

Q&A: Alice Flarend teaches teens to think out loud

The seasoned high school physics teacher challenges students to engage in an increasingly distracted world.

By **Jenessa Duncombe**



▲ (Photo courtesy of Alice Flarend.)

“Students come to my classroom and say, ‘We’ve heard about you,’” says Alice Flarend. As a physics teacher for 26 years at Bellwood–Antis High School in rural central Pennsylvania, she has earned a reputation by asking her students to explain out loud what they’re thinking. In the classroom, she says, “the power of talk is huge.”

Flarend grew up in Chicago, where her father was an electrician at a steel mill and her mother was a secretary. Despite having no “nuclear roots,” Flarend took an interest in nuclear science in a high school chemistry class and focused on nuclear engineering for her bachelor’s and master’s studies. Midway through her doctoral program, she pivoted to teaching high school.

Unlike typical high school physics courses, Flarend’s classes include modern-day physics topics such as quantum information science. She trains other teachers in the subject and has cowritten two quantum physics books aimed at high school students. In 2023, she received the Paul W. Zitzewitz Award for Excellence in K–12 Physics Teaching from the American Association of Physics Teachers (AAPT).

The following interview has been edited for length and clarity.

Tell me about your path into teaching.

I went to the University of Michigan for my PhD in nuclear engineering

and had a great adviser, but I found out I was much more interested in why people didn't understand nuclear science. This was post-Chernobyl, and I remember Greenpeace protesting nuclear energy on campus.

A group of us nuclear engineering graduate students would visit schools. More than one teacher said, "We want to know about how things blow up." We would tell them that nuclear reactors don't blow up like a nuclear bomb. We were hearing people's ideas that nuclear energy is so inherently dangerous.

These experiences were way more interesting to me than going to my PhD lab. So, I thought I'd try teaching for a year and see if I liked it. If not, I told myself that I'd go back and get my PhD and make more money. I found an all-girls private school in Toledo, Ohio, called St Ursula Academy. They hired me.

How did it go?

Before I took the job, I had done some cursory reading on teaching. And I thought I had to explain science clearly and do hands-on problems. But the people-management aspect of teaching is something that was very unexpected to me. Working in a PhD lab, the neutrons I worked with didn't care if it was Monday or Friday afternoon. My neutrons didn't have a dog that died or a boyfriend that broke up with them. That aspect was very challenging for me and still is. But I ended up really liking it.

You've been teaching high school for more than 30 years. How has your approach changed?

Something I struggled with early in my career is the question, "Is my job to prepare kids for college physics, or is my job to help them understand physics?," which in a way are two different things. I'm on the

"Let's have them understand physics" side. I can help them be curious and to not think of physics as plugging numbers into an equation. If they can live a more interesting scientifically minded life, not be scared of it, that's worth it.

What's one way that you bring quantum physics into your high school classroom?

I anchor a quantum unit in quantum cryptography, which is needed because when quantum computers get powerful enough to break our current system of encryption, we will need a way to encrypt information that even a quantum computer can't break. The unit uses photo polarization to help students understand quantum states and superposition.

You also train other teachers on quantum science. Can you give us an example?

A majority of physics teachers do not have any colleagues teaching physics within their building, so they have no resources right down the hall. In many districts, the people teaching physics are doing so under an emergency certification and they need help with both content and classroom activities.

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One really fantastic model of professional development for teachers was Quantum For All. We hosted middle and high school teachers for a week during the summer and taught them classroom-ready quantum activities

that, at that point, we'd vetted for years. Then the next week, we hosted a quantum camp for middle and high school kids, and those teachers taught those kids. It gave teachers a reason for learning the subject, and it made it a little less scary because the teachers had lots of support around them. The camps were held 2022 through 2025.

Teachers can struggle if they haven't dealt with quantum physics. They're learning again. You remember what it's like to be uncertain and not know all the answers.

A lot of the students liked it. Of course, they're teenagers, so some of them were very apathetic.

You've cowritten two books about quantum physics for advanced high school and early-college students. How did that come about?

I got this email from Bob Hilborn, an emeritus physics professor at Amherst College, out of the blue right before COVID. Bob was looking for an "Alice" to write a quantum book with, because there is a quantum trope of Bob and Alice. The book, *Quantum Computing: From Alice to Bob*, was very conversational and accessible but still with some linear algebra with two-by-two matrices. No calculus.

Bob taught from the book for a college course, and that ended up being the inspiration for the second book, which comes out in July, called *Quantum Computing and Quantum Physics: A Linear Algebra Approach*. It's more of a standard textbook on quantum physics and quantum computing. We took a conversational, low-key approach in the writing. We tried not to write a stuffy, boring textbook.

After 15 years of teaching, you went back to school for your

PhD in science curriculum and instruction. What did you learn?

My dissertation was about language and listening. Humans use language not only to communicate but also to think, problem solve, and learn. This is what I do in my classes. Students come to my class on the first day and say, "You're going to ask why a lot. You're always going to ask us to explain what we're thinking." I say, "Exactly, which is why this class is not going to be hard for you, because you're going to figure stuff out as you're talking."

It's hard to get them to talk. And it's not a pandemic thing. Students are used to the idea of, Tell me what you want me to know, and I'll tell it back to you, and I'll remain completely unchanged and uneducated. That's too strong a statement, but I try to get them to talk.

One example is the next-generation science standards: They are much more about having kids be scientists and gain proficiency in science practices, including designing experiments and asking research questions. Students take a more active leadership role in deciding what needs to be learned and how they can go about gathering evidence. When I use the next-generation science standards, the students are kind of shocked that scientists talk so much. The stereotype of scientists is that they work by themselves in a lab and don't talk to people.

What challenges do students face today?

Phones are definitely an issue, but they are also an opportunity. Recently, we were playing with a Tesla coil and finding out that you can play music in a square-wave format on the coil using your phone. People say that kids today don't think or do anything creative and

that they have no drive because their faces are just in their phones. These were amazing kids. We need to work on a curriculum that utilizes these digital tools to keep kids advancing and being active builders of their interests and their lives.

I try to give them opportunities to use digital tools in ways that help them learn better. I saw a speaker at an AAPT conference talk about how he has students make videos of their homework. Students would take a problem and explain how they got their solution. When someone's explaining a problem, you can tell pretty clearly whether they're faking it. I have done that a little bit with my students. The cheesy term is minds on, rather than just hands on.

I try to teach them to use AI well. I tell them to not just take the first answer but to ask the chatbot, "What do you mean by that number?" If I had to come down on a side, I am on the side of opportunity rather than AI being the end of everything.

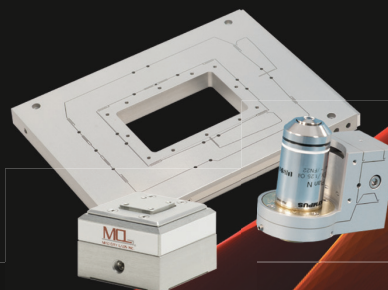
What would you say to someone interested in teaching high school science?

We are in such a teacher shortage right now that it's actually easy to get a job, especially if you're a science person. You're going to get a job, but it may be for less pay than what you're making in science. My son liked to say, "Remind me again, how much money could you be making as a nuclear engineer?" I'd say, "I'm happy with what I'm doing."

Teaching is being an engineer. I am solving problems in a particular context. If you think of it that way, it could be fun. And especially for a science person, you're still kind of doing what you were doing before. It's just in a much messier lab.

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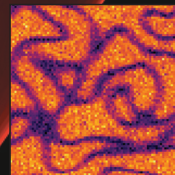


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