

A Close Reading of Richard Feynman, “The Making of a Scientist,” *Cricket Magazine*

UNIT SUMMARY

The goal of this 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 unpack Feynman’s memoir of interactions with his father that awaken the scientific spirit within him. By reading and re-reading the passage closely combined with classroom discussion about it, students will identify why and how Feynman started to look at the world through the eyes of a scientist. When combined with writing about the passage and teacher feedback, students will both learn how memoirs can be as deeply revealing as fiction and how to unpack the meaning of a first person narrative.

Reading Task: *Students will silently read the passage, first independently, and then following along with the text as the teacher and/or students read aloud. The teacher will then lead students through a set of concise, text-dependent questions that compel students to reread specific passages and discover the structure and meaning of Feynman’s prose.*

Vocabulary Task: *Most of the meanings of words in this selection can be discovered from careful reading of the context in which they appear. This practice is both called for by the standards and is vital. Teachers must be prepared to reinforce it constantly by modeling and holding students accountable for looking in the context for meaning as well.*

Discussion Task: *Students will discuss the passage in depth with their teacher and their classmates, performing activities that result in a close reading of Feynman’s text. The goal is to foster student confidence when encountering complex text and to reinforce the skills they have acquired regarding how to built and extend their understanding of a text.*

Writing Task: *Students will paraphrase different sentences and paragraphs of Feynman’s memoir and then write an explanatory essay detailing one of his examples and the lesson his father conveyed with it. Students might be afforded the opportunity to rewrite their explanation or revise their in-class paraphrases after participating in classroom discussion, allowing them to refashion both their understanding of the text and their expression of that understanding.*

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

Outline of Lesson: This lesson can be divided by the teacher into three days of instruction and reflection on the part of students and their teachers, with the option of a written homework assignment after Day 1, and the possibility of adding an additional day devoted to peer review and revision of a culminating writing assignment.

Day 1: The Influence of Feynman's Father

Day 1 Activities focus on CCSS Standards RI.5.1-4; W.5.2, 7-9; SL.5.1; L.5.4-6.

1. Teacher introduces the text and students read Feynman's memoir independently
2. Teacher then reads the text out loud to the class and students follow along in the text
3. Teacher asks the class a small set of guiding questions and tasks about the first half of the text
4. Teacher asks students to research an animal of their choosing and learn something about it that Feynman's father would consider knowledge.

Day 2: The Role of Observation

Day 2 Activities focus on CCSS Standards RI.5.1-4 & 8; W.5.2, 4 & 9; SL.5.1; L.5.4-6.

1. Teacher sets the scene by conducting a brief discussion of what has already transpired in Feynman's memoir
2. Teacher introduces the second half of the text and students read that part of Feynman's memoir independently
3. Teacher then reads the passage out loud to the class and students follow along in the text
4. Teacher asks the class a small set of guiding questions and tasks about the first half of the text
5. Students rewrite their sentences about what Feynman observed and add to it an explanation of the principle of inertia.

Day 3: "Lovely, Interesting Discussions"

Day 3 Activities focus on CCSS Standards RI.5.1-3; W.5.2, 4 & 9; SL.5.1; L.5.4-6.

1. Teacher sets the scene by conducting a brief discussion of what has already transpired in Feynman's memoir
2. Teacher introduces three paragraphs of the text and students read that part of Feynman's memoir independently
3. Teacher then reads the passage out loud to the class and students follow along in the text
4. Teacher asks the class a small set of guiding questions and tasks about the passage
5. Teacher rewrite their sentences on what Feynman observed and add to it an explanation of the principle of inertia.

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

Before I was born, my father told my mother, “If it’s a boy, he’s going to be a scientist.”¹ 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.

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

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knowledge

¹ Richard Feynman’s father made this statement in 1918. His youngest daughter, Joan, who was born a short time later, also became a scientist and earned a P.h.D in physics.

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.

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.)

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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.

Day 1: The Influence of Feynman’s Father

Day 1 Activities focus on CCSS Standards RI.5.1-4; W.5.2, 7-9; SL.5.1; L.5.4-6.

1. Teacher introduces the text and students read Feynman’s memoir independently
2. Teacher then reads the text out loud to the class and students follow along in the text
3. Teacher asks the class a small set of guiding questions and tasks about the first half of the text
4. Teacher asks students to research an animal of their choosing and learn something about it that Feynman’s father would consider knowledge.

Text under Discussion	Directions for Teachers/Guiding Questions For Students
<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>[read entire text]</p> <p>...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.</p>	<p>1. Introduce the text and ask students to read the first half of Feynman’s memoir independently</p> <p>Other than giving an initial gloss to words students would likely not be able to define from context (underlined in the text above), 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 text. 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.</p> <p>2. Read the first half of the text out loud to the class as students follow along in the text</p> <p>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 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.</p>

Guiding Concern #1	Directions for Teachers/Guiding Questions For Students
<p>What role did mathematics play as Feynman was growing up?</p> <p>Mathematics played a crucial role in his childhood, from his early interest in stacking of tiles to create patterns to later on trying to grasp the concept of scale. Feynman’s father was instrumental in teaching his son to translate mathematics into ideas and concepts that he could grasp.</p>	<p>3. Ask the class a small set of guiding questions and tasks about the first half of the text</p> <p>As students move through these questions, 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 may focus on academic vocabulary.</p>
Text Under Discussion	
<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>(Q1) What was Feynman’s father observing when his son was playing with the tiles? What sentence is the main point of this scene?</p> <p>Students are likely to say that he was showing his son about patterns or that he was teaching him basic math—both of which are true. But ask students to go back into the text to find the main point behind these observations—that his father “started very early to tell me about the world and how interesting it is.” That idea is central to the scene.</p> <p>(Q2) What point is Feynman trying to convey about the dinosaur story?</p> <p>This story describes how Feynman’s father would explain mathematical concepts like the notion of scale into realistic images that his son could grasp.</p> <p>(Q3) What does the word “magnitude” mean? Could we substitute the word “big” for magnitude?</p> <p>Feynman’s deliberate choice of words reflects the deep meaning he is trying to convey in this paragraph. “Magnitude” implies both size and importance, and strikes the right tone regarding the mystery of their extinction and the overall moral his father was modeling through his explanations: choose the right word or image to convey your precise meaning.</p> <p>Sidebar: Website on <i>Tyrannosaurus rex</i></p> <p>If students are intrigued to learn more about <i>Tyrannosaurus rex</i>, teachers can direct them to the informative National Geographic webpage about it:</p> <p>http://animals.nationalgeographic.com/animals/prehistoric/tyrannosaurus-rex/</p>

set of books covering all branches of knowledge

Guiding Concern #2	Directions for Teachers/Guiding Questions For Students
<p>What “counts” in the eyes of Feynman’s father?</p> <p>Feynman’s father was a keen observer of nature, and wanted his son to know about them as well. But his father believed that to know something was not to know its name, but rather to know what it does.</p>	<p>(Q4) Why did Feynman’s father take walks in the woods?</p> <p>Students might naturally gravitate towards the fact that Feynman’s father “had a special relationship” with his son as the reason; but that’s why he would walk with only his son in the woods and not the other boys—not why he was walking there in the first place. The answer lies earlier in the paragraph, where Feynman explains that they went on walks together so his father could tell him “about interesting things that were going on in the woods.” Importantly, this is the second time Feynman uses the word “interesting” to describe his father’s reasons for acting.</p>
Text Under Discussion	
<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 field. One kid says to me, “See that bird? What kind of bird is that?”</p> <p>I said, “I haven’t the slightest idea what kind of a bird it is.”</p> <p>He says, “It’s a brown-throated thrush. Your father doesn’t teach you anything!”</p> <p>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 <i>Chutto Lapittida</i>. In Portuguese it’s a <i>Bom da Peida</i>. In Chinese, it’s a <i>Chung-long-tah</i>, and in Japanese, it’s a <i>Katano Tekeda</i>. 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 <i>doing</i>—that’s what counts.” (I learned very early the difference between knowing the name of something and knowing something.)</p>	<p>(Q5) What distinction does Feynman make between naming and knowing and how does it connect to the lesson his father is trying to teach him in the example about the birds?</p> <p>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’s father, what really matters—the difference between knowing the name of something and knowing something—is knowing what a bird <i>does</i>. The final sentence of the first half of the memoir captures this notion: “I learned very early the difference between knowing the name of something and knowing something.”</p> <p>4. Ask students to research an animal of their choosing and learn something about it that Feynman’s father would consider knowledge.</p> <p>Students should demonstrate their grasp of the message Feynman’s father was trying to teach his son through an authentic learning experience where they briefly research an animal of their choosing and discover 1-2 facts about what the animal does. Students could perform the research at the end of class with the aid of an Encyclopedia (reinforcing the vocabulary word learned earlier in the day) or as homework, and then open the next day’s class by quickly sharing their fact with the class as a whole.</p>

Day 2: The Role of Observation

Day 2 Activities focus on CCSS Standards RI.5.1-4 & 8; W.5.2, 4 & 9; SL.5.1; L.5.4-6.

1. Teacher sets the scene by conducting a brief discussion of what has already transpired in Feynman’s memoir
2. Teacher introduces the second half of the text and students read that part of Feynman’s memoir independently
3. Teacher then reads the passage out loud to the class and students follow along in the text
4. Teacher asks the class a small set of guiding questions and tasks about the first half of the text
5. Students rewrite their sentences about what Feynman observed and add to it an explanation of the principle of inertia.

Text under Discussion	Directions for Teachers/Guiding Questions For Students
<p>He said, “For example, look: the bird pecks at its feathers all the time. See it walking around, pecking at its feathers?”</p> <p>[read second half of text]</p> <p>...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.</p>	<p>1. Set the scene by conducting a brief discussion of what has already transpired in Feynman’s memoir.</p> <p>Recap the previous day’s lessons by using the guiding concerns for that Day to refresh and reinforce the learning students have performed so far. Particularly important for transitioning to this day is reminding students about what it means to know about birds, as this day’s reading picks up the memoir at that point.</p> <p>2. Introduce the text and ask students to read Feynman’s memoir independently</p> <p>Like in Day One, do not give 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 (except for words that lack contextual clues for decoding their meaning – they are glossed in the margin), instead of privileging background knowledge, it levels the playing field for all students as they seek to comprehend Feynman’s text. It is critical to cultivating independence and creating a culture of close reading that students initially grapple with rich texts like Feynman’s memoir without the aid of a lot of prefatory material, extensive notes, or even teacher explanations.</p> <p>3. Read the second half of the text out loud to the class and ask students to follow along in the text</p> <p>Asking students to listen again to the second half of “The Making of a Scientist” exposes them again to the rhythms and meaning of Feynman’s language before they begin their 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.</p>

Guiding Concern #1	Directions for Teachers/Guiding Questions For Students
<p>How does Feynman’s and his father’s observations lead to a deep insight into the nature of things?</p> <p>Feynman and his father test hypotheses to see if they are true or not, letting their observations lead them to new conjectures until they discover a guiding principle underlying all the evidence they have seen. By ruling out some ideas (feather straightening) in favor of others (lice picking), they arrive at the idea that no food source goes unexploited in nature.</p>	<p>4. Ask the class a small set of guiding questions and tasks about the second half of the text</p> <p>As students move through these questions, 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 may focus on academic vocabulary.</p> <p>(Q1) What two explanations do Feynman and his father explore regarding the pecking behavior of the birds?</p>
<p>Text Under Discussion</p> <p>He said, “For example, look: the bird pecks at its feathers all the time. See it walking around, pecking at its feathers?”</p> <p>“Yeah.”</p> <p>He says, “Why do you think birds peck at their feathers?”</p> <p>I said, “Well, maybe they mess up their feathers when they fly, so they’re pecking them in order to straighten them out.”</p> <p>“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?”</p> <p>“Yeah.”</p> <p>He says, “Let’s look and see if they peck more just after they land.”</p> <p>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?”</p> <p>“Because there are lice bothering it,” he says. “The lice eat flakes of protein that come off its feathers.”</p> <p>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.”</p> <p>Finally he says, “So you see, everywhere there’s a source of food, there’s <i>some</i> form of life that finds it.”</p> <p>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 <u>detail</u>, but what he was telling me was right in <u>principle</u>.</p>	<p>Students should first recollect the lesson learned on day one – to know something is to know why it <i>does</i> something – and then apply it to this example. The bird does something: pecks at its feathers. To know the bird would then be to know why it pecks at its feathers, and Feynman’s father explores Feynman’s tentative answer about arraigining their feathers before offering up his idea that the bird is picking at lice.</p> <p>(Q2) Why are lice on the birds? Why are mites on the lice? Why is there bacteria on the mites?</p> <p>All of these questions are linked in that each animal exploits a food supply provided by a different animal: bacteria eat the sugarlike emissions of the mites, mites eat the waxy stuff on the legs of lice, and lice eat the protein flakes from the skin of the birds.</p> <p>(Q3) Explain what Feynman means when he says that the story his father told him “was probably incorrect in <i>detail</i>, but what he was telling me was right in <i>principle</i>.”</p> <p>This is a good comprehension question to test to see if students truly understand Feynman’s point. To his earlier insight that to know is to know something he adds what it is you should know: the underlying principle. The details of the stories his father told him—like the names of the birds or the precise relationship between lice and mites—might be incorrect in the particulars. But to Feynman and his father, the details are there merely to illustrate the principle that <i>some</i> form of life (no matter how small or insignificant) will utilize an available source of food.</p>

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Guiding Concern #2	Directions for Teachers/Guiding Questions For Students
<p>How did Feynman discover the principle of inertia?</p> <p>Like his father taught him to do, Feynman was observing the motion of a ball in his wagon and was puzzled by it. His father helped him generalize his observations into the principle of inertia, and showed him how further observations would confirm the law.</p>	<p>Put what Feynman noticed with respect to his wagon into your own words.</p> <p>This activity challenges students to attempt to grasp what Feynman saw and in two or three sentences put it into their own words without asking questions of the teacher. In order for students to accomplish a task like this successfully, they will need practice in focusing and writing independently. Circulate and check comprehension while students are writing.</p>
<p>Text Under Discussion</p> <p>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.</p> <p>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?"</p> <p>"That, nobody knows," he said. "The general principle is that things which are moving <u>tend</u> to keep on moving, and things which are standing still tend to keep on moving, and things which are standing still tend to stand still, unless you push them hard. This <u>tendency</u> is called 'inertia,' but nobody knows why it's true." Now, that's a deep understanding. He didn't just give me the name.</p> <p>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."</p> <p>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.</p> <p>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 <i>all</i> the sciences. (It just happens I do physics better.)</p> <p>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.</p>	<p>Group students together and ask them to create simple experiments that illustrate the law of inertia.</p> <p>Feynman's example shows the principle of inertia at work, and similar experiments can be easily constructed using classroom materials. Alternatively, show students examples of inertia.</p> <p>Sidebar: Website on Inertia The following website has several helpful videos of the law of inertia: http://www.wonderhowto.com/how-to-demonstrate-newtons-law-inertia-223913/</p> <p>(Q4) Why is inertia a general principle versus merely an observation?</p> <p>It's important to check to see that students know what it means to be a principle (a point Feynman stressed in his explanation of what it means to know something). You can do so by exploring the meaning of "tends"/"tendency" and how a principle governs multiple examples. Point out that Feynman's father is quick to confess to not knowing <i>why</i> there is a law of inertia ("nobody knows") but <i>does</i> explain the law through an example that he then uses to extract a "general principle."</p> <p>5. Ask students rewrite their sentences on what Feynman observed and add to it an explanation of the principle of inertia.</p> <p>Based on what they have learned, students rewrite their brief paragraph on Feynman's observations and integrate into it how those observations led to recognizing the principle of inertia. Be sure that students state the law of inertia in their own words as well and that it accurately reflects an understanding of what a principle means. If time permits students can perform the rewrite in class or complete it for homework.</p>

Day 3: “Lovely, Interesting Discussions”

Day 3 Activities focus on CCSS Standards RI.5.1-3; W.5.2, 4 & 9; SL.5.1; L.5.4-6.

1. Teacher sets the scene by conducting a brief discussion of what has already transpired in Feynman’s memoir
2. Teacher introduces three paragraphs of the text and students read that part of Feynman’s memoir independently
3. Teacher then reads the passage out loud to the class and students follow along in the text
4. Teacher asks the class a small set of guiding questions and tasks about the passage
5. Teacher rewrite their sentences on what Feynman observed and add to it an explanation of the principle of inertia.

Text under Discussion	Directions for Teachers/Guiding Questions For Students
<p>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...</p> <p>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 <i>all</i> the sciences. (It just happens I do physics better.)</p> <p>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.</p>	<p>1. Set the scene by conducting a brief discussion of what has already transpired in Feynman’s memoir.</p> <p>Recap the previous day’s lessons by using the guiding concerns for that day to refresh and reinforce the learning students have performed so far. Particularly important for transitioning to this day is reminding students of how Feynman arrived at the principle of inertia—initially through observation and then generalizing to arrive at the principle.</p> <p>2. Introduce the text and ask students to read Feynman’s conclusion independently</p> <p>Remain silent while students read the text silently. It is critical to cultivating independence and creating a culture of close reading that students initially grapple with rich texts like Feynman’s memoir without the aid of prefatory material, extensive notes, or even teacher explanations.</p> <p>3. Read the conclusion of Feynman’s memoir out loud to the class and students follow along in the text</p> <p>Asking students to listen again to the conclusion of “The Making of a Scientist” lays the groundwork for a close reading of the passage.</p>

Guiding Concern #1	Directions for Teachers/Guiding Questions For Students
<p>Why were the discussions with his father so influential for Feynman?</p> <p>His father gave Feynman not merely the tools for understanding the world through a scientific worldview, but also imbued him with the spirit of open-minded inquiry that has stayed with him his entire life.</p>	<p>4. Ask the class a small set of guiding questions and tasks about the second half of the text</p> <p>As students move through these questions, be sure to check for and reinforce their understanding of academic vocabulary in the corresponding text (which is boldfaced the first time it appears in the text). At times the questions may focus on academic vocabulary.</p> <p>(Q1) How did Feynman’s father influence the course of Feynman’s life?</p>
<p>Text Under Discussion</p> <p>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...</p> <p>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 <i>all</i> the sciences. (It just happens I do physics better.)</p> <p>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.</p>	<p>His father modeled for Feynman a way of approaching the world through “examples and discussions” that were “wonders” and were “interesting”—so full of wonder and so interesting, in fact, that they have “motivated” him to spend the rest of his life studying science.</p> <p>5. Students write a page length explanatory essay in response to one of the following prompts:</p> <p>(A) In the final paragraph Feynman says he “was given something wonderful when he was a child.” Using two examples from the text, explain what it was his father gave him.</p> <p>Feynman beautifully discusses how his father “educated” him and how the instruction he received “motivated me for the rest of my 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” natural phenomena that will spark his mind to discover the underlying principle of what he is observing.</p> <p>(B) Pick one of the examples that Feynman uses in his piece (the dinosaur, the birds, or the wagon) and explain both the example and the lesson Feynman’s father was trying to teach him with it.</p> <p>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 after. Students should put the principle Feynman’s father was trying to convey in the example under investigation (“try to figure out what [I read] really means”; “the difference between knowing the name of something and knowing something”) into their own words.</p> <p>During the next class period the explanatory essay could be peer reviewed and or time set aside to revise them.</p>

Appendix: Additional Resources about Richard Feynman's "The Making of a Scientist"

1) <http://www.youtube.com/watch?v=695Flhmjmg4>

A brief 5 minute video of Richard Feynman in conversation describing the influence of his father on his life (based largely on the text of "The Making of a Scientist.")

2) *Feynman* by Jim Ottaviani, with art by Leland Myrick and coloring by Hilary Sycamore (First Second, 2011)

An illustrated novel of Feynman's life, with early chapters covering his childhood with his father.