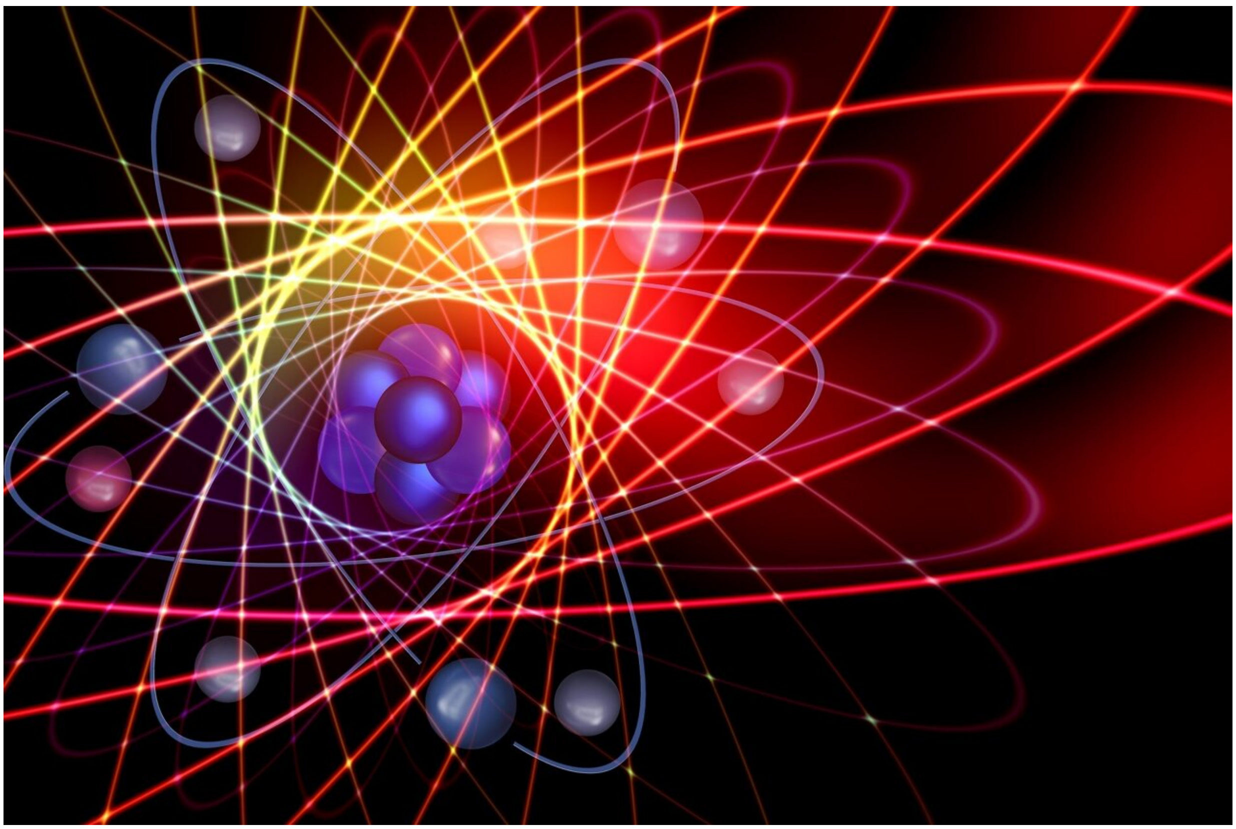
Quantum information science is rarely taught in high school—here's why that matters

September 11 2023, by Karen J. Matsler



Credit: Pixabay/CC0 Public Domain

The first time I heard about quantum information science, I was at a teacher development workshop in Canada in 2008.

I already knew that quantum science was the study of the smallest objects in nature. I also knew that information science was the study of computers and the internet. What I didn't know was that quantum information science—sometimes called QIS— was a new field of science and technology, combining physical science, math, computer science and engineering.

Until then, I didn't realize how QIS was key to so many everyday items, like cellphones, satellites, MRI machines, lasers, cybersecurity and solar technology. I was a physics teacher and didn't know this, so I knew other teachers didn't either. And if they didn't know about it, that meant K-12 students were definitely not learning it.

I vowed to do a better job of teaching these concepts in my own classroom and to the teachers I mentor. But I quickly discovered significant barriers.

Those barriers include:

- Lack of materials about quantum information science that high school students can understand.
- Limited funding and opportunities for teacher professional development focusing on quantum information science.
- Lack of state or federal quantum information science standards for schools to follow.

With the help of colleagues, I organized Quantum for All in 2020 to help give high school teachers support in teaching quantum information science. The project received nearly US$1 million in funding from the National Science Foundation. The goal of the grant is to help students become quantum smart by teaching K-12 educators how to teach QIS.

Quantum jobs are everywhere

From a societal perspective, there are many reasons to invest in quantum education at the high school level.

The quantum information technology market is poised to be worth $44 billion by 2028. Yet one study estimates a major talent shortage in the industry—with the number of open jobs outnumbering the number of qualified applicants by about 3 to 1.

Not having fundamental knowledge in the field may keep students from pursuing these highly paid jobs. Annual salaries can start at about $100,000 for quantum engineers, developers and scientists. Quantum physicists can earn up to $170,000.

While there is a need for quantum science talent in many industries, one of the most critical is in national security.

National security

Historically, huge scientific and technological advancements have been made in the United States when politicians invest in efforts they deem critical to national security—think of the space race, where the U.S. spent US$257 billion over 13 years, or the atomic bomb that cost about $30 billion to $50 billion over four years, both in today's dollars.

In 2016, the U.S. government recognized the importance of quantum information science in maintaining the country's strategic edge when China launched the world's first quantum satellite, showcasing its emerging space and technology program. U.S. military leaders also worried that China was on the verge of creating "hack proof" communications tools far more sophisticated than American designs. This raises questions about which nation will dominate from space in times of crisis.

The Center for New American Security, a Washington-based think tank, warned that China's focus on quantum science as part of its research efforts could help that country surpass the U.S. as an economic and military superpower.

In 2018, the National Quantum Initiative Act was signed into law "to accelerate quantum research and development" and "develop a quantum information science and technology workforce pipeline." However, the initiative lacked details on how this workforce would be developed.

Quantum science education

With a new national focus on quantum information science, the National Quantum Network was launched in 2020 to help support and coordinate the K-12 education efforts, expand available learning tools and create opportunities for students to envision their role in a quantum workforce.

The most logical venue for exposure to quantum information science would be a high school physics course. However, as many as 16% to 39% of high school students do not attend high schools where physics is offered each year.

Traditional professional development focuses on teaching the teacher, rather than helping the teacher prepare to teach. That's why I and other researchers are studying the effectiveness of a different professional development model. Components of the model include having the content taught by fellow science teachers.

Our model educates teachers one week and then allows them to teach students at a camp the following week while the information and techniques are still fresh. Research has shown that this approach is more effective than doing summer workshops that don't allow teachers to try out what they learned until much later.

This model also allows teachers to gain confidence as they practice teaching techniques with fellow science teachers, making it more likely they will implement this knowledge in their own lessons. The lessons being developed by the project can be embedded into existing STEM curricula—science, technology, engineering and math—or taught as stand-alone topics.

Examples of quantum information science lessons that have been developed include levitation, where students are shown the basics of superconductors and quantum levitation. These concepts are already being used in applications such as Maglev trains, which use magnets to quietly float above the tracks instead of using wheels. There are many benefits to this type of travel, including energy efficiency, fewer derailments, less maintenance and less impact on the environment.

Other lessons involve understanding cryptography and cybersecurity. Cryptography is the technique of coding information—or encryption—so it can only be read by the intended receiver, whereas cybersecurity is the process or procedures taken to keep information secure in devices and networks.

As districts and educators begin to implement quantum information science concepts, my colleagues and I are collecting feedback from teachers on the effectiveness of their lessons and student engagement. This feedback will be used to inform how to add quantum information into more lessons.

If this new model of teacher education works, it could be expanded nationwide.

This type of professional development may be expensive due to the time teachers need to learn the content and increase their teaching confidence. But failing to prepare students for the jobs of the future could be even more costly if the U.S. yields its place in quantum technology, allowing countries like China to assert their supremacy in the field.

Provided by The Conversation

Citation: Quantum information science is rarely taught in high school—here's why that matters (2023, September 11) retrieved 20 June 2024 from https://phys.org/news/2023-09-quantum-science-rarely-taught-high.html