TOWARD A MORE RELATIVISTIC VIEW OF SCIENCE: NEWSPAPERS AS A PEDAGOGICAL TOOL

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Abstract

Science teachers have an obligation to help students develop intellectually which at times can be antithetical to scientific thinking. Using William Perry's theory of intellectual development, this article explores the use of controversy in the science classroom to help 'nudge' student development from dualistic to relativistic thinking. Three specific issues are discussed: stem cells, intelligent design, and global warming. Students can sometimes leave a science class with the mistaken view that science has the ability to answer all questions which can cause cognitive dissonance between scientific knowledge and other forms of knowledge. This article suggests that simply posing the question about the limits of science's reach can provide a pedagogically rich curriculum. Using newspapers can help science teachers deal with student intellectual development in ways that the traditional curriculum cannot.

Key Words: Newspapers; Pedagogy; Science; Scientific method.

Resumo

Os professores de ciências têm a obrigação de ajudar os alunos a desenvolverem-se intelectualmente o que, por vezes, pode ser antitético ao pensamento científico. Recorrendo à teoria de desenvolvimento intelectual de William Perry, este artigo explora a utilização de controvérsias na aula de ciências como forma de ajudar os alunos a passarem de um pensamento dualista para um pensamento relativista. São discutidos três assuntos específicos: células estaminais, teoria do *design* inteligente e aquecimento global. Por vezes, os alunos podem sair das aulas de ciências com a ideia errónea de que a ciência tem a capacidade de resolver qualquer questão, podendo originar dissonância cognitiva entre o conhecimento científico e outras formas de conhecimento. Este artigo sugere que a simples abordagem da questão dos limites do empreendimento científico pode proporcionar um currículo

pedagogicamente rico. A utilização de jornais permite aos professores de ciências estimular o desenvolvimento intelectual dos alunos de formas não abrangidas pelo currículo tradicional.

Palavras-chave: Jornais; Pedagogia; Ciência; Método científico.

Introduction

> *"Literary intellectuals at one pole—at the other scientists...Between the two a gulf of mutual incomprehension."*
>
> Snow, 1959

The use of newspapers as an educational tool in a science classroom can provide students with a clearer view of the limits of scientific thought and thus teach them a more realistic view of science. Newspaper coverage of scientific issues may also help students see the connection between science and other fields of knowledge. Understanding the limitations of science and the interaction of scientific thought with other forms of knowledge will help students develop intellectually: they will move away from a dualistic conception of knowledge, especially scientific knowledge, and move towards a more relativistic view.

The role of science in today's society has become increasingly more important and complex yet one could argue that the teaching of science has become more reductionistic and simplified. At a time when scientific research often requires a more narrow focus in order to make progress, the broader aspects of science are neglected by many science teachers. While reductionism has certainly provided a beneficial paradigm during the last two hundred years, the same reductionism that propels scientific progress can hinder intellectual development when used in a classroom. Teachers in higher education must be willing to step back from their disciplinary silo and take a broader view of knowledge. The responsible teacher in the 21st century must be able to help students to see as much of the entire picture regarding knowledge as possible.

A pedagogical tool to assist teachers in moving beyond the silo of disciplinary knowledge is the daily newspaper. The newspaper covers controversial science: studies that have just been reported, theories that challenge religious views, political clashes between science and policy issues, and other stimulating aspects of science. Because a major goal of education centers on critical thinking associated with intellectual development, teachers often need educational activities that engage students in issues that create cognitive dissonance. By looking at one particular intellectual development theory, that of William Perry, a case is made in

this article for using newspapers as part of the scientific curriculum. Through the lens of Perry's theory an argument is made for teaching science in less didactic ways so that students might leave a science course thinking in more relativistic, as opposed to dualistic, terms. An argument for viewing science as one part of a larger world of knowledge will be offered as a different paradigm for conceptualizing science teaching. Three specific instances of scientific issues in the news will be explored to provide possible topics for a teacher who aspires to introduce more relativism into the curriculum. The article concludes with practical implications for the classroom.

Perry's Development Scheme

A leading theory of intellectual development is that of William Perry, who theorized nine stages of development that are often reduced to four major stages: dualism, multiplicity, relativism, and commitment (in relativism). Perry argued that college students often begin their educational career at the lowest rung of the intellectual development ladder, viewing knowledge in terms of right or wrong (Perry, 1968). Students next develop a view that multiple forms of knowledge are possible, what Nelson refers to as the "Baskin-Robbins stage" (p. 171), i.e. all forms are knowledge are equally valid in much the same way that any preference in ice cream flavors is equally valid (Nelson, 1999). Many students do not progress past multiplicity during their college years but in the year following college most students seem to rapidly develop a more relativistic view of knowledge, i.e. some ideas are more sound than others (Baxter Magolda, 2001; Belenky *et al.*, 1986). Not all human beings will develop into a committed form of relativism but those who reach that stage accept a variety of views, can articulate the strengths of each view, and still hold a particular view strongly based on the individual's perception of the information. The central claim in this article regarding Perry's scheme is that students in higher education are often taught science using a dualistic view of scientific knowledge. The traditional teaching methods of lecture, laboratories, and textbooks promulgate the notion that ideas are either right or wrong and that the scientific method can be employed as the arbiter of the correctness of those ideas.

Science teachers are perfectly positioned to help students better understand science as one particular epistemological construct. A teacher need not revert to an approach that promotes multiplicity of all claims to knowledge; a teacher can begin to cultivate in students a commitment in relativism. When a teacher acknowledges the limitations of science, scientific thought no longer seems like the monolith that students often see. Instead science becomes one of many possible ways to view the world. A teacher must be willing to confront controversial

subjects as a way of 'nudging' intellectual development (Kloss, 1994). In order to facilitate developmental change the teacher must be willing to provide the appropriate amount of challenge and support. Too often in science courses the challenges posed to students center on conceptual understanding of a particular scientific concept and students are taught to search for the *right* answer. This continual searching for correct answers may unwittingly enforce a dualistic view of scientific knowledge. Students may not develop an appreciation for the tentative aspects of science because the pedagogy insinuates that all problems have *one* correct answer.

Minimizing Dualistic Thinking in Science

Many of the claims in this article echo the call made by Paul Feyerabend regarding the role of the scientist (Feyerabend, 1975):

> *"A scientist who wishes to maximize the empirical content of the views he holds and who wants to understand them as clearly as he possibly can must therefore introduce other views; that is, he must adopt a pluralistic methodology. He must compare ideas with other ideas rather than with 'experience' and he must try to improve rather than discard the views that have failed in the competition"* (p. 21).

Feyerabend argues for commitment in relativism: all knowledge is tentative but one can still take a stance on each topic. The stance must be taken with the clear understanding that as knowledge accumulates a different stance may be adopted. At the risk of seeming to open an argument about the Science Wars, perhaps Feyerabend's 'pluralistic methodology' would prove more useful in the science classroom than the scientific method. The scientific method serves a valuable purpose for the progress of science but the progress of knowledge requires a more comprehensive understanding that newspapers can help foster in the classroom.

The pedagogy in the science classrooms, as described above, might contribute, either knowingly or unknowingly, to a dualistic view. Science students are routinely taught the 'scientific method' as if that method alone distinguished scientific thought from all other modes of thinking. Too often students leave a science classroom with exactly the bifurcated view of knowledge that Snow articulates in *The Two Cultures* (Snow, 1959). Not only do students cling to this bifurcated view but the students often consider that scientific reasoning holds the keys to true knowledge while literature, the 'softer' sciences, history, and other areas of knowledge are peppered with multiple opinions. Thus in Perry's scheme the science student might separate all

knowledge into two spheres: scientific and other. In the scientific sphere knowledge is either right or wrong while in the 'other' sphere knowledge consists of a multitude of opinions. Within this 'other' sphere of knowledge choosing a particular opinion is no different than choosing an ice cream flavor. Taking a rather pessimistic view of science education one might conclude that science teachers promulgate the conception that within science knowledge is possible but outside of science knowledge does not truly exist, a doubly dualistic way of thinking. Outside of the safety of the scientific method, in essence, lies merely a variety of divergent viewpoints with no sound means of choosing one form over another.

Scholars have previously elaborated on the varieties of knowledge related to science. Two prominent expositions are works by E. O. Wilson (Wilson, 1998) and Daniel Dennett (Dennett, 2006). Both Wilson and Dennett try to promote a view that scientific knowledge should be expanded beyond the bounds of traditional scientific disciplines and both have been met with some measure of hostility.

Wilson argued in *Consilience: The Unity of Knowledge* for a 'literal jumping together (pg. 8)' of knowledge. He claimed that Enlightenment thinkers were basically correct when claiming that science deserved an elevated epistemological status. Wilson argued eloquently for the use of science to pursue humane ends yet Wilson's argument centered on recognizing science as *the* source of knowledge. Such claims do not seem to fall within the traditional realm of science and are often met with incredulity by other thinkers. Jeremy Bernstein (Bernstein, 1998) began a particularly scathing review of *Consilience* with an ad hominem: "It is not uncommon for people approaching the outer shores of middle age to go slightly dotty" (p. 64). The attack on Wilson can be viewed as an attack on the arrogance of science. Bernstein summarizes Wilson's central argument with apparent distaste:

> *"Wilson genuinely feels that once we know enough about physics, chemistry, and biology, there will be nothing on earth we cannot explain. And by nothing, he means nothing"* (p. 64).

Bernstein praises Wilson for his "calm, measured tones" but is clearly aghast at the proposition that science can explain everything.

Daniel Dennett recently argued in *Breaking the Spell: Religion as Natural Phenomenon* that the study of religion was amenable to scientific investigation. A critical assessment of Dennett's argument (Wieseltier, 2006) in *The New York Times Book Review* dismissed the

entire premise of the book with two sentences: “The question of the place of science in human life is not a scientific question. It is a philosophical question.” Dennet foresaw such criticism:

> *“Anyone who tries to bring an evolutionary perspective to bear on any item of human culture, not just religion, can expect rebuffs ranging from howls of outrage to haughty dismissal from the literary, historical, and cultural experts in the humanities and social sciences”* (p. 259).

The treatment of religion as a natural part of the world seems to overextend the reach of science. Science educators cannot necessarily expect students to accept the notion that different disciplines overlap but an educator can certainly make students aware that science does seem to have limits. The lesson to extract from the reviews of Wilson and Dennett might be that knowledge can be viewed relatively. One could certainly debate whether the authors or the reviewers seem to be more dualistic in their thinking but no doubt remains that disagreement does exist among thinkers. The disagreement touches on a central epistemological question alluded to by C. P. Snow regarding the different types of knowledge. Snow suggested that science is separated from other fields of knowledge by a chasm. Bridging that chasm seems to be an important educational aim but perhaps a better metaphor is a Venn diagram so that the teacher’s role is helping students explore where overlap exists among different cultures as described in the next section.

‘Overlapping Magesteria?’

One could argue that Snow was correct when identifying the gulf between science and other forms of knowledge but evidence seems to indicate that humans tend to categorize knowledge in ways that do not always work. Stephen Jay Gould eloquently argued for a categorization of different realms of knowledge with his provocative phrase “nonoverlapping magesteria” (Gould, 1997). The concern by most thinkers outside of science, as well as some within science, is that scientific thinking can become egotistical thinking when it leads to an obliteration of other realms of knowledge. Scientists and science teachers may propagate the view of scientific superiority by placing ideas such as the scientific method on an epistemological pedestal. The hostile reaction by critics like Bernstein and Wieseltier might emanate from a fear that science is a territorial power with plans to rule the entire world of knowledge. The animus directed at Wilson and Dennett might be explained by the apparent world domination of scientific thought. Poets, historians, philosophers, political thinkers, and

artists, as well as many social scientists, bristle at the notion that science will eventually provide answers for everything worth knowing. Science is part of a larger world of knowledge but scientific thinking cannot answer all questions. The magesteria seem to overlap and the areas of overlap seem critically important. In a recent interview John C. Mutter, deputy director of the Earth Institute at Columbia University, was asked about poverty: "I've come to think that some of the answers to global poverty might be found in the places where the social and hard sciences inform each other" (Dreifus, 2006). No matter what stance an individual teacher adopts regarding the overlap of the disciplines, newspaper articles continue to confront the issue on a regular basis.

A major concern in 'science wars' is relevant to the teaching of science (Brown, 2001): "A justified skepticism about a number of particular cases can, unfortunately, get easily generalized into skepticism about reason and evidence everywhere" (p. 152). Using newspapers permits teachers an opportunity to discuss the value of scientific investigation at the same time admitting the limitations of scientific thinking. Newspaper stories can stimulate critical thinking about science and can help students view the scientific method in a new light. Excessive reliance on promoting the scientific method can solidify the student view that science deals only with dualism because the scientific method allows one to uncover the truth of any issue.

While not all teachers may feel qualified to lead such a classroom discussion, the use of newspapers—with coverage that is so new that both students and teachers are essentially on level ground concerning exposure to the information—permits the teacher to make subtle points about knowledge. Exposing students to controversial views involving science may help students clarify their own epistemological views. The clarification of what constitutes scientific thinking and the limitations of that thinking may help students progress on Perry's intellectual development scale. Helping students appreciate relativism while in school should help prepare those students to avoid the shock of relativistic thinking that often greets them upon graduation.

If a teacher opts to include controversy in the classroom then an understanding of some of the issues regarding scientific versus non-scientific thinking should help the teacher examine the most pedagogically efficacious ways of nudging students to higher intellectual development. The next section details three specific instances of controversial subjects that received substantial media coverage in the United States during 2005.

Three Examples of Science in the News

Each of the three issues discussed below provides a slightly different context in which to view the overarching idea that arises from the examples: scientific knowledge cannot provide resolution to all controversial subjects. A corollary idea that students should take from these examples is that scientific knowledge is tentative. Because content coverage often takes precedence over critical thinking inside the classroom students are often educationally uninformed about current controversial issues. While a student in the typical classroom is continually exposed to factual information, putting those facts in a broader context is viewed by many science teachers as being outside the scientific realm.

A teacher wanting to incorporate relativism into the science curriculum might consider including activities associated with newspaper coverage of science. The treatment of science by journalists might first appear to be at odds with the science that students are learning in a classroom. Journalists often emphasize the controversy in science yet students learning from a textbook might not connect the controversy with any of the information learned in the classroom. When a major study recently found that low-fat diets might not lower the risk of negative health consequences some readers might have questioned the entire scientific enterprise. A hypothetical reader could reason that if science cannot provide answers to dietary information then perhaps nutrition is not amenable to scientific study. A teacher has an obligation to provide alternative conclusions to an article such as this. Within the field of science the failure to find convincing evidence is not a problem with science as explained in the article: “But Dr. Freedman, the Berkeley statistician, said the overall lesson was clear: ‘We, in the scientific community, often give strong advice based on flimsy evidence,’ he said. ‘That's why we have to do experiments’” (Kolata, 2006). A teacher could use such an article as a pedagogical tool to explore the nature of science. Helping students to develop a more relativistic view of science can be one step on the stairway to higher intellectual development.

The three examples of recent scientific controversies that will be explored are stem cell research, intelligent design, and global warming. These subjects serve as means to argue for an increased role of current events within the science classroom and within classrooms across the curriculum. All three issues present enormous sociological challenges that have the potential to greatly influence the development of thought. A search for newspaper articles during the year 2005 in the United States using the ProQuest database suggests that each of the three issues received substantial coverage. The phrase ‘stem cells’ resulted in 1462 hits; intelligent design (in large part due to the Dover decision) produced 657 hits; and ‘global warming’ generated

1263 hits. A teacher looking to enliven the classroom with topical ideas could have chosen any of these three 'hot button' issues in 2005 to help promote intellectual development and explore the role of science in the larger world of knowledge. The focus in the three examples is not a summary of news coverage but instead tries to convey why the controversy exists. Each topic will be explored in relation to the connections of science with the larger world of knowledge.

Stem Cells

The controversy surrounding stem cells can ignite a strong emotional response. Intense feelings provide a means of engaging students with classroom information. The concept of stem cells can therefore be utilized in science courses for majors as well as courses for non-majors. The resolution of the debate that must be internalized by every individual will usually not involve a focus only on scientific questions. Stem cells touch on several areas of human knowledge and they raise interesting issues about the role that science can play in such debates.

One of the clearest statements about science in twenty-first century occurred in a speech by George W. Bush in August 2001 regarding his decision to limit the stem cell lines available to federally funded scientists:

> *"At its core, this issue forces us to confront fundamental questions about the beginnings of life and the ends of science. It lies at a difficult moral intersection juxtaposing the need to protect life in all its phases with the prospect of saving and improving life in all its stages. As the discoveries of modern science create tremendous hope, they also lay vast ethical minefields. As the genius of science extends the horizons of what we can do, we increasingly confront complex questions about what we should do"* (Bush, 2001b).

An intriguing dichotomy is presented in the speech between science and ethics. While Bush claims that science deals with what is possible to accomplish, ethics deals what is worth accomplishing. Students sometimes want professors, parents, and other authority figures to assume the role of ethical arbiter: amidst all the confusion associated with issues like stem cells, students might want the comfortable dualism where stem cell research is either right or wrong. Creating such a false dichotomy, though, devalues the educational experience. Stem cell research clearly has potential for improving the human condition but the cost of doing so might be unacceptably high for some individuals. Science cannot assume the mantle of ultimate arbiter regarding the use of stem cells. Many technical aspects of stem cell research can be

effectively addressed by scientific inquiry but the larger questions concerning the research enterprise seem to lie outside the scientific realm.

The scientific ideas that emerge by studying stem cells can be explored using newspaper coverage. The extension of stem cells touches on debates regarding growing organs for transplantation, treatment of diseases such as Parkinson's and diabetes, and the science behind cloning an entire organism. The methodology underlying the techniques poses scientific challenges that can be explored in a science classroom. Using newspapers to help frame the discussion may heighten the relevance of the topic for students. Using newspapers can also extend the discussion beyond the traditional scope of the scientific curriculum.

Newspaper coverage of the on-going stem cell debate often focuses on the tension between using science to improve human health at the risk of violating established ethical principles. A science educator, especially in biology, could use some portion of the curriculum to examine the debate with an eye to helping students discover why science and ethics seem to exist in discrete realms. The merging of science and ethics in a single human mind provides fertile educational opportunities to help students examine the seemingly disparate ways of framing the debate.

Intelligent Design

The theory of intelligent design poses interesting issues. Teachers are positioned to handle questions concerning the issues from students, especially students who wonder what all the fuss is about. Unlike the stem cell debate the stakes do not seem to be as high regarding intelligent design so the furor surrounding this issue might at first seem enigmatic to students. The core issue at stake, though, is the very definition of science.

Because the establishment of the boundaries of science—if any exist—is not generally part of traditional curriculum, newspaper coverage for this issue could provide a science teacher the opportunity to more clearly define science. Providing a more precise definition of science does not mean that a science teacher must 'teach the controversy' as has been suggested some politicians. The issue is not necessarily about presenting a fair and balanced approach for both sides of the argument but instead could serve as springboard for discussing why some people refuse to 'believe' in evolution. Using a controversial subject like intelligent design can also provide a science teacher fertile subject for discussing sometimes arid ideas such as theory development.

Intelligent design theory essentially posits that the irreducible complexity of living organisms refutes the idea of evolution because complex systems of molecules and organs could not have arisen from evolutionary trial and error. The theory of intelligent design was on trial in 2005 in United States District Court for the Middle District of Pennsylvania in the case of Tammy Kitzmiller, et. al. v. Dover Area School District, et. al. The resulting memorandum opinion from Judge John E. Jones III was 139 pages in length and ruled broadly that intelligent design is not science. The resolution under consideration was made by the Dover School Board on October 18, 2004: "Students will be made award of gaps/problems in Darwin's theory and of other theories of evolution including, but not limited to, intelligent design." The ruling by Judge Jones defines the central argument at the trial:

> *"On November 19, 2004, the Defendant Dover Area School District announced by press release that, commencing in January 2005, teachers would be required to read the following statement to students in the ninth grade biology class at Dover High School: 'The Pennsylvania Academic Standards require students to learn about Darwin's Theory of Evolution and eventually to take a standardized test of which evolution is a part. Because Darwin's Theory is a theory, it continues to be tested as new evidence is discovered. The Theory is not a Fact. Gaps in the Theory exist for which there is not evidence. A theory is defined as a well-tested explanation that unifies a broad range of observations. Intelligent Design is an explanation of the origin of life that differs from Darwin's view. The reference book, Of Pandas and People, is available for students who might be interested in gaining an understanding of what Intelligent Design actually involves. With respect to any theory, students are encouraged to keep an open mind. The school leaves the discussion of the Origins of Life to individual students and their families. As a Standards-driven district, class instruction focuses upon preparing students to achieve proficiency on Standards-based assessments"* (pp. 1-2).

The court document contains extensive discussion about almost every facet of the statement but a few points are germane to the argument that newspapers can help students develop intellectually. The explanation of the word 'theory' deserves attention from science teachers. Judge Jones made clear that using the term 'theory' was meant to undermine the scientific justification for evolution.

> *"The evidence in this case reveals that Defendants [the school board] do not mandate a similar pronouncement about any other aspect of the biology curriculum or the curriculum*

> *for any other course, despite the fact that state standards directly address numerous other topics covered in the biology curriculum and the students' other classes, and despite the fact that standardized tests cover such other topics as well"* (p. 39).

A teacher in any scientific discipline could ask students why court cases have not been undertaken for quantum theory, gravitational theory, resonance theory, molecular orbital theory, or Lewis acid/base theory? Many definitions of theory exist but one clear statement comes from Sir Karl Popper: "Theories are nets cast to catch what we call 'the world': to rationalize, to explain, and to master it. We endeavor to make the mesh ever finer and finer" (p. 59). Evolution is a scientific theory that attempts to explain the changes that occur in living organisms over time.

Although the court ruling suggests that intelligent design 'has utterly no place in a science curriculum (p. 89)' by introducing the idea teachers are not promoting anti-scientific thinking but instead are promoting critical thinking. Evolution has succeeded because the theory embodies scientific thinking. Theological thinking may override the scientific aspects of evolution for some individuals. A clear-eyed approach to the differences between scientific and theological thinking may help students develop a more relativistic approach to both types of thinking. Perhaps each individual will need to reconcile the two cultures differently. Gould resolved his conflict by keeping science and religion separate but not all individuals will choose to resolve the conflict in the same way. Teaching students to think critically about a controversy such as intelligent design helps students to reconcile multiple types of information being provided. Education provides the opportunity for expanding thinking not constricting it. A sensitive subject such as intelligent design can provide the nudge that some students need to progress in their intellectual development.

As with the stem cell debate, newspapers can inform the controversy involved with intelligent design and evolution. Archaeological findings continue to be unearthed. These data seemingly provide additional support for evolutionary theory yet questions arise about the scientific proof of evolutionary theory. Teachers can utilize current findings to propel students to a deeper understanding of evolutionary thought. As with stem cells, the newspaper coverage often discusses the aspects of the debate that seem to fall outside the purview of science. By acknowledging the limitations of scientific theories students may be encouraged to do the intellectual work necessary to try to resolve some of the conflicts in their own mind. Newspapers can provide the catalyst for initiating such thought.

Global Warming

The final example of newspaper coverage on scientific controversies may be the most pressing. A recent newspaper review of two books (Flannery, 2006; Linden, 2006) about climate change stakes a claim for the importance of addressing relativism in science:

> *"The science of global warming has been making dramatic headlines. NASA scientists recently reported that 2005 was the hottest year on record. Researchers studying the oldest core of Greenland ice yet extracted have also reported that there is more heat-trapping carbon dioxide in the atmosphere now than at any other point in the past 650,000 years"* (Zimmer, 2006).

In the same article the author claims that global warming is "…a fiendishly complex political puzzle, and there may not be much time to decide how to act." A tantalizing question for science students seems ideally suited for critical analysis: "Why would the author claim that climate change is a political puzzle rather than a scientific one?"

The article explains that two books stake a claim to using scientific evidence to press for political action. Yet the author questions whether the data that indicates a gradual warming of the earth will lead to a resolution on the issue of global warming. Surely science was necessary to provide information about the average annual temperatures but any actions resulting from that data will not involve much science. Some politicians may exploit the lack of scientific certainty as a rationale for inaction. President Bush made the following claim: "The policy challenge is to act in a serious and sensible way, given the limits of our knowledge. While scientific uncertainties remain, we can begin now to address the factors that contribute to climate change" (Bush, 2001a). As in the Dover case discussed above, where the argument for teaching intelligent design was because evolution had gaps 'for which there is not evidence', the policies made by governments need to be made in the face of 'scientific uncertainties.'

Students can examine the issue of global warming by searching for evidence collected by scientists. Rather than a teacher amassing a vast array of data and then overwhelming students with data, a superior pedagogical approach might be to have the students investigate some of the claims themselves. The issue is a complicated one that results in the media either treating global warming in dualistic ways or in multiplistic ways. Some writers focus solely on the data indicating that the earth is warming and claim that this information is correct (dualism). Others

look at the gaps in the data and the various interpretations of the data (not always by scientists) and claim that there is no 'right' answer concerning global warming (multiplicity).

Michael Crichton's *State of Fear* has generated a lot of press because of the author's bold assertions that the dire warnings about global warming "have little basis in fact or science (Crichton, 2004)." Crichton was called as a Senate witness presumably because of the footnotes and bibliographic information included in *State of Fear*. Students know of Crichton for *Jurassic Park* if not for his many other novels and the possibility for a discussion of Crichton's credentials given that he has an undergraduate degree in anthropology and an M.D. The opportunity to explore the reasons why people such as a Crichton have such strongly held views seems educationally rich.

A savvy teacher can employ the news coverage on global warming to help students develop a mature intellectual stance concerning global warming. Teachers are obligated to encourage students to think in new ways and avoid the knee-jerk reactions to sensitive issues such as global warming. Many students have heard the issue discussed around the dinner table and many people have strongly held beliefs concerning global warming. A classroom can be a safe haven for calmly exploring several rational approaches to the data. Certainly a bit of controversy can help engage the students in the discussion but ultimately the teacher must help students develop an ability to think beyond individual experience to try to take into account other pieces of information including scientific data and other people's opinions about that data.

Implications for Teaching

Within all three controversies just described lies a definitional problem about science. What constitutes science? When does enough 'scientific' evidence exist to make 'scientifically-based' decisions? The somewhat alarming answer is that science never provides concrete evidence. Science depends on constantly seeking new evidence such that no issue is ever settled in science.

The main claim in this article has been that science teachers can help students develop a more realistic view of science via newspapers. By wrestling with scientific ideas reported in the newspaper students can be nudged to higher intellectual levels as they move beyond dualism or multiplicity into relativism. Interestingly the Dover decision included an oblique reference to intellectual development when Judge Jones wrote that "…the disclaimer [regarding theories] relies upon the very same 'contrived dualism' that the court in *McLean* recognized to be a

creationist tactic that has 'no scientific factual basis or legitimate educational purpose'…" (p. 42).

Teachers can encourage critical thinking by presenting students with controversial issues that have no clearly defined resolutions. Many pedagogically rich activities can be centered on controversies such as the ones discussed in this article. Much collaborative learning can be instituted to encourage students to wrestle with controversial ideas while listening to what others have to say about a particular issue. Previous work on using newspapers in the classroom provides a wealth of suggestions for a teacher wishing to take advantage of curricular possibilities. Several pieces deal specifically with newspapers in the science classroom (Dimopoulos & Koulaidis, 2003; Dunbar *et al.*, 2003; Jarman & McLune, 2003, 2005; Shibley, 2003) while others deal with disciplines outside science but offer sound pedagogical advice that can be applied in the science classroom (Ianacone, 2001; McGhie, 1990; Rider, 1992).

The science wars may not end any time soon but students do not have to get mired in the minutia of the science wars to appreciate the relativism inherent in scientific thinking. Science provides theories that often improve the quality of life. The strength of scientific thinking, though, is sometimes undermined by claiming to have too much access to Truth. If students are provided with a more realistic view of scientific thinking the cognitive dissonance that occurs when science seems to fail (in areas like stem cell research, intelligent design, and global warming) can be muted. Science offers much to the world of knowledge but it can not offer unfettered access to the Truth. Helping students to understand the limitations of science should be a primary mission of science teachers. For teachers willing to undertake this challenging activity no better pedagogical source exists than the newspaper.

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