest and posttest data. An interview was conducted with the classroom teacher at the end of the intervention period to gather descriptive data. The purpose of the interview was to gain information regarding the teacher's perspective about the effectiveness of integrating the QAR into science instruction. Since she had no prior experience or training in this method of teaching, the interview provided information regarding how she viewed QAR's effectiveness in assisting struggling readers in comprehending science text. It would also offer insights into how confident she felt in using the teaching method following teacher training.

The first author held a one day training session for the classroom teacher on the use of the QAR reading comprehension strategy and how to effectively integrate it into science instruction. The special education teacher attended a half day training session taught by the first author in correct administration of the ARI.

Procedures

The ARI was administered to each student by the special education teacher before and after the 4 week implementation period. The results served as the pretest and the posttest. In administering any informal reading inventory, a graded word list is used to determine the reading level of the comprehension passage that will be read by the student. The special education teacher followed all of the directions for properly administering the assessment. Because the ARI has passages from specific content areas that can be used to assess reading comprehension, science expository passages were read by the students to determine their reading levels. None of the passages used were on the topic of *Force and Motion* which was the unit of study students would be learning during the four week implementation period. The topics of the passages used were:

1st Grade-The Five Senses
2nd Grade-Hearing Sounds
3rd Grade-Changing Matter
4th Grade-A Comet

Students read the passages aloud, and the special education teacher then asked students the comprehension questions from the passage. Based on the ARI pretest results, three students were reading at the first grade level, one at the second grade level, five at the third grade level, and one was reading on grade level.

The first author provided support to the classroom teacher during the 4 week intervention period by observing the science lessons that integrated the QAR strategy. Over the 4 week period, the classroom teacher used this strategy in each 50 minute science lesson for a total of 20 lessons. Meetings between the classroom teacher and first author followed each lesson for the purpose of debriefing. These observations verified that instruction in the identification and use of QAR strategies were part of the teachers' daily science instruction. Likewise, all of the students were observed using QAR strategies to answer questions during their science class.

During the intervention period, the classroom teacher used the fourth grade science textbook and children's books of expository text on the topic of *Force and Motion*. If the text being used was the science textbook, the teacher read the text aloud to the students as they followed along in their textbooks. If the text used was a children's expository trade book, the teacher read the book aloud as the students listened.

The teacher explicitly taught the four different types of questions during the first 2 weeks of the intervention and had students practice identifying each type of question based on the science text she used for the lesson. She created motivating, engaging lessons for students that involved them in a lot of interaction and discussion. The special education teacher worked with the students with special needs during these lessons, giving them support as was needed. The special education teacher provided help in both the identification of questions and the use of the QAR strategies.

During the 3rd and 4th weeks, the students applied their knowledge of the four types of questions to identify the kind of question being asked, and to answer the questions. The teacher used questions that were included in the science textbook for the lessons from the book, and she created the questions when trade books were used. She made sure to create questions from all four categories in the QAR for the lessons and activities. These lessons were also very motivating and engaging. Students were

involved in activities that involved small group work, as well as whole group and partner lessons. The special education teacher assisted the students with special needs during these lessons.

At the end of the 4 week implementation period, the special education teacher, once again, administered the comprehension section of the ARI to each student. The same science passages were used that had been administered for the pretest. This was used as posttest data. Because the duration of the study was only 4 weeks, it was decided not to administer the graded word lists as part of the posttest. The focus of the study was to find if instruction in the QAR strategy and application of the strategy would assist students in comprehending science content material; it was not expected nor anticipated that students' grade levels in reading would change.

Results

All students' reading comprehension scores improved from the pretest to the posttest. A dependent samples *t* test computed on the percent of items correct indicated that students' posttest scores were higher than their pretest scores. In addition, significant differences between pretest and posttest scores were found for the four different types of questions, as can be seen in Table 1. As can be seen in Table 2, the students had a significantly higher percentage of questions answered correctly on the overall ARI and for all question types after the intervention. Removing the one student whose reading level was at grade level, did not change the pattern of results.

Table 1
Results of Dependent t Tests for Pretest and Posttest Scores on the ARI and Four Question Types (N = 10)

Score	*df*	*t*	*p*	*Cohen's d*
ARI total score	9	8.46	.00	2.27
Right There	9	6.00	.00	2.53
Think and Search	9	2.76	.02	0.68
Author and Me	9	3.00	.02	1.22
On My Own	9	.3.67	.01	1.47

Table 2
Percent Correct on ARI and Four Question Types (N = 10)

Score	*M*	*SD*	*SEM*
ARI total score pre	.41	.25	.08
ARI total score post	.85	.12	.04
Right There pre	.40	.26	.08
Right There post	.93	.14	.04
Think and Search pre	.48	.39	.12
Think and Search post	.73	.34	.11
Author and Me Pre	.35	.47	.15
Author and Me Post	.85	.38	.11
On My Own Pre	.30	.48	.15
On My Own Post	.90	.32	.10

The interview with the classroom teacher provided insights regarding the importance of teacher training and support in the effective integration of the QAR literacy strategy into science instruction for struggling students. Her comments indicated an increase in her confidence level in effectively teaching these students to read science content material.

Discussion

The results of this study show that the integration QAR literacy strategy can be successfully implemented into science instruction and as a collateral effect it may increase the reading achievement of both struggling readers and students with a reading disability. Though this was an extremely small sample of students, it is very promising because of the significant increase in the students' ability to answer comprehension questions after reading science text over the 4 week period. The significant differences for all four question types for all students from pretest to posttest for these 10 participants (all of whom struggled with reading) is an indicator of the impact this strategy may have in assisting students in comprehending science text. For these students, reading expository text, specifically science expository text, is very frustrating. When shown specific strategies that enable them to be successful, they can achieve success. Future studies will need to build upon this and provide empirical evidence of the QAR strategy's impact upon student achievement in science.

One extremely interesting result of this study was that the students made the highest gains in the two types of higher-order thinking types of questions, *Author and Me* and *On My Own*. The first author had no information regarding any other type of instruction regarding critical thinking skills that these students received during this intervention period in other classes; however, this may have had an effect on the results if this instruction was in place. However, because the progress in these two types of questions was significant, the implication is that students who struggle to read may benefit from strategies such as the QAR to enhance their critical thinking skills. *Author and Me* type questions require students to use information from the book and their background knowledge to answer the questions. *On My Own* types of questions require students to rely solely on background knowledge. Therefore, students must analyze, synthesize, and evaluate the information in order to generate the answers to these types of questions (Raphael et al., 2006). In the content area of science, as students move into higher grade levels, the text becomes more difficult, and more critical thinking is needed in order to be successful in this area. This strategy can assist teachers in ways to help struggling students perform at these higher levels of thinking.

The interview with the classroom teacher showed the importance of teacher training and support for teachers working with struggling readers. Integrating a literacy strategy into science instruction was a very new idea for this teacher. Because she was working with this self-contained ability group of struggling readers, she lacked confidence in being able to teach them effectively. The idea of integrating a literacy strategy into science instruction was very intimidating for her at the beginning of the study.

In the interview, the teacher stated that "the training made her much more aware of how literacy strategies can be used with students with reading disabilities and students who struggle with reading." She said that after receiving the training that she "was anxious to implement the strategy with her students." This showed that her confidence level had risen after the one day of training because of her excitement to begin using the information in her lessons.

She mentioned several times that she had never been told that reading comprehension strategies could be used to teach science, or any other content area. She alleged that even if she had learned this in her college training, she probably would have been resistant to do with this group of students because she thought she might "do something wrong" since she had not been trained as a special education teacher. Her comments are very telling with regard to the importance of general education teachers' attitudes toward working with special education students and low ability students. Mungai and Devin (2002) explain just how important this is when working with students with special needs. They state, "Teacher attitudes and behaviors in the classroom have the most immediate and powerful impact on students' academic development and performance" (p. 44).

When specifically asked about the QAR strategy, one comment the teacher made referred to the fact that she had not realized "how easily reading comprehension strategies could be incorporated into science instruction." She said that learning how to present the material and the questions in a way that would hold the students' interest made her realize how students, especially students who struggled with reading, could be explicitly taught how to look at specific questions that were being asked and find clues in the questions that would lead them to the answers. She went on to say that it was extremely difficult for them to answer questions, especially in science, because the content was difficult for them to understand. She discovered, through the QAR strategy instruction training, "that even struggling readers can be shown how to be successful at answering questions." The first author noticed during the observation periods, the progression of both students and the teacher in feeling comfortable with the strategy. The students had difficulty in the beginning, which the teacher attributed to them not having been exposed to any strategies that focused on questions as most focus on answers. As the lessons progressed, she

became more confident in creating the lessons and the questions, and the students became much better at determining and creating the different question types.

The teacher also described how her perceptions had changed regarding how students with reading disabilities and students who are struggling to read learn to read expository text. She stated, "I would definitely say that this strategy worked. My students were all interested in my lessons, and they were taking pride in searching for the correct answers." She went on to say, "This made a huge difference in my class and it helped me to realize just how capable my students are." She stated that in the future she would use the QAR strategy with struggling readers and students with reading disabilities.

Conclusion

The QAR strategy can be introduced to and effectively used in elementary science instruction. The teacher, with minimal professional development on the use of QAR, was able to implement this strategy when teaching 4th grade science to struggling readers and students with reading disabilities. Students were able to learn to and use the QAR strategies in the context of their science class. There is also evidence that this strategy instruction may have lead to improved reading abilities. Future studies will need to investigate the use of the QAR strategy in science instruction.

A very important component of assisting these students was teacher training and support. The comments from the interview with the teacher following the intervention period supported the significance of how the training and support gave her confidence to work with struggling readers.

Further studies need to be conducted with a larger sample of students (including using a control group) and in different content areas in order to document the progress struggling readers might make by using the QAR strategy. The integration of other literacy strategies into science instruction should also be investigated. It was found in this study, that when a general education teacher was given training and support in effective strategy use in content area instruction, she was more likely to use the strategies in her teaching of low ability students. Many general education teachers simply need the confidence that they can assist these students in being successful.

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