

Teach science through argument, professor says

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Jonathan Osborne, professor of science education, says teachers should help students learn to argue a position from available evidence. Credit: Linda A. Cicero

(Phys.org) —Teaching students how to argue based on available evidence engages them in the scientific process and provides a better idea of how science actually works. The challenge is training teachers.

Earth orbits the sun. [Microorganisms](#) cause infectious disease. Plants use

[carbon dioxide](#) to grow. Most of us know these scientific truths from our earliest school days. They're accepted facts. But astronomers, [microbiologists](#) and [botanists](#) once fought for these concepts using arguments based on evidence. Science, it seems, arrives at its tenets through argument.

Science education should follow suit, says Stanford education Professor Jonathan Osborne. Teachers should help students learn to argue a position from available evidence, he says, helping them learn why we know what we know.

Osborne believes that this educational model, "argumentation," makes science education more valuable, not just for future scientists but for the public at large. His recent work suggests that training teachers how to implement this model is the toughest challenge that lies ahead.

Last year, the National Research Council, in collaboration with other national science education organizations, released [A Framework for K-12 Science Education](#), which states are using to develop new science curriculum standards. A key practice, the report reads, is "engaging in argument from evidence."

"In science, people argue for their ideas, in terms of the evidence that they have," Osborne said. "There should be more opportunities to look at why some ideas are wrong, as well as what the right ideas are."

Argumentation invites students to consider the foundations of science, Osborne said.

"It's having opportunities for students to engage in that process of thinking about why we believe what we do in science."

Osborne teaches in the Graduate School of Education and has firsthand

experience as a science teacher. After earning a master's degree in physics, he taught in London high schools for nine years in the '70s before pursuing a doctorate in education. Now an expert in science education, Osborne believes there is a disconnect between how science is done and how it is taught.

"There's not enough discussion and argumentation," he said. "It puts off students because they feel that somehow it's very authoritarian. Science isn't like that."

As a result, public scientific literacy suffers. Society needs to know science's major ideas, why they are important and how they are justified, Osborne said. The last component, justification, is lacking in [science education](#), he said. Peer review, for example, is a cornerstone of scientific validation, but is not taught in K-12 curricula.

"That's a bit worrying," Osborne said.

In 2004, Osborne and colleagues studied 12 teachers and how they used argumentation during science lessons. The students' argumentation skills improved, but researchers concluded that students needed more time than one school year to show significant improvement.

In 2007 they launched a large-scale, two-year study at four schools in the United Kingdom. Because individual teachers come and go, Osborne and his colleagues sought to embed the new method in the faculty of an entire school. "Lead teachers" learned argumentation from training videos and passed their training along to their colleagues. Researchers tracked students' reasoning ability, argumentation skills, views about knowledge and engagement with science.

The results, recently published in the *Journal of Research in Science Teaching*, were surprising –measures of students' skill and understanding

did not significantly improve.

"This is more of a challenge that we thought it was," he said.

He and his co-authors have a few theories. Perhaps even two school years is insufficient time to see a significant effect. Or maybe the assessments of students' skills were insufficient.

"Measuring students' skills in argumentation is something which, as a field, we have not developed," Osborne said.

Or their teacher training methods may need re-thinking. Osborne is now working to help teachers implement argumentation hands-on during summer sessions. He and his colleagues continue to work on this problem, but time is growing short – 26 states, including California, will release their [Next Generation Science Standards](#) this spring.

"A lot of teachers will be considering this in the next few years," Osborne said.

Publishing a "null result" paper – a negative result – shows that Osborne is willing to adapt his scientific inquiry to follow the path of available evidence – just as he hopes [students](#) will.

More information: [dx.doi.org/10.1002/tea.21073](https://doi.org/10.1002/tea.21073)

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