ARTICLE

"But if It's in the Newspaper, Doesn't That Mean It's True?" Developing Critical Reading & Analysis Skills by Evaluating Newspaper Science with CREATE

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Abstract

The media will likely be a major source of science information after college for non-science majors. It is thus essential that all students learn to critically read newspaper/Internet science. I have adapted the CREATE approach, an active-learning method originally designed for close reading of journal articles (Hoskins et al., 2007), for use with a newspaper article written for the general public. The analysis challenges students to read closely, learn to represent data and design experiments, and think creatively about scientific issues and their social implications. The approaches outlined here can be adapted to any scientific reading and analysis.

Key Words: *Newspaper science; CREATE approach; critical reading; experimental design; data analysis.*

For college students who do not major in science, reading biology textbooks will be a rare event once the required biology semester ends. Newspapers, the Internet, and television will be the main sources of science information (Gardner & Sullivan, 2004; Yalof & Dautrich, 2006; Gudrais, 2007). Unlike textbooks, newspaper or online science articles often present scientific conclusions in the absence of representations of actual data. Data mentioned but not shown are easily ignored, leading casual readers to passively accept a given article's conclusions. Reporters often reinterpret and summarize information from primary sources (journal articles) or simplify findings from long-term scientific studies. The writing may reflect the reporters' gaps in understanding, changes in the editing process, or even subtle biases. In order to understand science, especially as it develops during their postcollege years, it is essential that students learn to read science writing with a critical eye, ideally achieving scientific literacy (Elliott, 2006). With the goals of building students' critical analytical skills and understanding of the research process, I have designed a classroom exercise on "newspaper science" using the active-learning approach termed CREATE (Consider, Read, Elucidate hypotheses, Analyze and interpret the data, and Think of the next Experiment; Hoskins et al., 2007; Hoskins, 2008). In this 1.5- to 2-hour exercise, students' work in class models many of the intellectual activities undertaken by research scientists in their laboratories. The classroom focus is on collaborative critical analysis of scientific writing, interpretation of data, and consideration of the real-life mechanisms by which science research is designed, funded, and carried out.

Unlike textbooks, newspaper or online science articles often present scientific conclusions in the absence of representations of actual data.

The CREATE method is a novel approach to the use of primary literature in undergraduate classes, developed with two main goals: (1) demystify the process of reading journal articles and (2) humanize science and scientists. CREATE was originally designed as an elective class for junior and senior biology majors, focused on analysis of a linked set of journal articles. In brief, the CREATE class challenged students to read and analyze a "module" – four journal articles produced sequentially from a single laboratory – using a set of pedagogical tools that helped them "decode" the data, interpret the results, and follow the evolution of a project as it developed over several years. The students received one paper at a time and were given only partial papers – the titles, abstracts, and discussions were initially withheld. In closely reading the experiments performed and the methodology used (rather than relying on the abstract and discussion), the students learned to think like scientists as they critically evaluated data, considered their implications, and designed their own follow-up experiments. Pedagogical tools taught in class included concept mapping, figure annotation, and the use of cartooning to visually represent what went on in the lab (for details, see Hoskins et al., 2007). Students designed "the next experiment to do" after reading each paper. These were compared in class in a small-group activity that mimicked the workings of actual grant-review panels. At the conclusion of the module, the students interviewed the paper's authors by e-mail, gaining unique behind-the-scenes insight into the motivations and personalities of a variety of scientists at different stages in their careers (postdoc, graduate student, professor).

The original CREATE class was a semester in duration. Assessment data indicated that students made gains in critical-thinking ability and content integration and developed more positive attitudes about research and researchers. In postcourse interviews students noted that CREATE improved their ability to read and understand primary literature while also increasing their interest in science and scientists. Many suggested that learning the method earlier in their college careers would have been beneficial. In order to bring some of the benefits

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of CREATE analysis to other courses, and to less advanced students, I have adapted the methodology for shorter-term interventions in classes that cannot devote as much time to the process.

I present a CREATE-based classroom activity involving analysis of a brief (ca. 800 words) newspaper article on purported links between produce prices and obesity in children (Table 1). The article is written for the general reader, can be read quickly in either a high school or college class, and addresses a topic of interest to students – food and weight. Analysis of the article reveals a number of logical gaps and dangling questions, which can be used as starting points for discussion of study design, data interpretation, the nature of science (Schwartz et al., 2004), and issues of science and society (Strauss, 2005; Elliott, 2006; Table 2). Lessons of this sort can (1) provide students with a structured approach that can be used for any scientific reading; (2) jolt students out of passivity with exercises that require them to use both their critical faculties and their creativity, thus to "take charge of their own learning" in alignment with best practices in science education (Chickering & Gamson, 1987; Brooks & Brooks, 1993; Siebert & McIntosh, 2001; National Research Council, 1996, 2000, 2003); and (3) highlight both "how science works" and issues of science and society.

The class is based on a *Wall Street Journal* article, "Study links produce prices to obesity," by Rhonda L. Rundle (2005). The piece focuses on a study by the Rand Corporation that was published in *Public Health*. According to the article, produce prices in a number of US cities were found to correlate with obesity levels of children in the same cities. The article is easy to read and illuminates a variety of scientific issues. I have used the outlined lesson plan with first-year biology majors (4-hour laboratory session, 20 students, part of a hands-on lab that introduced the chemistry of various biomolecules), with nonmajors taking a required biology course (2-hour lecture class, 30 students, a discussion period focused on human health and nutrition), and in a summer intensive program for high school students, focused on how scientists do research.

CREATE analysis of newspaper science is built on five sequential steps, each of which requires active participation and creative thought.

Table 1. Steps in the CREATE approach and activities undertaken by students in class.

CREATE Step	Student Activity
Consider	Construct concept maps, note topics for review, define variables and begin to sort out their relationships.
Read	Define unfamiliar words, draw cartoons or diagrams to depict studies done, and/or create charts or graphs to represent data described but not illustrated.
Elucidate hypotheses	Define the hypotheses being tested or questions being addressed in the study.
Analyze & interpret the data	Examine the cartoons, diagrams, hypotheses, questions, charts, and/or graphs and determine what the data mean.
Think of the next **E**xperiment	What experiment or study should be done next? Outline your follow-up study on a transparency for in-class discussion.

Table 2. Interrelated scientific, nature-of-science, and science-and-society topics stemming from CREATE analysis of the "obesity" article. Depending on the level of the class and the specific course goals, the instructor may cover any or all of these topics.

Correlation vs. Causation	A "link" between two issues does not necessarily signify a causal connection. Consider, in this case, "A new study that offers insights into childhood obesity found a strong link between fruits and vegetable prices and weight gains in young children" (this is the first sentence of the article).
Variables & Controls	Defining variables leads to the realization that there may be "missing variables" – including, in this case, (1) whether prices in fact affected the amount of produce bought by parents and (2) how much produce any child actually consumed. The need for controls, or baseline groups for comparison, can be clarified.
Soundness of Data	Are all data equally useful? How big should "N" be? How should participants in a study be selected? Students develop scientific detection skills and learn the universal language of data analysis.
Scientific Skepticism	Many students assume that if something is in print it is "true" and thus unassailable. Showing that published science is still open to analysis, criticism, and debate invites students to hone their analytical skills. As students "think like scientists," they learn that scientific findings are open to evaluation from diverse viewpoints and should not be accepted passively.
Nature of Science	Students see that the way in which data are presented can influence their interpretation. Through designing their own new studies, students start to see scientific exploration as a creative process with no single "right answer."
Experimental Design	Many students have little experience in trying to design an experiment. Basing the students' experimental designs on their critical analysis of published work helps them define parameters to control and to test. Students are often surprised that everyone designs a different experiment. This activity reveals science as a field open to diverse viewpoints and approaches.
Science & Society	Students learn how science is funded. Links between public and private agencies raise interesting issues for discussion. Related topics (in this case the Food Pyramid; see text for discussion) illustrate how "scientific" advice to the public can be affected by data that are subject to reevaluation and change.

Working through the CREATE steps, which align well with current recommendations of science-reform documents (Brooks & Brooks, 1993; American Association for Higher Education, 2000; National Research Council, 2000, 2003; Siebert & McIntosh, 2001) provides students a framework for critical analysis of the article. Several activities are done in small groups of three or four students. They can remain in a single small group throughout the exercise or remix, at the discretion of the instructor. The lesson takes approximately 1.5 hours but can be expanded or shortened depending on the time available and the level of sophistication of the class. If the instructor prefers, some portions (e.g., "design a better experiment") could be assigned as homework, rather than done in small-group brainstorming sessions in class.

○ Consider

Concept mapping (Novak 1990, 1998; Allen & Tanner 2003) can be taught in an earlier class or introduced here. I set the stage for the topic area by leading a group concept-mapping activity. The class collaboratively makes a concept map on the topic of obesity by proposing related concepts and directing me as I organize them on the blackboard using directional connecting lines and labeled links (15–20 minutes, depending on the students' familiarity with concept mapping).

The initial "obesity" concept map created by the instructor with class input is used to rapidly identify, organize, and review background material. Students suggest concepts to include on the basis of their preexisting understanding of the general topic. Proposed topics typically include fats, metabolism, carbohydrates, calories, exercise, body mass index, and the like. Making this group map on the board is a quick way to review basic concepts (e.g., calories = energy, structure of fats vs. carbohydrates, how cellular respiration relates to energy production) and set the stage for understanding the article.

Working in small groups, the students next skim the brief article and identify general themes. The groups then list additional concepts to be added to the consensus map on the basis of the central issues raised. Students typically add topics such as different regions of the country, produce prices, fast food restaurants, and family income to the existing concept map, deciding on their own links and labels. Extracting these concepts and establishing real or potential relationships between them in the concept map is a first step in defining variables whose relationships could potentially be tested experimentally. A brief group discussion can review fundamental questions (e.g., Is produce less fattening than junk food? How does food consumption relate to weight? What is the role of exercise and metabolism?), setting the stage for further analysis.

○ Read

The students (1) read the complete article closely, looking up (on the Web or in classroom dictionaries) the meanings of any words they don't recognize; (2) work in groups of three or four to draw flow charts that outline how the study discussed was apparently done; and (3) construct "what the data must have looked like" (20–30 minutes).

The data mentioned in the article are not illustrated. I ask the students: If the reporter had visually represented the data described, using a chart or graph, what might that chart or graph have looked like? The students work together to decide how to plot hypothetical data on a transparency. By working backward from the reporter's verbal description and the conclusions of the study to the putative data, the students employ visualization and challenge themselves to imagine how the study was done, making their own decisions about what data to represent and how to do so. Each transparency is viewed by the whole class as I determine the range of examples present and choose representative cases to discuss further.

The main data referred to in the paper are the price of produce in various cities (two of which, Vesalia, California, and Mobile, Alabama, are named) and the relative weight gain of children in these cities between kindergarten and third grade. In devising graphs representing the findings reported, students often make graphing errors that can be caught and corrected. For example, some groups of students use a continuous line to connect their plotted points. When asked to "define the city represented by a point on the line halfway between Vesalia and Mobile," they quickly recognize the problem and realize that the nature of the data one has collected determines the sort of representation that is appropriate. This discovery opens the door for a comparison of continuous processes (e.g., velocity graphed as distance vs. time) and data of the sort presented verbally in the article (e.g., relative cost of produce – higher or lower than national average – or amount of weight gain – above or below average) in different geographic locations. Such a discussion may be brief or detailed, depending on the class's background and the goals of the instructor.

For many students, particularly nonmajors, this exercise may be the first time they have had to generate their own representation of data, without being told in advance what to plot and how to plot it. When asked why they drew their (inappropriate) graphs as they did, students typically respond: "Because when you draw points on a graph, you are supposed to connect them." Correcting this misconception helps students develop the ability to represent data appropriately, and demonstrates that the way in which one interprets an experiment's findings can be affected by the way in which the data are represented (Clement, 1989; Schnotz et al., 1993; Berg & Phillips, 1994; Kasprisin & Pettinari, 1995; Mathewson, 1999; Foertsch, 2000).

○ Elucidate the Hypotheses

The students return to the small groups and discuss what hypotheses were being tested, or questions being answered, by the data gathered (10–15 minutes).

In a typical journal article, the introduction, methods, results, and discussion sections are presented separately and sequentially. In newspaper science, they are intermingled, and the article may also reflect opinions or preconceptions of the reporter writing the story. This step challenges students to step back from the specifics of the article and look at what basic question was in fact being addressed in the experiments, surveys, or studies performed. This helps students define central concepts and not lose track of "big picture" questions.

The hypotheses generated by the student groups are added to the data cartoons and serve as the basis for analysis of the article's conclusions. It is often surprising to students that not all groups come up with the same hypothesis or experimental question, even though all students read the same brief article.

○ Analyze & Interpret the Data

Having concept-mapped key themes, examined how the study was done, and considered the data obtained, the students are prepared to analyze and interpret the article's claims in a whole-class discussion (time spent here depends on which concepts are addressed and to what depth). Some issues outlined below have been raised by my students during the discussion. Alternatively, an instructor can ask leading questions that challenge students to consider particular issues (up to 30 minutes, depending on the goals of the instructor).

The data described in the obesity article raise a number of questions. For example, after reading closely, students note that 6918 children in 59 metropolitan areas were studied. Most students do not, until prompted, perform the simple calculation that shows that, if equal numbers of children were studied in every region, this breaks down to about 117 per city. Once they do the math, students immediately wonder whether enough children were studied. This leads to discussion of (1) how scientists choose "N" for a given study and (2) sampling – another important general issue in experimental design. At my college in Manhattan, students consider: If you were screening 117 children in New York City, how would you select them? All from Greenwich Village? From Harlem? Nine children from each of 13 different neighborhoods? Students typically point out that children's eating patterns could be quite different from neighborhood to neighborhood. This realization leads in turn to the question of whether children in Vesalia, California, are less diverse than children in New York or other cities included in the study. Students point out that if an investigator were sampling a very small town, 117 might be "a lot" of the children, but in New York City, 117 is a very small fraction. The instructor challenges the class to decide how, in principle, such problems could be addressed.

Other questions my students have raised include the following. Were the same proportions of boys and girls represented in the samples from different cities? Should weight gain in girls and boys be compared separately? How does ethnic background, or home cooking versus restaurant visits, influence food consumption? What about exercise? Do city children get as much exercise, on average, as students in suburbs or rural settings? Is the physical education requirement in schools the same in every state? Do some schools offer fast food in their cafeterias? What did the study's author mean by "We tortured the data hard, looking for such an effect [between obesity and location of fast food restaurants], but nothing shows up"? Students have also suggested that it is not fair to assume that if produce prices are high, parents will buy less produce. Some point out that parents, aware that vegetables and fruits are important components of a healthy diet, may continue to buy produce despite the price, making cuts elsewhere in their household budgets. Questions also arise about the fact that the Rand Corporation, which did the study, was funded by the US Department of Agriculture (USDA). Students' concern about potential conflicts of interest allows broadening of the lesson to include a discussion of sources of financial support for research and of how funding decisions are made.

Although the article quotes a lead investigator in the study as saying "The results don't mean that high prices for healthy foods cause obesity," the same investigator states earlier in the article that "These findings [that there are more obese children in areas of the country where produce is expensive] may help explain the growing obesity epidemic among children over the past 20 years." To the average reader, the implications are that (a) produce prices rise, (b) parents buy less produce, (c) parents feed children less produce, (d) children eat something else that is presumably fattening, and (e) children gain excess weight.

The article, however, only describes findings related to "a" and "e." While one could infer a scenario in which "a" leads to "b," which leads to "c," and so on, no data in support of this scenario are presented. Yet the first sentence of the article states that the study found "a *strong* link between fruit and vegetable prices and weight gains in young children" (emphasis mine). Thus, the article provides an excellent opportunity for examination of the fundamental issue of correlation and causation. As students discuss such ideas, they (1) experience challenges faced by scientists in designing and interpreting comparable studies, (2) realize that they often confuse correlation with proof, and (3) recognize that taking newspaper science at face value may be unwise.

○ Think of the Next Experiment

Next the students are challenged to choose one of the hypotheses developed in class and design an experiment or study by which to test it (20–30 minutes). The students return to small groups (these can be the same as before or a new mix, depending on the instructor's wishes) to design a new study or experiment that could provide real insight into the causes of childhood obesity. Small-group brainstorming about which hypothesis to test, what controls to include, and how to handle sampling is guided by the instructor, who moves from group to group, checking in to make sure that all members of the group are voicing an opinion.

Groups designing improved correlation studies typically work their way through consideration of whether it would be more accurate to track equal, larger numbers of children per town or instead to sample the same proportion (e.g., 20%) of children in every town. Weighing these possibilities helps students practice math skills – a daunting task for some cohorts, especially nonmajors. Depending on the sophistication of the class, statistical considerations could be introduced. That is, do you have to study 100,000 children to obtain a "reasonable" sample? Or could 1000 be enough? Why is a sample of 10 almost certainly "too small"? Is "average" amount of weight gain the best measure? How can statistical analysis help you decide whether weight differences between particular cohorts of subjects are meaningful?

Other groups of students discuss quite different approaches to the issue. Would a survey of eating habits in a large number of children provide essential data? What about a case study of a few families? Or a controlled laboratory experiment that tests, perhaps in mice or rats, whether eating junk food rather than vegetables leads to obesity?

Experimental designs range widely. Some groups design grocery-store exit surveys to examine whether parents in fact purchase less produce when prices go up. Others want to know whether the more overweight children in fact consumed less produce. Some have proposed raising four groups of genetically identical lab mice on different diets and examining how diet composition (especially junk food vs. vegetables) relates to weight gain. Each group writes its hypothesis and diagrams the proposed study on a transparency. In light of the previous discussion, students are aware of the need to have a clearly defined question, an adequate "N," a careful sampling plan, and a way to analyze the data in an unbiased manner.

Comparing the group-consensus experiments using the overhead projector allows the whole class to offer constructive criticism of each proposal and facilitates broader discussion of related issues. For example, the mouse experiment can be expanded into a consideration of the "model systems" approach and discussion of how investigators learn information relevant to humans by studying other animals. This discussion, in turn, can lead to a review of evolution or the Human Genome Project, underscoring why findings in mice are likely to be relevant to humans. The broad topic of research in animals, often an area of great concern to nonmajors, could also be discussed. If time permits, the small groups can reconvene as student "grant panels" (for details, see Hoskins et al., 2007) and choose one proposed experiment for "funding." Alternatively, the class as a whole can debate which is the most worthy experiment or study. Grant-panel deliberations highlight the human side of science for students, as they realize that many of the proposed experiments are solid and worthwhile; there is no single "obvious" choice, and to a degree the experiment deemed "best" may reflect the evaluator's personal preference.

This open-ended lesson can be modified depending on the time available (Table 3). The design of experiments in additional model systems, for example, could be a team or individual homework assignment. The newspaper article could serve as a bridge to the students' library research, leading to a deeper examination of, for example, how a "healthy diet" is defined, the role of produce in such a diet, and the mechanism(s) by which excess fat leads to disease. An advanced class could read the original obesity study in *Public Health* (the study described in the newspaper article) and see whether any of the criticisms raised in class are addressed in the primary source. That is, are students' concerns with the newspaper version of the study inherent to the study design, or does the newspaper's version of events inaccurately summarize the actual study? This issue can serve as the springboard for a general consideration of newspaper or Internet science – if it's published, does that mean it's "true"?

Additional concept maps created in small groups can be used to link new ideas to those proposed at the start of class and to visually represent spinoff projects that the students developed in brainstorming sessions. Establishing such connections between ideas supports learning (Bransford et al., 1999). I introduce one related issue, the composition of the USDA Food Pyramid, which changed significantly between 1992 (USDA 1992) and 2004 (http://www.mypyramid.gov).

Discussion of the range of issues noted above helps the students consider that science constantly changes as new findings are integrated with previous knowledge and that new research provides insights that may lead to new interpretations of long-standing data. For example, in the 2004

Table 3. CREATE steps adapted for short articles read and analyzed in class.

CREATE Step	Student Activity
Consider	• Before the article is handed out, the instructor develops a group concept map on the broad topic addressed in the article. Instructor uses the map to review relevant biology (15–20 minutes).
Read	• Students skim the article and extract additional related concepts to add to the previously drawn map. • Students look up and define unfamiliar words. • Working in small groups, students draw flow charts indicating how the study described in the article was done. • Groups create representations of the data described in the article. Not all groups will do this the same way. Groups put their consensus ideas on transparencies (20–30 minutes).
Elucidate hypotheses	• Using the representations they created, groups work to reach consensus on the hypothesis being tested or question being asked by the authors of the study or experiment described in the article (10–15 minutes).
Analyze & interpret the data	• Look closely at the data as they relate to the hypotheses or questions proposed. • Examine the parameters of the study – what "should" be closely controlled? • Critically discuss issues including sampling, decisions on N, how best to represent relationships graphically, and how scientific studies are designed and funded, with specific reference to topics addressed in the article. • Broaden the discussion to science and society and/or to challenges common to all experimental designs (30 minutes).
Think of the next **E**xperiment	• Students return to small groups (same as before or a new mix) to design a follow-up experiment. Proposed experiments are diagrammed on transparencies, for discussion and vetting by whole class (25–35 minutes). • Grant-panel exercise (for details, see Hoskins et al., 2007) can be performed. • All students can be assigned to design additional experiments as homework for discussion or grant panels in an upcoming class.

Food Pyramid, the role of complex carbohydrates was deemphasized and exercise was added as a complement to a balanced diet. Class discussion focuses on why the Food Pyramid changed – because of scientific findings, political considerations (e.g., the dairy lobby), or both? The students' library research into the reasons for a new pyramid highlight the interactions of scientific findings and social practice.

Overall, CREATE's active approach to learning, in this case examining a short article's scientific conclusions in light of the experiments or studies that may or may not strongly support them, highlights potential distortions that can occur when findings are distilled from original sources and repackaged as "newspaper (or Internet) science." Many students have the sense that if something is in print it should be accepted without question. Discovering gaps in the "obesity" article's logic, and designing their own follow-up studies, increases the students' awareness that controversy, multiple interpretations, creativity, and skepticism are all part of science (Mead & Scharmann, 1994; Germann & Aram, 1996; Steitz, 2003; Seethaler, 2005).

In sum, using CREATE to analyze newspaper science is an inexpensive way to bring topical issues into the classroom and develop habits of critical analysis that can be applied to any reading. The large- and small-group classroom activities guide students in modeling the activities of working scientists as they closely read and intelligently criticize published work, engage in data analysis, and design their own experiments. Because faculty members are not spending the bulk of class time lecturing, they are free to bring their personal sidebar stories and experiences (for example, of participating in bona fide grant-review panels) to the classroom, which enhances the students' understanding (Hoskins & Stevens, 2009). The lesson outlined here provides substantial insight into the nature of science, a topic underemphasized in textbooks. Thus, by using CREATE to analyze a deceptively "simple" newspaper science article, students can learn to think like scientists.

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