

# Purposeful Instruction

## MIXING UP THE “I,” “WE,” AND “YOU”

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Would you vote for a toilet-to-tap initiative? Although the idea sounds revolting, you know how to build knowledge to answer this question. Students must be taught these same inquiry skills.

Science is a challenging subject. The widely reported Trends in International Mathematics and Science Study (Williams et al., 2009) found that American eighth graders ranked 11th worldwide in scientific knowledge, with some subgroups, including African Americans and Hispanics/Latinos, ranking even lower. There have been numerous calls for reform in science education (AAAS, 1993; National Research Council [NRC], 1996; Rutherford & Ahlgren, 1989), especially inquiry-based instruction intended to enable students to understand how to solve problems by sharing dilemmas that invite weighing evidence, drawing on background knowledge, and considering possible explanations for data (Minner, Levy, & Century, 2010).

The reading, writing, and language demands of science are substantial, and as Lemke (1990) noted, the conceptual density of scientific themes makes it difficult for many students to engage in scientific discourse. Although inquiry-based instruction might appear easy, implementation involves multiple factors, including critical thinking skills, the ability to draw on prior knowledge, and the capacity to use terminology that describes the science being considered. In essence, inquiry learning requires a foundation of specialized information.

For decades literacy researchers (Herber, 1970) have advocated for fostering text comprehension skills that cause students to note text structures, vocabulary, and organizational devices that aid in understanding science texts. Researchers have also focused on the role of the text, the reader, and the instruction the reader receives (Hand et al., 2003; Ritchie, Tomas, & Tones, 2011). Some see these approaches as being in conflict with inquiry approaches (Kirschner, Sweller, & Clark, 2006). After all, how can essential content literacy skills be taught within the context of inquiry-based instruction, which relies on discovery and self-direction? As a case in point, consider the experiences of a student we know. Cesar attends a typical comprehensive middle school in an urban neighborhood where we have the opportunity to work with the teachers and assigned university students. Recently the first author



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observed a class at the request of Cesar's teacher, Mr. Barnett, during a week when his sixth-grade students were starting a new unit in science. The description noted below resulted from the qualitative data she collected. The following observation notes and student thoughts from interviews with Cesar and two of his classmates were then discussed and analyzed with the other authors, and resulting suggestions were shared with Mr. Barnett, who is intent on engaging his students in effective scientific inquiry.

### The Observation

Cesar's class is studying the pH of the oceans and its effects on marine organisms. They are addressing the content standard: the number and types of organisms in an ecosystem depend on factors such as the amount of light, the pH of the environment, and/or the temperature range. The current lesson focuses on the pH component of this standard. After viewing a short video clip that was included with the textbook, Mr. Barnett plans to have students observe how increasing acidity, an effect of the burning of fossil fuels, affects calcium carbonate. Here's a portion of what Cesar and his peers have been assigned to read:

Increased concentrations of carbon dioxide in the atmosphere indicate that more of the gas is dissolved in seawater. This results in a rise in pH and a corresponding increase in acidity. The consequences for marine organisms could verge on being called catastrophic. Recent studies, including one significant publication in the journal *Nature*, have homed in on carbon-dioxide-rich environments, such as the underwater vents off the Italian coast. At these vents, carbon dioxide is emitted, causing the surrounding area to be markedly more acidic than other regions of the ocean. Sea urchins and sea snails similarly seem to suffer negative effects to populations that are located closer to the vents.

Cesar's head reeled as he attempted to read this passage. Struggling to recall what he had learned about acids and bases in earlier grades, he remembered that a particular type of scale is used to measure pH. Wracking his brain to recall past learning, Cesar asked, "Which has a low number and which has a high number? Acids or bases?" He remembered that the element hydrogen was involved, but that's about all. The phrase about chemical carbon dioxide was confusing, too. In addition to remembering

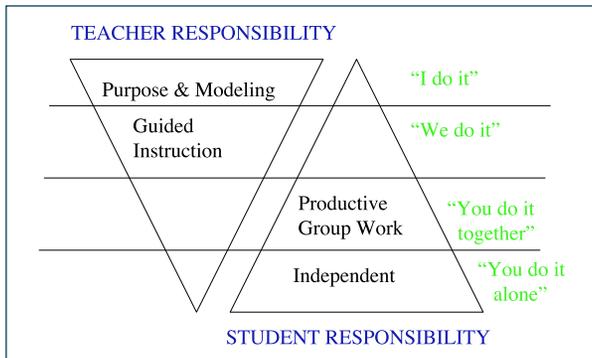
little about the science concepts, terms such as *consequences*, *vents*, *verge*, *acidic*, and *markedly* made the passage difficult. After a concerted effort of about four minutes, Cesar, along with two of his classmates, put their heads down on their desks. The challenging concepts and language had won, and Cesar's posture of loss—head down, eyes closed—clearly indicated how he felt. Cesar never got to the inquiry component because he was defeated by the reading demands of the text. He would have been no better off had his teacher started with the inquiry component. Cesar did not know enough to ask a relevant question and then analyze data to find the answer. He might have been able to complete some parts of the inquiry lab but not enough to ensure his deep understanding of the impact of pH on the organisms that live in an environment.

### Making Science Instruction Purposeful

How can teachers help students, including those like Cesar who are unable to read the grade-level text, acquire the skills needed to consider data, think about what they know, and confidently use appropriate concepts and vocabulary to capture and convey their understanding? One possible model is the Gradual Release of Responsibility (GRR) framework (Pearson & Gallagher, 1983). This framework, rooted in the work of Piaget (1952), Vygotsky (1962, 1978), and Bandura (1965), meshes research-based concepts related to cognitive structures and schema, the zone of proximal development, attention and retention, and scaffolded instruction. Others (Fisher & Frey, 2008) have built on this foundation to construct a model that is flexible and adaptable to an array of learning situations and that includes four components: (1) purpose and modeling, (2) guided instruction, (3) productive group work, and (4) independent tasks (see Figure 1).

In some classes, these components are implemented in a linear fashion, steps 1 through 4. Although this implementation often works well, it is not the only way a teacher can proceed with a lesson that includes the GRR framework. Science instructors looking to foster inquiry thinking may want to move recursively among the framework's components. Let's consider how doing so might have supported learning for Cesar, who lacked the vocabulary and background knowledge needed to comprehend his assigned reading. Rather than admitting he didn't know enough to persevere,

FIGURE 1 Gradual Release of Responsibility Framework



Cesar preferred to make his defeat look intentional, as if he hadn't *felt* like participating. We offer shared revisions to Mr. Barnett's instruction as we explore the GRR framework. Then we consider the outcomes in terms of student achievement from a neighboring school, where science teachers consistently use GRR.

### Purpose and Modeling

Lessons do not have to begin with purpose and modeling. Mr. Barnett might establish the purpose at the outset of the lesson so that students can activate their relevant background knowledge. On other days, Mr. Barnett might first engage students in other components of the framework, revealing the purpose after students have engaged in inquiry. In these situations, students often intuit the purpose and check with their teacher to see if they have the same purpose. Regardless, at some point in each lesson, purpose setting and modeling must support developing academic background knowledge, or what a person knows about content related to school subjects such as science, math, and English (Marzano, 2004).

Mr. Barnett might begin with a short, high-interest YouTube video about the acidity of the oceans (e.g., [www.youtube.com/watch?v=W9cS0rl\\_NyI](http://www.youtube.com/watch?v=W9cS0rl_NyI)). After a few minutes of watching, students could share their thoughts with a partner by responding to teacher-posed questions designed to stimulate inquiry: What does current research seem to show about the relationship between acidic water and global warming? What next steps might you and your partner take to investigate this further?

While viewing and sharing partner talk, students build background knowledge as real-world scientists do, banking new understandings. Students learn about how and where researchers are studying the relationship between acidity and climate change. Imagine how much easier it is for learners to understand how carbon dioxide can become dissolved in our oceans when they watch a video news clip in which a trail of cars on an interstate, spewing out exhaust fumes, drift over the Pacific Ocean. To add to the students' store of knowledge and language, the teacher might read an excerpt from *Going Blue: A Teen Guide to Saving Our Oceans* (Kaye, Cousteau, & EarthEcho International, 2010). With these background-building supports, students will likely gain an understanding of a critical, real-world problem and will be better able to speculate about investigations or ideas related to the problem.

Most scientists agree that ocean acidification appears to be correlated to increased carbon dioxide emissions, but others hold a differing perspective on the issue. Keeping the methods of true inquiry in mind, Mr. Barnett would want to include readings, podcasts, or other media that discuss the skeptics' views of the claim that ocean acidification is caused by the excessive introduction of carbon dioxide into the water (Hendriks & Duarte, 2010). have conducted a meta-analysis that focuses on evidence and judgments surrounding ocean acidification. Multiple perspectives of any issue should be considered as a part of the investigation model of thinking. For example, some people think that oceans are large enough to buffer the carbon dioxide that is being dissolved into the water. Mr. Barnett would want his students to investigate all sides of this issue.

Mr. Barnett might want to post the purpose statement for this lesson: to investigate the decrease in the number of organisms with shells in the ocean because of increased ocean acidity. Upon reading, students would understand that they are focusing on why ocean habitats contain fewer animals and plants today than in years past.

Next, Mr. Barnett could model his thinking through a think aloud that explains how he makes connections between content resources. By allowing students to hear how an expert thinks, they are better able to build vocabulary, access prior knowledge, and fill in gaps in background knowledge (Grant & Fisher, 2009). He might say the following:

I noticed that the video showed lots of ways that carbon dioxide gas is put into the atmosphere... burning gas, driving cars, factories releasing carbon dioxide into the atmosphere. I wonder where all that gas goes? When I read the excerpt from the book about oceans, I learned that ocean acidification is caused by the absorption of carbon by the oceans. I remember that when we studied corals, we learned that organisms that have shells, like corals, can't survive in water that is too acidic. I'm thinking that there must be a connection between our air pollution and the survival of animals and plants in the ocean. Maybe it has something to do with ocean acidification. I'd like to test these ideas.

Doing so, Mr. Barnett could integrate his background knowledge to develop ideas of inquiry and establish a purpose for learning—to investigate a real-world problem.

In addition to background knowledge, students need to acquire both general academic and domain-specific vocabulary. Mr. Barnett could have started his lesson with an introduction to key terms such as *acidification*, *carbon dioxide*, *pH*, and *absorption*. Additionally, general academic words such as *decline*, *increased*, and *capacity* might add to students' understanding of the concepts being studied. Choosing 5 to 10 keywords to focus on during the lesson can help students negotiate content materials with more brain-powered dexterity. There are many ways to develop students' vocabulary knowledge, including through the use of a vocabulary self-awareness chart and Frayer word cards. The vocabulary self-awareness chart, based on the work of Blachowicz and Fisher (1996), helps students tap into background knowledge and provides a place to record terms that they think they might not know (Figure 2). Inquiry into unfamiliar word meanings is supported. Some of the words might be assigned, whereas others can be identified by the students. Thus, students might have different words on their charts based on the texts they read. When

using a vocabulary self-awareness chart, students have the opportunity to indicate if they know either a definition or a related example. If they have prior vocabulary knowledge, they are guided to recall and record. If not, they have a place to document this. In the latter, the goal is for the student to think about and gain an awareness of new words to be learned. If done at the start of a unit, the vocabulary self-awareness chart could provide Mr. Barnett with data regarding his students' knowledge of pertinent vocabulary.

Once the words to be taught have been decided, students could create Frayer word cards (Frayer, Frederick, & Klausmeier, 1969). Figure 3 shows a Frayer card for the term *acidification*. A Frayer card has four parts: (1) definition, (2) distinguishing characteristics, (3) examples, and (4) nonexamples. By identifying and thinking about these four aspects of a word, students are going beyond the superficial definition. In science, this is critical. Consider the term *acidification*. A simple definition, according to Merriam-Webster's online resource, is "to make acid or to acidify." An astute student might then look up the definition of *acid* and would find that it is "a chemical with a pH less than 7." This discovery

FIGURE 2 A Vocabulary Self-Awareness Chart

Vocabulary Term	Know a Definition	Know an Example	Don't Know Either	Definition	Example
<i>acidification</i>			√		
<i>carbon dioxide</i>	√			A gas made up of two elements on the periodic table	
<i>pH</i>		√			A certain acid has a pH of 3
<i>absorption</i>		√			A paper towel soaking up water on the counter
<i>decline</i>	√			To grow smaller in numbers	
<i>increased</i>	√	√		To become greater or larger	The world's population has increased or grown larger over the last 10 years.
<i>capacity</i>			√		

might lead to a dictionary search for *pH*, and on and on goes the definition treasure hunt. After all this word searching, the student may still be unsure of the word meaning. A Frayer word card augments the dictionary definition with other elements of understanding. The part of the card that calls for distinguishing characteristics might include *has a sour taste, pollutes the environment, caused by too much carbon dioxide in the environment*. The part designated for examples might include *water that has a pH below 7, soil that absorbs acid rain, and foods with vinegar or lemon juice*. Nonexamples might be *cleaner with that is ammonia-based, a chemical that is more alkaline or basic, or an antacid that has a pH above 7*. To further support understanding, Mr. Barnett might even ask his students to draw a picture or add a visual to the back of the card. For this example, a student might draw acid rain falling into a body of water.

### Productive Group Work

Alternatively, Mr. Barnett could start a lesson with productive group work. Productive group work provides students with the opportunity to put their knowledge into action. When scientists solve real-world problems, they use their own data, in conjunction with the data and ideas of others, to develop solutions. It is important to remember that students, especially those in elementary or middle school grades, are just trying out inquiry skills for the first time. The NRC (2000) describes five essential areas of focus for inquiry instruction:

1. Learners are engaged by scientifically oriented questions.
2. Learners give priority to evidence, which allows them to develop and evaluate

explanations that address scientifically oriented questions.

3. Learners formulate explanations from evidence to address scientifically oriented questions.
4. Learners evaluate their explanations in light of alternative explanations, particularly those reflecting scientific understanding.
5. Learners communicate and justify their proposed explanations. (p. 25)

The challenge of productive group work is the demand on background knowledge. To address this area, Mr. Barnett could start with groups of three or four students searching the Internet for information about pH using a classroom structure such as Internet Reciprocal Teaching (Castek, 2006; ctell1.uconn.edu/IRA/InternetRT.htm). In this structure, students question, summarize, predict, and clarify the texts they find. With peer support and a familiar instructional routine, students can build their background knowledge and then activate it in subsequent inquiry lessons or reading tasks.

As part of the acidification investigations, Mr. Barnett might ask new partner teams or reconfigured small groups to develop a plan to stem the problem of ocean acidification based on further reading and an exchange of ideas. He might share a textbook reading, along with other accessible documents, that discusses the damage and harm inflicted upon marine organisms and coral reefs around the world due to increasing ocean acidity. Following this, students could be tasked with developing a plan that might be presented in a podcast format or as a narrated video or electronic slide presentation. At this point, students would have acquired background knowledge, experimental data, and an understanding of current research—all the right elements needed to develop scientific solutions to real-world problems.

### Guided Instruction

Most students benefit greatly from an apprenticeship-like thinking experience, in which the teacher guides them to become more expert in a thinking task. Once Mr. Barnett has modeled through

FIGURE 3 Frayer Word Card

<b>Definition</b>	<b>Characteristics</b>
<i>To make more acidic by lowering the pH to a value below 7.</i>	<i>Has a sour taste, pollutes the environment, caused by too much carbon dioxide in the environment.</i>
<b>Examples</b>	<b>Nonexamples</b>
<i>Water that has a pH below 7, soil that absorbs acid rain, and foods with vinegar or lemon juice</i>	<i>Cleaner that is ammonia-based, to become more alkaline or basic, or an antacid that has a pH above 7</i>

a think aloud how he considers the parameters of a science problem, he can support students' thinking and inquiry. He might ask partners to brainstorm, and to document in writing, plans for an experiment that will test the effects of increasing acidity on calcium carbonate, the material that makes up most shells of marine organisms. To scaffold this activity, he could provide a template for inquiry thinking that includes built-in mechanisms for collegial conversations (see Figure 4). Students could generate inquiry plans using the guide-sheet template. As groups proceed through the process, they could pause for collegial discussions and expand the template to include members' ideas. Like real scientists, they could consider new perspectives, revise ideas, and construct new knowledge in a meaningful, lasting manner.

To be sure students understand how to use the inquiry process, Mr. Barnett could model each component of the template by conducting a think aloud in the manner described previously, using sample data and ideas. While modeling his thoughts and the partner process, he would complete the guide sheet with corresponding ideas. Next, he would ask students to practice with a partner to model an idea they might have, to test, for example, the effects of acids on fish in the ocean. After practicing with a partner, students would then tackle the real science problem for the lesson: to investigate the decrease in the number of organisms with shells in the ocean because of increased ocean acidity.

Following this activity, Mr. Barnett would want to monitor student progress by moving around the room, listening in on conversations between partners. His "next steps" would be dependent on his on-the-spot analysis of what each student needs. To be adequately prepared for the teacher-guide role, Mr. Barnett might, in advance of this component of instruction, predict

and anticipate where students will need support. He could consider questions or concerns that might arise and would thus be more prepared with responses, visual aids, or supplemental materials that support student learning.

Consider, for example, how Mr. Barnett might respond if Cesar told his partner that he wanted to investigate how acid affects calcium carbonate in the following manner:

I want to drop a solution with a pH 7 on a piece of calcium carbonate shell. Then I'll observe what happens. If nothing happens, I'll try a solution with a pH of 8 on the same piece of shell. I'll continue this by increasing the pH of the solution that I drop on the

FIGURE 4 Template to Guide Students Through the Inquiry Process

Area of Focus	My Ideas	My Partner's Ideas	Our Ideas (after our discussion)
<i>Before the Investigation/Experiment</i>			
<i>What question do you want to study?</i>			
<i>What evidence would you want to look for in order to study your question?</i>			
<i>How will you record your evidence or data? (design a chart or data table to hold your evidence)</i>			
<i>After the Investigation/Experiment</i>			
<i>What does your data tell you?</i>			
<i>How do your ideas connect with the ideas of others in your class? How do your ideas connect with those of other scientists studying the same concepts?</i>			
<i>What are your conclusions? Record your conclusions by writing two or three paragraphs. Be sure that your ideas are based on your evidence/data.</i>			

shell. I'll keep observing and will record my observations.

Hearing this conversation, he might strategically ask Cesar about the numbers on the pH scale by saying, "Which numbers on the pH scale represent acids?" If Cesar is unable to respond satisfactorily, he could offer a physical cue by pointing to the pH chart on the wall or in the textbook as a reference. Cesar would hopefully be able to note that solutions with a pH below 7, not above 7, are acidic. Before Mr. Barnett resorts to *direct explanation*, he should give Cesar the chance to dig into his store of background knowledge by offering a *prompt* or *cue* (Figure 5). Prompts are statements or comments provided by a teacher to guide students to think about prior learning or experiences. Cues are suggestions that help students shift their attention to what is relevant and important to their understanding. If Mr. Barnett asks a question intended to help Cesar recall that a pH value below 7 indicates that the solution is acidic, he is prompting. If he points to a pH chart, he is offering a cue. Both methods of guided instruction help move Cesar along the learning continuum toward more expert content thinking. It is critical to note that Mr. Barnett's role in the guided-instruction component of the GRR is essential. This is the phase in which students need teacher expertise to overturn and discard misconceptions and misunderstandings.

### Independent Tasks

For students to truly internalize science concepts and content, they must wrestle with ideas in a way that allows them to negotiate personal meaning. After providing Cesar and his peers with ample scaffolds in the form of modeling, guided instruction, and productive group work, they are ready to apply their knowledge to a related scenario. By having opportunities to write and speak about the content, they can express their understandings in ways that require making individual connections. For example, Mr. Barnett might now offer students a new but related reading for their individual

consideration. Students might read the article "New Ocean Acidification Study Shows Added Danger to Already Struggling Coral Reefs" ([www.sciencedaily.com/releases/2010/11/101108151328.htm](http://www.sciencedaily.com/releases/2010/11/101108151328.htm)) and then be asked to interpret the content by integrating article ideas with previous learning. This could be done in verbal or written form. At this point, students would have the background knowledge, acquired vocabulary, and investigative experience to tackle the ideas presented in the article. Helping students further negotiate meaning and incorporate ideas, Mr. Barnett might assign a RAFT writing task (Santa & Havens, 1995) in which students independently demonstrate their understanding of the inquiry process as it relates to the target content. Creating RAFTs encourages writing from multiple perspectives.

RAFT stands for the following:

R = role (who is the writer, what is the role of the writer?)

A = audience (to whom are you writing?)

F = format (what format should the writing be in?)

T = topic (what are you writing about?)

**FIGURE 5** Examples of Teacher Prompts and Cues in Response to Student Misunderstandings

What Student Might Say	How Teacher Might Respond
I want to drop a solution with a pH 7 on a piece of calcium carbonate shell. Then I'll observe what happens. If nothing happens, I'll try a solution with a pH of 8 on the same piece of shell. I'll continue this by increasing the pH of the solution that I drop on the shell.	Teacher might ask, "Which numbers on the pH scale represent acids?" (a prompt to help student recall prior knowledge)
The solutions that have pH numbers that are above 7 are acids.	Teacher might say, "Let's take a look at the pH chart in your textbook. What does this tell us about the pH of acids?" (a cue to help direct the student's attention to the correct content information).
I don't understand this chart. Aren't pH numbers over 7 bases?	Teacher might say, "Let's review the chart together. Solutions, like vinegar and lemon juice, that are acids have pH values that are below 7. This means that acids have pH values below 7. Bases, like ammonia, which you use sometimes for housecleaning, have pH values. Ammonia has a pH above 7. Bases have pH values above 7. Now can you try to explain the chart and pH to me." (direct explanation is used if prompts and cues are not adequate).

After reading the article “New Ocean Acidification Study Shows Added Danger to Already Struggling Coral,” students can respond to the following RAFT:

- R = sea urchin
- A = marine life
- F = letter
- T = how acidification affects building my shells

In addition to being an effective way to assess student understanding of the content, RAFTs are helpful in providing differentiation. Teachers can modify the role, audience, format, or topic to match students’ literacy strengths. Consider how each RAFT in Figure 6 would meet the needs of a diverse group of students in Cesar’s class.

With new knowledge from their vocabulary work, video viewing, readings, discussions, and inquiry investigations, students are well prepared to document in a creative, relevant form their understandings of the demise of the reefs off the Florida coast and the relationship to ocean acidification. Reading these writings, Mr. Barnett should be able to get a sense of which students have gained a deep understanding of the concepts of ocean acidification, as seen through a lens of inquiry, and which ones need more support.

### Using a Gradual Release of Responsibility to Foster Inquiry

Inquiry-based instruction is predicated on increasing the cognitive and metacognitive responsibilities of learners as they build toward solutions (Bransford, Brown, & Cocking, 2000). The flexibility and adaptability of the GRR model makes it the perfect framework for inquiry-based instruction. A teacher who prefers to start with a *productive group-work activity*, so that students can grapple with concepts in a truly investigative manner, is free to do so. That teacher might then move from the collaborative activity to *model* how she thinks about the concept being studied. This might be followed by an opportunity for *guided instruction* and additional *productive group work*. The GRR model does not have to flow linearly from

modeling to guided instruction to productive group work and finally to independent practice. Although that flow pattern is clearly an effective way to organize and instruct, it is not the only way that the GRR can be implemented.

The teacher-expert makes the decision regarding when to model or when to offer prompts and cues. Decisions depend on what the students need during instruction. Because inquiry-based instruction is exploratory, it behooves a teacher to use an instructional model such as GRR that is both intentional and adaptable and fluidly supports shifts among modeling, guided practice, collaborative practice, and individual learning. This fluidity is exemplified in Figures 7 and 8.

### Outcomes From an Inquiry GRR Approach

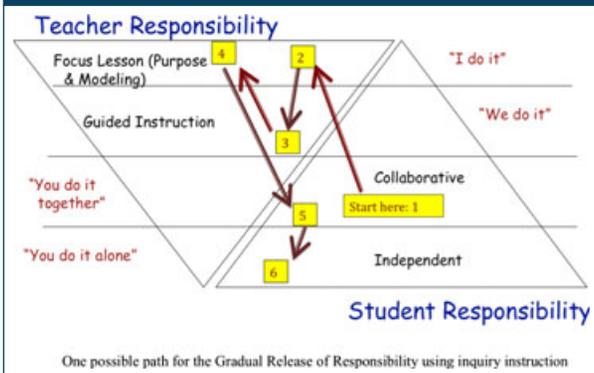
Cesar’s class experience was not positive and did not result in his learning, either through content literacy or inquiry. The recommendations we made about the various learning tasks that students could complete were drawn from real classrooms in a school where inquiry GRR lessons were implemented.

These classrooms are situated in an urban school that has a strong commitment to staff development and the implementation of GRR. Over two years, when earth science teachers focused on implementing the gradual release of responsibility with inquiry, the achievement scores on the state assessment increased from 36% of students scoring proficient or advanced to 61% achieving at those levels. Further, the number of students scoring in the lowest categories, far below basic, was reduced from 21% to 11%. The overall grade point average in these earth science classes increased from 2.33 to 3.11, and attendance increased from 91.4% to 95.4%. With each measure, positive outcomes were associated with improved quality instruction.

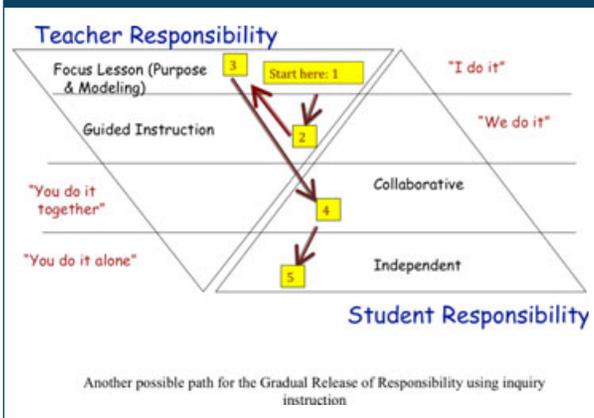
FIGURE 6 Examples of RAFT

R =	researcher	R =	reporter	R =	scientist
A =	scuba divers	A =	Florida residents	A =	journal readers
F =	list	F =	public service announcement	F =	science journal article
T =	3 reasons why acidification is threatening	T =	a new danger to reefs and coral	T =	why organisms are susceptible to predation and damage

**FIGURE 7** The Gradual Release of Responsibility Is a Fluid, Flexible, and Recursive Model



**FIGURE 8** A Personalized Gradual Release Model



Importantly, such growth was not limited to earth science. As we have investigated improved science instruction using content literacy approaches in a GRR framework, we have noted improved achievement in additional classes. Changes in chemistry at the same school were also evident, with student achievement increasing from 7% proficient or advanced to 23%.

### An Invitation to Innovate, Inquire, Investigate, and Intentionally Instruct

If strategic and thoughtful lessons are implemented, children like Cesar are capable of transforming from confused students into proficient science thinkers and readers. The GRR model allows a teacher to shift the responsibility of learning from self to students and vice versa, depending on what is needed. The content area of science, with its core of inquiry and investigation,

is best understood by students when they have access to the four "O's":

1. Opportunities to explore and evaluate ideas with their peers
2. Opportunities to observe models of expert science thinking
3. Opportunities to test ideas with the knowledge that a skilled teacher, who uses appropriate prompts and cues, will steer them toward desired learning
4. Opportunities to personally apply what they have learned to relevant, real-world scenarios using the background knowledge and skills acquired through previous classroom activities

Imagine the dynamic and informed conversations that might capture the attention of Cesar, drawing him into participation and piquing his curiosity and engagement with the study of science topics. When this happens, Cesar and other students assume a major role in their continued learning. This curiosity and understanding of how to secure information to support one's learning is what is needed for students to become lifelong investigators of the scientific questions encountered in everyday life: Which fuel makes my car work better with less pollution? How is my running affected by what I eat? Should I vote for sewer-to-tap initiatives? Instruction that provides students with insights into how to acquire the information needed to study questions that arise through inquiry supports their becoming informed participants in scientific study. Students aren't just filled with conceptually unrelated facts; rather, they become informed participants who understand how daily life, work, and their world is augmented by science and promoted through their power as consumers. When a question arises, they know how to investigate sources to secure information that supports their intelligent participation. A well-planned lesson, using the components of the GRR model, provides an ideal scenario in which inquiry as a major feature of learning occurs throughout the study, with teachers transferring independence and personal ownership for understanding and knowing to each student. Our experience in classrooms in which teachers are implementing a recursive model

## Take Action

### STEPS FOR IMMEDIATE IMPLEMENTATION

To use a gradual release of responsibility instructional frame to support scientific inquiry and teaching, we suggest the following supportive considerations.

- ✓ Develop your understanding of the gradual release of responsibility model. We have identified resources in the References list to support this.
- ✓ Select a topic of scientific study that you are planning to teach.
- ✓ Identify the lesson purpose.
- ✓ Plan the lesson(s) using the lesson suggestions we identified for Mr. Barnett. Remember that the GRR model can be used recursively. If you want to begin with an inquiry question before modeling your thinking, you can still use GRR for your instructional frame.
- ✓ Plan your thinking-aloud models. Some scripting ensures that you will address all the points related to accomplishing the lesson purpose.
- ✓ Consider the new scientific vocabulary to be learned and how best to teach each word and concept. You may want to try vocabulary activities similar to those we suggested to Mr. Barnett.
- ✓ Think about the misconceptions your students may encounter. Doing so will allow you to identify possible cues, prompts, questions, and direct explanations that you can share during guided instruction to support their developing understandings.
- ✓ Identify productive group-work tasks that relate to the purpose and continue to expand students' developing bases of knowledge and language.
- ✓ Assess your students' engagement and learning on a continual basis and reteach or extend as needed.
- ✓ Remember to assess your instruction throughout the lesson, because what you do plays a primary role in what your students are learning.

of GRR suggests that science and literacy do not have to be at odds, but that, when combined, they support intentional inquiry-based learning.

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## More to Explore

### CONNECTED CONTENT-BASED RESOURCES

The following articles and lesson examples support further exploration of using a Gradual Release of Responsibility instructional frame to support science inquiry and teaching.

- Fisher, D., & Frey, N. (2008). Homework and the gradual release of responsibility: Making student “responsibility” possible. *English Journal*, 98(2), 40–45.
- Fisher, D., & Frey, N. (2011). *The purposeful classroom: How to structure lessons with learning goals in mind*. Alexandria, VA: ASCD.
- Grant, M., & Lapp, D. (2011). Teaching science literacy. *Educational Leadership*, 68(6). [www.ascd.org/publications/educational-leadership/mar11/vol68/num06/Teaching-Science-Literacy.aspx](http://www.ascd.org/publications/educational-leadership/mar11/vol68/num06/Teaching-Science-Literacy.aspx)
- Johnson, K., Lapp, D., & Grant, M. (2011). *Wallwisher: Supporting, engagement, instruction, and assessment*. [engage.reading.org/READING/Blogsnbpsnbps/BlogViewer/?BlogKey=9a2ad03e-52e5-49c0-a3b6-c6c3c81bf49c](http://engage.reading.org/READING/Blogsnbpsnbps/BlogViewer/?BlogKey=9a2ad03e-52e5-49c0-a3b6-c6c3c81bf49c)
- [www.readwritethink.org/professional-development/strategy-guides/supporting-comprehension-strategies-english-30106.html](http://www.readwritethink.org/professional-development/strategy-guides/supporting-comprehension-strategies-english-30106.html)