

Short Communication

An Attention-Grabbing Approach to Introducing Students to Argumentation in Science

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Date received: 13/01/2010

Date accepted: 05/04/2010

Abstract

Argumentation and basic logic are foundations of scientific inquiry, and thus should be foundations of science education. Students often are uninterested in formal logic, and do not understand the connection to science or society. I describe a way to engage students in the study of argumentation and to help develop student's ability to critically analyse argumentation in real-world science contexts. Following a demonstration of fallacious but persuasive argumentation, they practice logic, identifying fallacies, then construct their own arguments.

Keywords: argumentation, rhetoric, logic, fallacy

Logical argumentation is a key feature of scientific discourse (Siegel, 1995, Kuhn, 1993). Basic logic is a precursor to the sophisticated conceptual development and understanding required of educated citizens and practicing scientists (Osborne, 2005). Moreover, argumentation is useful both to persuade and as an inquiry process itself (Meiland, 1989). Yet, few university students receive adequate, explicit training in logic and rhetoric, and fewer still have the opportunity to take an active role in argumentative discourse (Duschl and Osborne, 2002).

The hook:

I sought to teach basic logic and argumentation in a way that would capture the students' attention and impress upon them its central role in evaluating scientific information (Driver *et al.*, 2000, Sampson and Gleim, 2009). The second plenary session of two undergraduate biology courses for non-majors included a 'deceptive' lecture: a passionate argument that global climate change is not anthropogenic, and moreover is not occurring. The lecture included temperature records with no increases, sea level records showing no rising oceans, data demonstrating increase in crop productivity and increasing areal extent of forested land in the US, and finally a petition signed by several thousand scientists stating global climate change is not a problem.

At the end of the tirade, I asked who would sign their name to the petition. Nearly every hand was raised. I then revealed the deception. Nervous laughter echoed in the otherwise silent room. We then slowly reviewed the argument – there were no lies, no manufactured data, just a very biased and purposefully constructed (though ultimately flawed) argument.

For instance, the thousand-year temperature records were from single locations — to which *global* climate change makes no specific prediction. Some temperature and sea level records were only ten years long — much too short to meaningfully evaluate a change over many decades. The timber and agricultural data were irrelevant, being driven by forces independent of climate change. Less overt tactics were also used; I spoke forcefully, authoritatively. The colours on each slide were varied to create a dizzying effect, and the lecture was fast-paced. The final straw was the strong appeal to authority — the petition signed by thousands of

scientists with advanced degrees (unbeknown to the students, most were employed by the energy industry). As students reflected on this experience, most realised that they believed the lecture in part because of the academic setting, and that *they just had not thought critically*. I had their attention.

The assignments:

The students, in groups of four, were asked to create an argument similar to mine in its persuasive and purposively deceptive nature, about another controversial scientific topic. The only rule was that no information could be made up — no lying. They would have several weeks to research, prepare, and then present their arguments to the class orally, and be evaluated based on how persuasive they were.

In preparation, we spent one three-hour lab period learning library research skills (e.g. how to find scientific content on the Internet, narrow results, assess credibility, distinguish between primary and secondary literature). To accomplish these goals, I guided the students to a number of websites of varying quality and passed out sample journal articles, magazine articles, and advertisements with a ‘scientific’ look about them. We discussed the features of trustworthy sources and of those we should be skeptical. After just one session, students easily could pick out original research from ‘processed’ information, and could identify at least some potential biases (e.g. ‘experts’ with a financial interest in the topic).

Table 1 Student perception survey results after argumentation coursework. Responses were given using a 5 point Likert scale (1=strongly agree, 2=disagree, 3=neither agree or disagree, 4=agree, 5=strongly agree). Note: sample size for the third question is lower because it was absent from the survey in one course.

Question	Average response	Modal Response	Proportion agreed	n
The assignment was worthwhile	3.93	4	0.79	169
I learned more from this assignment than I would have from a standard research project	3.85	4	0.68	169
I thought this assignment was more interesting than a standard research project	4.27	4	0.89	128
I feel better prepared to detect biased or one-sided arguments	4.04	4	0.80	169
I feel better prepared to evaluate scientific issues I might encounter in the “real-world”	3.89	4	0.72	169
I found some presentations persuasive, even though I knew they were hiding contradictory evidence	4.00	4	0.83	169

We spent another lab period working explicitly on formal logic (e.g. valid argument — if the premises are true, the conclusions must be true; sound argument — a valid argument with true premises). Students were taught many of the most common logical fallacies; For example, a ‘false dichotomy’ argument has the form: “A or B is true, A is not true, so B must be true”, which is logically valid but unsound because the first premise is false, that is, possibilities besides A or B have been ignored. In small groups, students then worked through a series of 25 arguments (presented as in-class worksheets) and tried to determine if each was valid and/or sound. Students then practiced making their own such arguments with simple, real-world examples. By learning the general form of arguments in abstraction first, then in simplified contexts, students were better able to distinguish complex and subtle examples from biology in the real world.

At the end of the semester, students presented their own persuasive arguments in 12 minute talks (with Powerpoint visuals) on topics such as the healthfulness of organic produce (or, genetically modified produce), the evolution of modern humans, and whether the chemical DDT should be used to combat malaria. The students in the audience were challenged to identify when and how the presenters were being deceptive – i.e. to be active, critical thinkers. The responses from a perception survey following the assignments were overwhelmingly positive (Table 1); most students were more interested and felt they learned more than they would from traditional assignments. Students mostly felt better able to deal with deceptive argumentation in the real-world. Almost a year later, one student wrote to say she saved a great deal of money by seeing through a deceptive sales pitch using things she learned in our class! Fascinatingly, most students reported that many of their peer's arguments were still persuasive, even knowing that the presentations were purposively manipulative.

This is a risky approach. Many of my colleagues were skeptical; wouldn't students get confused about the importance of scientific truthfulness and integrity? Wouldn't students be listening to a lot of 'misinformation' during the presentations? In practice, though, students largely 'got it'. They understood I had not lied, only presented a biased argument, and they understood it was to make a point: that truthful facts can be strung together to support incorrect arguments, and only critical analysis can separate out valid, sound arguments. They were interested, engaged, and liked the idea of doing something different. Without the initial lecture, I am not convinced the assignments would be nearly as successful – the key was to properly motivate the students, essentially by appealing to their pride. They did not want to be as easily fooled in the future. Learning how to construct faulty logical arguments through exposure practice may be a particularly engaging way of learning scientific argumentation.

Acknowledgements: JMW was supported by the College of Science and Technology and Department of Biology at Radford University.

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