

Richard Feynman, “The Making of a Scientist” - Grade 6

Originally published in *Cricket Magazine*, October 1995 (Vol. 23, #2).

Learning Objective: The goal of this two to three day exemplar is to give students the opportunity to use the reading and writing habits they’ve been practicing on a regular basis to absorb deep lessons from Richard Feynman’s recollections of interactions with his father. By reading and rereading the passage closely, and focusing their reading through a series of questions and discussion about the text, students will identify how and why Feynman started to look at the world through the eyes of a scientist. When combined with writing about the passage, students will discover how much they can learn from a memoir.

Reading Task: *Students will silently read the passage in question on a given day—first independently and then following along with the text as the teacher and/or skillful students read aloud. Depending on the difficulties of a given text and the teacher’s knowledge of the fluency abilities of students, the order of the student silent read and the teacher reading aloud with students following might be reversed. What is important is to allow all students to interact with challenging text on their own as frequently and independently as possible. Students will then reread specific passages in response to a set of concise, text-dependent questions that compel them to examine the meaning and structure of Feynman’s prose. Therefore, rereading is deliberately built into the instructional unit.*

Vocabulary Task: *Most of the meanings of words in the exemplar text can be discovered by students from careful reading of the context in which they appear. Teachers can use discussions to model and reinforce how to learn vocabulary from contextual clues, and students must be held accountable for engaging in this practice. Where it is judged this is not possible, underlined words are defined briefly for students to the right of the text in a separate column whenever the original text is reproduced. At times, this is all the support these defined words need. At other times, particularly with abstract words, teachers will need to spend more time explaining and discussing them. In addition, in subsequent close readings of passages of the text, high value academic (‘Tier Two’) words have been **bolded** to draw attention to them. Given how crucial vocabulary knowledge is for academic and career success, it is essential that these high value words be discussed and lingered over during the instructional sequence.*

Sentence Syntax Task: *On occasion, students will encounter particularly difficult sentences to decode. Teachers should engage in a close examination of such sentences to help students discover how they are built and how they convey meaning. While many questions addressing important aspects of the text double as questions about syntax, students should receive regular supported practice in deciphering complex sentences. It is crucial that the help they receive in unpacking text complexity focuses both on the precise meaning of what the author is saying and why the author might have constructed the sentence in this particular fashion. That practice will in turn support students’ ability to unpack meaning from syntactically complex sentences they encounter in future reading.*

Discussion Task: *Students will discuss the exemplar text in depth with their teacher and their classmates, performing activities that result in a close reading of Feynman’s memoir. The goal is to foster student confidence when encountering complex text and to*

reinforce the skills they have acquired regarding how to build and extend their understanding of a text. A general principle is to always reread the

passage that provides evidence for the question under discussion. This gives students another encounter with the text, helping them develop fluency and reinforcing their use of text evidence.

Writing Task: *Students will paraphrase different sentences and paragraphs of Feynman's memoir and then write an informal explanatory essay detailing how one of the interactions between him and his father illustrates a deeper lesson. Teachers might afford students the opportunity to revise their in-class paraphrases after participating in classroom discussion or even rewrite their explanation after receiving teacher feedback, allowing them to refashion both their understanding of the text and their expression of that understanding.*

Text Selection: This exemplar text, taken from the highly regarded children's magazine *Cricket*, speaks directly and without condescension to students about why Feynman became a scientist. The clear and compelling examples offer vivid and concrete avenues for exploration and close reading.

Outline of Lesson Plan: This lesson can be delivered in two or three days of instruction and reflection on the part of students and their teacher.

Standards Covered: The following Common Core State Standards are the focus of this assignment: RI.6.1, RI.6.2, RI.6.4, RI.6.8; W.6.2, W.6.4, W.6.9; SL.6.1; L.6.4, L.6.5, L.6.6.

The Text: Feynman, Richard. “The Making of a Scientist”

Exemplar Text	Vocabulary

<p>Before I was born, my father told my mother, “If it’s a boy, he’s going to be a scientist.” When I was just a little kid, very small in a highchair, my father brought home a lot of little bathroom tiles—seconds—of different colors. We played with them, my father setting them up vertically on my highchair like dominoes, and I would push one end so they would all go down.</p> <p>Then after a while, I’d help set them up. Pretty soon, we’re setting them up in a more complicated way: two white tiles and a blue tile, two white tiles and a blue tile, and so on. When my mother saw that she said, “Leave the poor child alone. If he wants to put a blue tile, let him put a blue tile.”</p> <p>But my father said, “No, I want to show him what patterns are like and how interesting they are. It’s a kind of elementary mathematics.” So he started very early to tell me about the world and how interesting it is.</p> <p>We had the <i>Encyclopaedia Britannica</i> at home. When I was a small boy he used to sit me on his lap and read to me from the <i>Britannica</i>. We would be reading, say, about dinosaurs. It would be talking about the <i>Tyrannosaurus rex</i>, and it would say something like, “This dinosaur is twenty-five feet high and its head is six feet across.”</p> <p>My father would stop reading and say, “Now, let’s see what that means. That would mean that if he stood in our front yard, he would be tall enough to put his head through our window up here.” (We were on the second floor.) “But his head would be too wide to fit in the window.” Everything he read to me he would translate as best he could into some reality.</p> <p>It was very exciting and very, very interesting to think there were animals of such magnitude—and that they all died out, and that nobody knew why. I wasn’t frightened that there would be one coming in my window as a consequence of this. But I learned from my father to translate: everything I read I try to figure out what it really means, what it’s really saying.</p> <p>We used to go to the Catskill Mountains, a place where people from New York City would go in the summer. The fathers would all return to New York to work during the week and come back only for the weekend. On weekends, my father would take me for walks in the woods and he’d tell me about interesting things that were going on in the woods. When the other mothers saw this, they thought it was wonderful and that the other fathers should take their sons for walks. They tried to work on them but they didn’t get anywhere at first. They wanted my father to take all the kids, but he didn’t want to because he had a special relationship with me. So it ended up that the other fathers had to take their children for walks the next weekend.</p> <p>The next Monday, when the fathers were all back at work, we kids were playing in a</p>	<p><i>Large set of books covering all sorts of knowledge</i></p>
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field. One kid says to me, “See that bird? What kind of bird is that?”

I said, “I haven’t the **slightest** idea what kind of a bird it is.”

He says, “It’s a brown-throated thrush. Your father doesn’t teach you anything!”

But it was the opposite. He had already taught me: “See that bird?” he says. “It’s a Spencer’s warbler.” (I knew he didn’t know the real name.) “Well, in Italian, it’s a *Chutto Lapittida*. In Portuguese it’s a *Bom da Peida*. In Chinese, it’s a *Chung-long-tah*, and in Japanese, it’s a *Katano Tekeda*. You can know the name of the bird in all the languages of the world, but when you’re finished, you’ll know absolutely nothing whatever about the bird. You’ll only know about humans in different places, and what they call the bird. So let’s look at the bird and see what it’s *doing*—that’s what counts.” (I learned very early the difference between knowing the name of something and knowing something.)

He said, “For example, look: the bird **pecks** at its feathers all the time. See it walking around, **pecking** at its feathers?”

“Yeah.”

He says, “Why do you think birds **peck** at their feathers?”

I said, “Well, maybe they mess up their feathers when they fly, so they’re **pecking** them in order to straighten them out.”

“All right,” he says. “If that were the case, then they would **peck** a lot just after they’ve been flying. Then, after they’ve been on the ground a while, they wouldn’t **peck** so much anymore—you know what I mean?”

“Yeah.”

He says, “Let’s look and see if they **peck** more just after they land.”

It wasn’t hard to tell: there was not much difference between the birds that had been walking around a bit and those that had just landed. So I said, “I give up. Why does a bird **peck** at its feathers?”

“Because there are **lice** bothering it,” he says. “The **lice** eat **flakes** of **protein** that come off its feathers.”

He continued, “Each **louse** has some **waxy** stuff on its legs, and little **mites** eat that. The **mites** don’t **digest** it perfectly, so they **emit** from their rear ends a sugarlike material, in which **bacteria** grow.”

Finally he says, “So you see, everywhere there’s a source of food, there’s *some* form of life that finds it.”

Now, I knew that it may not have been exactly a **louse**, that it might not be exactly true that the **louse’s** legs have **mites**. That story was probably incorrect in detail, but what he was telling me was right in principle.

Not having experience with many fathers, I didn’t realize how **remarkable** he was. How did he learn the deep principles of science and the love of it, what’s behind it, and why it’s worth doing? I never really asked him, because I just **assumed** that those were things that fathers knew.

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My father taught me to **notice** things. One day, I was playing with an “express wagon,” a little wagon with a **railing** around it. It had a ball in it, and when I pulled the wagon, I noticed something about the way the ball moved. I went to my father and said, “Say, Pop, I noticed something. When I pull the wagon, the ball rolls to the back of the wagon. And when I’m pulling it along and I **suddenly** stop, the ball rolls to the front of the wagon. Why is that?”

“That, nobody knows,” he said. “The general principle is that things which are moving tend to keep on moving, and things which are standing still tend to stand still, unless you push them hard. This tendency is called ‘**inertia**,’ but nobody knows why it’s true.” Now, that’s a deep understanding. He didn’t just give me the name.

He went on to say, “If you look from the side, you’ll see that it’s the back of the wagon that you’re pulling against the ball, and the ball stands still. As a matter of fact, from the **friction** it starts to move forward a little bit in **relation** to the ground. It doesn’t move back.”

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and set the ball up again and pulled the wagon.
Looking sideways, I saw that indeed he was right.
Relative to the sidewalk, it moved forward a little bit.

That's the way I was educated by my father,
with those kinds of examples and discussions: no
pressure—just lovely, interesting discussions. It has
motivated me for the rest of my life, and makes me
interested in *all* the sciences. (It just happens I do
physics better.)

I've been caught, so to speak—like someone
who was given something wonderful
when he was a child, and he's always looking for it
again. I'm always looking, like a child, for the wonders
I know I'm going to find—maybe not every time, but
every once in a while.

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Day One: Instructional Exemplar for Feynman’s “The Making of a Scientist”

Summary of Activities

- 1. Teacher introduces the day’s passage with minimal commentary and students read it independently (5 minutes)
- 2. Teacher or a skillful reader then reads the passage out loud to the class as students follow along in the text (5 minutes)
- 3. Teacher asks the class to discuss the first set of text-dependent questions and perform targeted tasks about the passage, with answers in the form of notes, annotations to the text, or more formal responses as appropriate (40 minutes)
- 4. For homework, teacher asks students to reread the passage and refine their answers to the questions.

Text Passage under Discussion	Directions for Teachers/Guiding Questions For Students

Before I was born, my father told my mother, “If it’s a boy, he’s going to be a scientist.” When I was just a little kid, very small in a **highchair**, my father brought home a lot of little bathroom tiles—**seconds**—of different colors. We played with them, my father setting them up **vertically** on my **highchair** like dominoes, and I would push one end so they would all go down...

[read the intervening paragraphs]

But it was the opposite. He had already taught me: “See that bird?” he says. “It’s a Spencer’s warbler.” (I knew he didn’t know the real name.) “Well, in Italian, it’s a *Chutto Lapittida*. In Portuguese it’s a *Bom da Peida*. In Chinese, it’s a *Chung-long-tah*, and in Japanese, it’s a *Katano Tekeda*. You can know the name of the bird in all the languages of the world, but when you’re finished, you’ll know absolutely nothing whatever about the bird. You’ll only know about humans in different places, and what they call the bird. So let’s look at the bird and see what it’s *doing*—that’s what counts.” (I learned very early the difference between knowing the name of something and knowing something.)

1. Introduce the passage and students read independently.

Other than giving the brief definitions offered to words students would likely not be able to define from context (underlined in the text), avoid giving any background context or instructional guidance at the outset of the lesson while students are reading the text silently. This close reading approach forces students to rely exclusively on the text instead of privileging background knowledge and levels the playing field for all students as they seek to comprehend Feynman’s memoir. It is critical to cultivating independence and creating a culture of close reading that students initially grapple with rich texts like Feynman’s prose without the aid of prefatory material, extensive notes, or even teacher explanations.

2. Read the passage out loud to the class as students follow along in the text.

Asking students to listen to “The Making of a Scientist” exposes students a second time to the rhythms and meaning of his language before they begin their own close reading of the passage. Speaking clearly and carefully will allow students to follow Feynman’s narrative, and reading out loud with students following along improves fluency while offering all students access to this complex text. Accurate and skillful modeling of the reading provides students who may be dysfluent with accurate pronunciations and syntactic patterns of English.

**Text Passage under
Discussion**

Directions for Teachers/Guiding Questions For Students

Before I was born, my father told my mother, “If it’s a boy, he’s going to be a scientist.” When I was just a little kid, very small in a **highchair**, my father brought home a lot of little bathroom tiles—**seconds**—of different colors. We played with them, my father setting them up **vertically** on my **highchair** like dominoes, and I would push one end so they would all go down.

Then after a while, I’d help set them up. Pretty soon, we’re setting them up in a more **complicated** way: two white tiles and a blue tile, two white tiles and a blue tile, and so on. When my mother saw that she said, “Leave the poor child alone. If he wants to put a blue tile, let him put a blue tile.”

But my father said, “No, I want to show him what patterns are like and how interesting they are. It’s a kind of **elementary** mathematics.” So he started very early to tell me about the world and how interesting it is.

We had the *Encyclopaedia Britannica* at home. When I was a small boy he used to sit me on his lap and read to me from the *Britannica*. We would be reading, say, about dinosaurs. It would be talking about the *Tyrannosaurus rex*, and it would say something like, “This dinosaur is twenty-five feet high and its head is six feet across.”

My father would stop reading and say, “Now, let’s see what that means. That would mean that if he stood in our front yard, he would be tall enough to put his head through our window up here.” (We were on the second floor.) “But his head would be too wide to fit in the window.” Everything he read to me he would **translate** as best he could into some **reality**.

It was very exciting and very, very interesting to think there were animals of such **magnitude**—and that they all died out, and that nobody knew why. I wasn’t **frightened** that there would be one coming in my window as a **consequence** of this. But I learned from my father to **translate**: everything I read I try to figure out what it really means, what it’s really saying.

*Large set
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3. Ask the class to answer a small set of text-dependent guided questions and perform targeted tasks about the passage, with answers in the form of notes, annotations to the text, or more formal responses as appropriate.

As students move through these questions and reread Feynman’s memoir, be sure to check for and reinforce their understanding of academic vocabulary in the corresponding text (which will be **boldfaced** the first time it appears in the text). At times, the questions themselves may focus on academic vocabulary.

(Q1) What was Feynman’s father trying to teach his son with the tiles? What sentence is the main point of this scene?

Students will likely say that he was teaching his son about patterns or possibly that he was teaching him math. Teachers should ask students to go back into the text to find the main point—something even more important than patterns and math that his father was trying to teach him: “So he started very early to tell me about the world and how interesting it is.”

Ask students to put the last paragraph of the text passage (“It was very exciting...”) into their own words.

The message Feynman is trying to convey by the dinosaur example aligns quite well with this task: When you read something, you must translate it so you truly understand it. His choice of words like “magnitude” and “consequence” are deliberate and reflect the deep meaning of these words. (“Magnitude” implies both size and importance, for example.) Students should investigate whether their synonyms for these words capture the full sense of what Feynman is implying. If time permits, after students share their answers with one another and the class, students could be offered the opportunity to rewrite their paraphrase.

Sidebar: Website on *Tyrannosaurus rex*

If students are intrigued to learn more about *Tyrannosaurus rex*, teachers can direct them to the informative National Geographic webpage on that dinosaur:

<http://animals.nationalgeographic.com/animals/prehistoric/tyrannosaurus-rex/>

**Text Passage under
Discussion**

Directions for Teachers/Guiding Questions For Students

We used to go to the Catskill Mountains, a place where people from New York City would go in the summer. The fathers would all return to New York to work during the week and come back only for the weekend. On weekends, my father would take me for walks in the woods and he'd tell me about interesting things that were going on in the woods. When the other mothers saw this, they thought it was wonderful and that the other fathers should take their sons for walks. They tried to work on them but they didn't get anywhere at first. They wanted my father to take all the kids, but he didn't want to because he had a special relationship with me. So it ended up that the other fathers had to take their children for walks the next weekend.

The next Monday, when the fathers were all back at work, we kids were playing in a field. One kid says to me, "See that bird? What kind of bird is that?"

I said, "I haven't the **slightest** idea what kind of a bird it is."

He says, "It's a brown-throated thrush. Your father doesn't teach you anything!"

But it was the opposite. He had already taught me: "See that bird?" he says. "It's a Spencer's warbler." (I knew he didn't know the real name.) "Well, in Italian, it's a *Chutto Lapittida*. In Portuguese it's a *Bom da Peida*. In Chinese, it's a *Chung-long-tah*, and in Japanese, it's a *Katano Tekeda*. You can know the name of the bird in all the languages of the world, but when you're finished, you'll know absolutely nothing whatever about the bird. You'll only know about humans in different places, and what they call the bird. So let's look at the bird and see what it's *doing*—that's what counts." (I learned very early the difference between knowing the name of something and knowing something.)

(Q2) In this section of the text, Feynman put the word "doing" (in the final paragraph) in italics to draw attention to it. Why is he focusing on that word, and how does it connect to the lesson his father is trying to teach him in this example?

Feynman's father is trying to draw a distinction between recalling the name of a bird and genuinely knowing something about birds. The example is meant to illustrate that while the same bird is called different things in different languages, knowing the names of the bird (even made up names) doesn't tell you anything *about* the bird—only about what humans have called it. For Feynman, what really matters—the difference between knowing the name of something and knowing something—is captured in knowing what a bird *does*.

Day Two: Instructional Exemplar for Feynman’s “The Making of a Scientist”

Summary of Activities

- 1. Teacher introduces the day’s passage with minimal commentary and students read it independently (5 minutes)
- 2. Teacher or a skillful reader then reads the passage out loud to the class as students follow along in the text (5 minutes)
- 3. Teacher asks the class to discuss text-dependent questions and perform targeted tasks about the passage, with answers in the form of notes, annotations to the text, or more formal responses as appropriate (40 minutes)
- 4. Teacher assigns homework that asks students to write an explanation of one of Feynman’s examples and the lesson it represents

Text under Discussion	Directions for Teachers/Guiding Questions For Students
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He said, "For example, look: the bird **pecks** at its feathers all the time. See it walking around, **pecking** at its feathers?"

"Yeah."

He says, "Why do you think birds **peck** at their feathers?"

I said, "Well, maybe they mess up their feathers when they fly, so they're **pecking** them in order to straighten them out."

"All right," he says. "If that were the case, then they would **peck** a lot just after they've been flying. Then, after they've been on the ground a while, they wouldn't **peck** so much anymore—you know what I mean?"

"Yeah."

He says, "Let's look and see if they **peck** more just after they land."

It wasn't hard to tell: there was not much difference between the birds that had been walking around a bit and those that had just landed. So I said, "I give up. Why does a bird peck at its feathers?"

"Because there are **lice** bothering it," he says. "The **lice** eat **flakes** of protein that come off its feathers."

He continued, "Each **louse** has some **waxy** stuff on its legs, and little **mites** eat that. The **mites** don't **digest** it perfectly, so they **emit** from their rear ends a sugarlike material, in which **bacteria** grow."

Finally he says, "So you see, everywhere there's a source of food, there's *some* form of life that finds it."

Now, I knew that it may not have been exactly a **louse**, that it might not be exactly true that the **louse's** legs have **mites**. That story was probably incorrect in *detail*, but what he was telling me was right in *principle*.

(Q3) Why does Feynman's father tell him about the lice and the mites on birds?

Students should connect the lesson learned in the previous example—to know something is to know why it *does* something—to this one. The bird does something, namely pecks at its feathers. To know the bird would be to know *why* it pecks, and his father explores Feynman's tentative answer with him before offering up his explanation.

(Q4) Feynman's father says, "So you see, everywhere there's a source of food there's *some* form of life that finds it." Explain what is meant by this sentence and why "*some*" is in italics.

This is another good comprehension question to test and see if students truly understand Feynman's point about knowing. To his earlier insight about truly knowing something, this example adds the further point that knowledge of the *principle* in question is key. The details—like the names of the birds or the relationship between lice and mites—might be incorrect in the particulars. But to Feynman and his father, what really mattered was the discovery of the principle that *some* form of life (no matter how small or insignificant) will utilize an available source of food.

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Text under Discussion

Directions for Teachers/Guiding Questions For Students

Not having experience with many fathers, I didn't realize how **remarkable** he was. How did he learn the deep **principles** of science and the love of it, what's behind it, and why it's worth doing? I never really asked him, because I just **assumed** that those were things that fathers knew.

My father taught me to **notice** things. One day, I was playing with an "express wagon," a little wagon with a **railing** around it. It had a ball in it, and when I pulled the wagon, I noticed something about the way the ball moved. I went to my father and said, "Say, Pop, I noticed something. When I pull the wagon, the ball rolls to the back of the wagon. And when I'm pulling it along and I **suddenly** stop, the ball rolls to the front of the wagon. Why is that?"

"That, nobody knows," he said. "The general principle is that things which are moving tend to keep on moving, and things which are standing still tend to stand still, unless you push them hard. This tendency is called '**inertia**,' but nobody knows why it's true." Now, that's a deep understanding. He didn't just give me the name.

He went on to say, "If you look from the side, you'll see that it's the back of the wagon that you're pulling against the ball, and the ball stands still. As a matter of fact, from the **friction** it starts to move forward a little bit in **relation** to the ground. It doesn't move back."

I ran back to the little wagon and set the ball up again and pulled the wagon. Looking sideways, I saw that indeed he was right. **Relative** to the sidewalk, it moved forward a little bit.

That's the way I was educated by my father, with those kinds of examples and discussions: no pressure—just lovely, interesting discussions. It has **motivated** me for the rest of my life, and makes me interested in *all* the sciences. (It just happens I do physics better.)

I've been caught, so to speak—like someone who was given something wonderful when he was a child, and he's always looking for it again. I'm always looking, like a child, for the wonders I know I'm going to find—maybe not every time, but every once in a while.

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(Q5) After rereading the section of the text on the wagon and ball example, if materials allow, ask students to engage in this experiment themselves or to guide the teacher in physically re-creating it (or a similar experiment that illustrates the law of inertia).

Feynman's example shows the principle behind inertia—"that things which are moving tend to keep on moving, and things which are standing still tend to stand still"—a point he stressed in his explanation of what it means to know something. Teachers should note that Feynman's father is quick to confess to not knowing *why* there is a law of inertia ("nobody knows"), but *does* explain the law through an example that he then uses to extract a "general principle."

Sidebar: Website on Inertia

The following website has several helpful videos on the law of inertia:

<http://www.wonderhowto.com/how-to-demonstrate-newtons-law-inertia-223913/>

(Q6) In the final paragraph, Feynman says he "was given something wonderful when he was a child." Using two of the examples from the text, explain what he was given and how it influenced his life.

Feynman beautifully discusses how his father "educated" him and how it "motivated [him] for the rest of [his] life." What his father gave him was "lovely, interesting discussions" that "caught" his imagination as a child to such a degree that Feynman is "always looking for" those kinds of discussions.

Answering this question will require students to draw material from throughout the text and will be very useful to students when they transition to the writing assignment. Students should cite the principle Feynman's father was trying to convey in each example ("try to figure out what [I read] really means"; "the difference between knowing the name of something and knowing something").

Explanatory Writing Assignment: Directions for Teachers and Students / Guidance for Teachers

For homework, pick one of the examples that Feynman uses in his piece (the dinosaur, the birds, or the wagon) and in 2-3 paragraphs explain both the example and the lesson Feynman's father was trying to teach him with it.

Teachers should direct students back to their notes, as each of the examples will have been discussed at some length. Like Feynman, many students will organize their analysis by starting with the example and then deriving from it the lesson being taught, but it's perfectly valid if some students start with the lesson and then cite the example as an instance of the lesson learned.

Teachers may find it helpful to take one of the examples and develop notes on it (or divide the class into groups to do the same) so that students have a clear sense of how to develop the writing assignment with a rich use of the examples. This example could then be put "off limits" to students capable of this work independently but used as scaffolding for students who need more support.

Extension Activity for Day Three: During the next class period, the teacher could have students peer review or revise the explanatory writing pieces completed for homework.