Seminar: The Making of a Scientist
Lesson Plan
Text: The Making of A Scientist by Richard Feynman

Teacher: Subject:
Grade Levels: 4th-8th and 9th-12th Dates: 1-2 class periods

Overview: Feynman’s short reading is good for introducing students to the idea that some things we know from convention (communities and societies agreeing to call something by a certain name) and some things we know from nature (observing and discovering natural principles). Students will think for themselves and personalize compelling questions.

Activities
1. Read: Read text together as whole group or in two smaller groups. Look up words. Have students circle the words they don’t know and later write down every new word and its meaning in their journals.
2. Question: Explain to students that you wonder about the question that comes from the son’s idea to his friends: Do you know anything about the bird if all you know is its name? Suggest that there might be many answers. Keep track of the students’ responses for them in your choice of anecdotal record taking. This keeps student responses connected to speaking and most importantly, listening. You can observe the flow of conversation. Finally, ask students to return to their journals and write more about this idea. Suggest that sometimes we write to learn what we really think!
3. Observation: Ask students to look at the salmon. Invite them to the think about things they know through convention (e.g., this is a King salmon) and things they know from nature and direct experience or the salmon itself in this case (e.g. this salmon is the same on one side as it is on the other, it smells, or this salmon has dark spots on it). The teacher should write this list on the board for all to see and add to. Students can later copy these lists in their journals.
4. Extend: Continue the list as an on-going activity: Ask students to think of other things they know by convention and things they know from direct experience and from Nature. Encourage their observations through all subject areas and in and out of school.
5. Discussion: Ask students about their observations in Fish Camp: Ask our elders how they know what they know. Did school teach them? The salmon? The animals? How did you know what to do in Fish Camp activities?
**Note To Teacher:** It takes a little daily practice to ask, think and talk about how we know things." Just because I know" is not a response that opens the conversation but usually is an expression of frustration. Tying to the central text is an easy way to turn this frustration towards understanding (e.g., how would Feynman’s son have responded before his conversation with his dad? Afterwards?) Feynman, a scientist, discredits the rattling off of facts as a demonstration of knowledge and suggests that this gets in the way.

**Curriculum Materials**
Each student needs a copy of, *The Making of A Scientist* by Richard Feynman (see below); dictionaries, pens and pencils; freshly caught salmon that students can observe is needed for the second activity. Dry erase board or butcher paper and pens to keep a running tally on things we know by convention and things we know by nature.

**Assessment and Evaluation**
The teacher will keep anecdotal records, assessing each student’s ability to

- Progress with the idea that identifying natural principles is more accurate than knowing facts
- Think for self
- Personalize and ask compelling questions

**Curriculum Goals For The Making of a Scientist**

**English B.3.** Students will relate what is viewed, read and heard in own lives, to the world outside...other experiences.

**Eng.E.1.** Student will use information, both oral and written...to understand self and others.

**Science F.2.** Students will develop an understanding that some individuals, cultures, and societies use other beliefs and methods...to describe and understand the world
The Making of a Scientist, by Richard Feynman

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 Encyclopedia 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 Pêida. 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.

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."