# Assessing Critical-Thinking Skills Using Articles From the Popular Press

**By David R. Terry**

The *National Science Education Standards* (National Research Council, 1996), emphasizes that one of the primary goals of science education is to strengthen problem-solving and critical-thinking skills. In addition, *Science for All Americans* (American Association for the Advancement of Science, 1989) contends the following:

> Education should prepare people to read or listen . . . critically, deciding what evidence to pay attention to and what to dismiss, and distinguishing careful arguments from shoddy ones. Furthermore, people should be able to apply those same critical skills to their own observations, arguments, and conclusions, thereby becoming less bound by their own prejudices and rationalizations. (p. 139)

Meaningful science education requires an understanding of essential concepts, but it is just as important for scientifically literate persons to use critical thinking as they apply scientific understanding to their lives. Students should learn to use scientific information appropriately to make wise choices and to effectively solve problems that they encounter in life. They must be able to make well-informed judgments about the reliability and accuracy of scientific information that is presented to them. People who are scientifically literate do not simply provide information about scientific concepts in a quiz-show context; instead, they must use science skillfully while working through the often complex thinking tasks encountered in both personal and professional life (Swartz, 1997).

## Critical thinking and the evaluation of evidence

Bloom's *Taxonomy of Educational Objectives* (1956) has driven pedagogy for over 40 years and is considered one of the most influential educational monographs of the past half century. The highest level of thinking in Bloom's taxonomy is evaluation, and a major component of critical thinking involves examining internal evidence for logical consistency. Evaluation of evidence is a recurrent theme throughout various definitions of critical thinking, and it is featured prominently in the consensus statement developed in 1990 by the preeminent experts in the field (Facione, 1990). Other researchers have characterized critical thinking as evaluating the validity and reliability of information (Pithers & Soden, 2000), evaluating and making judgments about the implications of reading passages (Cheung, Rudowicz, Kwan, & Yue, 2002), and critically evaluating content found on the World Wide Web (Buffington, 2007).

Every valid definition of critical thinking requires that students engage in a deeper processing of information than is often seen in traditional science education (Morgan, 1995). Most experts in the field do not regard critical thinking as a body of knowledge to be delivered as a separate subject in school but, like reading and writing, as having applications in all areas of learning. It requires students to be actively involved in their learning as they attempt to understand and apply the information that they are exposed to. Recent research in cognitive science has emphasized the fact that many task-related concepts and skills apply across fields (Smith, 2002) while also acknowledging the influence that academic conceptions in distinct disciplines have on the current understanding of critical thinking (Jones, 2007).

## How can critical thinking be taught?

Instructional techniques that include high-level questioning, authentic investigations, and small-group learning might be the most valuable for encouraging critical-thinking skills among students. Those that encourage passivity in a learner are probably not going to support, and may even impede, critical thinking (Browne & Freeman, 2000). Richard Paul (1992), an expert in the field of critical thinking, recommended that activities and assignments should be designed so

that students must think their way through them. In the science classroom, instruction should require students to hypothesize, speculate, generalize, create, and evaluate while providing opportunities for identifying and solving problems, especially problems that are real and of interest and concern to students. For students to improve their critical-thinking skills they must engage in critical thinking itself (van Gelder, 2005).

It has been suggested that active learning strategies such as the case study teaching method might encourage the development of independent critical thinkers more effectively than most other methods of instruction (Herreid, 2004). A survey of over 100 faculty members in 23 states and Canada found that 89% believed that students would demonstrate stronger critical-thinking skills as a result of instruction with case studies (Yadav et al., 2007). Anecdotal evidence regarding higher-order thinking skills and the case study method of instruction is abundant, but the means for obtaining objective measurements are not readily or easily available to most college faculty. The same survey that found a majority of faculty convinced that the case study method would increase students' critical-thinking skills also determined that 68% of those faculty felt that assessing student learning with cases was a major obstacle. Fortunately, new and innovative methods for assessing critical thinking in the science classroom are becoming available (Bissell & Lemons, 2006). In this article I present another approach in which short news items from the popular press are used to assess success in improving critical thinking before and after case studies are taught. Evaluation of the effectiveness of the method is available in Terry (2007).

## A technique for assessing critical-thinking skills

I became interested in evaluating critical thinking when I taught a course with 40 students called Critical Thinking in Science at a small two-year college in Buffalo, New York. The course focused on the scientific process in the context of current and historical societal issues, and the case study method offered an excellent approach to this content. I was searching for an authentic way to assess the skills that the students were developing by working on the cases and felt that most instruments for examining critical thinking were not content-specific enough. After reading an article by Tyser and Cerbin (1991) that recommended a procedure for teaching critical thinking using science articles in the popular press, I was inspired to develop an instrument for evaluating critical-thinking skills in a similar manner.

The six case studies that were used in this course were selected from the National Center for Case Study Teaching in Science website (http://sciencecases.lib.buffalo.edu/cs/). Each case was chosen because it was controversial and made numerous claims with varying degrees of support. Consequently, they challenged the analytical abilities of the students. Moreover, I was able to find material in the popular press that was directly relevant to each topic. The cases and the reading material chosen were as follows:

- "The Raelians: Visionary Science or Quackery? A Case Study Exploring the Scientific Method and Human Cloning" by Scott D. Zimmerman (Reading material: "Goodbye, Dolly?", *Discover Magazine*, August 1999)
- "Torn at the Genes: One Family's Debate Over Genetically Altered Plants" by Jennifer Nelson (Reading material: "Autism Gene Found on Chromosome 17" by K. Svitil, *Discover Magazine*, August 2005)
- "Selecting the Perfect Baby: The Ethics of 'Embryo Design'" by Julia Omarzu (Reading material: "Genetic Screening—Sorting Bad From Good" by J. Miles, *The Advertiser*, 14 June 2005)
- "A Can of Bull?: Do Energy Drinks Really Provide a Source of Energy?" by Merle Heidemann and Gerald Urquhart (Reading material: "Food for Thought" by J. Selim, *Discover Magazine*, August 2003)
- "Love Potion #10" by Susan Holt (Reading material: "Are Purifiers/Distillers Slowly Killing You Because of Environmental Changes?", *Popular Science*, December 2005)
- "Mother's Milk Cures Cancer?: Researchers Deliberate Over Whether to Publish" by Linda Tichenor (Reading material: "Launching a War on Sleep" by R. M. Gorman, *Discover Magazine*, April 2003)

Each case was covered in three class periods of 80 minutes with three to five students working together in groups. After a brief introduction to the case on the first day, students used library and internet sources to research questions that were attached to the case. The

second day students finished their investigations and finalized their answers, and a whole class discussion closed out the topic on the third day. This research was part of a larger comparative study in which two sections of the same class used case studies. Both sections began the semester examining the same case study ("Extrasensory Perception—Pseudoscience?" by Sarah G. Stonefoot and Clyde Freeman Herreid) in order to familiarize the students with cases as well as to stimulate discussions about scientific inquiry and the nature of science. From this point forward, both sections covered the same topics, one using a case and the other engaging in "traditional" instruction. All of the genetics topics were examined via case studies in one of the sections—"The Raelians," "Torn at the Genes," and "Selecting the Perfect Baby"—whereas the other section learned about genetics through lectures, videos, and instructor-driven discussions. "A Can of Bull," "Love Potion #10," and "Mother's Milk" were used by the second section, whereas the first section covered these topics using mainly "passive" learning strategies.

Several days prior to each case, I gave the students a brief article dealing with the same general topic and asked them to identify a claim made in the article as well as to evaluate the validity of the claim. After the case was taught, the same article was again used and the same questions were addressed. This provided both a pre-and posttest of the students' abilities.

## Analyzing a case

To make the process clear let us take as an example "The Raelians." Here students were introduced to the topics of human cloning and pseudoscience through the story of Claude Vorilhon, a French journalist who made unusual claims regarding the influence of extraterrestrials on human history and purpose. The case describes the establishment of a company, Clonaid, whose goal was to produce the first human clone. During the case, the students read about the company's claims of success and considered the evidence as well as the ethical issues involved. Following are some of the questions that the case asks:

1. How could you identify an extraterrestrial? What evidence would you need to be convinced that a being had extraterrestrial origins?
2. Claims
   a. What steps would be involved in scientifically analyzing the claims of extraterrestrial origins for human beings? What experiments could you design to test this claim?
   b. How could you scientifically analyze the Raelian claims linking DNA to eternal life? What experiments could you design to test their claims?
3. Scientific issues
   a. What would "proof" of successful cloning be?
   b. Are the technical claims for Clonaid's cloning process consistent with the known technology (e.g., use of skin cells, use of cells from deceased people)? Are the five miscarriages to be expected?
   c. Other organisms such as plants, mice, and sheep have been cloned. Why has it taken longer to clone humans, or any other primates?
   d. Why does cloning require so many attempts? Why are birth defects and abnormalities common in clones?
4. Ethics
   a. Are there any reasons to promote or allow human cloning?
   b. Why would a successful clone be "deeply troubling" to anyone? Why is human cloning controversial?
   c. As a for-profit company, is it ethical for Clonaid to charge people to produce clones?
   d. Why is there a race to develop the first human clone? Will the first group/individual who produces a human clone benefit in any way?
5. Your conclusions
   a. Do you believe that Clonaid is a reputable company with the expertise to successfully clone a human being?
   b. Is it likely that Clonaid is/will be the first to produce a human clone?
   c. Should all human cloning be banned?

## The pre- and posttest challenge

Several weeks prior to working with this case, as well as immediately afterwards, students were asked to read a brief article from *Discover* magazine ("Goodbye Dolly," 1999) and answer a series of questions (see Figure 1). First they had to identify a claim made in the article, and then they were asked to assess the validity of the claim based on evidence presented in the article.

Most students were very adept at identifying explicit claims both before (83%) and after (95%) learning with the case study, and only a few students had difficulties. The most common error involved the false attribution of claims. For example, a

student might say that an autopsy revealed that a withered thymus gland was the cause of death, whereas in the article a defective donor cell received the explicit blame. In my experience students are reasonably comfortable identifying scientific claims but lack sophistication in identifying the merit of those claims. Although the purpose of this article is not to assess the data supporting the use of case study teaching, it is interesting to note that students did become more adept at identifying evidence or its lack after completing case studies even though this skill was not specifically addressed during instruction.

## Grading rubric for assessing popular articles

Basically, the technique that I am proposing is to use an article from the popular press to assess the ability of students to identify claims and to evaluate what evidence exists (if any) to support that claim. This is a valuable tool that can be used in a variety of situations, especially if a grading rubric can be established such as the one in Figure 2, which deals with only two issues: (1) Can the student identify a claim when he or she sees one? and (2) Can the student assess the validity of the evidence? Points are awarded on a four-point scale.

The power of this technique lies in its ability to elucidate the kinds of claims and evidence that students rely on when they read science articles. A second major strength of the procedure is the fact that it measures general critical-thinking skills in a content-specific manner. Third, it is a relatively straightforward instrument that can be created easily by teachers to measure at least one aspect of student critical-

**FIGURE 1**

**Topic 1—Cloning**
Read this passage and answer the questions that follow:

*After the circus procession of cloned sheep, cows, mice, and goats in the past couple years, humans seemed likely to join the list soon. Now this sobering news: A cloned calf in France dropped dead seven weeks after its birth.*

*The calf appeared healthy until days before her death; then she developed severe anemia and collapsed. An autopsy revealed a withered thymus gland, where white blood cells mature, suggesting that her immune system never started working. Jean-Paul Renard of the National Institute for Agronomic Research in Jouy-en-Josas, who cloned her, thinks a defective donor cell might be at fault. He points out that the cloning process can work fine—other clones produced with his technique are thriving—but concedes that 30 to 50 percent of cloned calves die shortly before and immediately after birth. "If we want to apply this technique outside of research," he says, "such a high rate of abortion and mortality will not be acceptable."*

(From "Goodbye Dolly," *Discover*, August 1999)

Identify one specific claim that is made in this passage. (Write the statement in your own words in the space below.)

Evaluate the following statements, check the one that applies, and provide justification in the space given:

❑ **The claim made in the article is valid.**
Summarize the relevant evidence from the article and explain why it is convincing.

❑ **The claim made in the article is not valid.**
Summarize the relevant evidence from the article and explain how it contradicts the claim.

❑ **The article does not contain sufficient support for the validity of the claim.**
Provide a specific example of additional evidence you would need to evaluate the claim.

**FIGURE 2**

**Rubric for Assessing Claims and Evidence**

Claim Identification

- No claim is identified; something other than a claim is identified (0 points).
- Identified claim is not explicitly made in the article (1 point).
- Appropriate claim is identified (2 points).

Validity of Evidence

- No evidence is provided for justification; evidence is completely inappropriate (0 points).
- Evidence is somewhat inappropriate; evidence does not support all aspects of claim; evidence is not from article (1 point).
- Appropriate evidence from article is provided (2 points).

thinking ability.

Relevant articles are readily available for virtually every conceivable scientific topic, and most can be modified to fit a particular group of students. With a sufficiently detailed rubric, the students' responses can point out misconceptions, fallacious logic, or general difficulties with the concept of appropriate evidence. With repeated use, this technique can provide specific information about how student thinking changes throughout a course, offering an effective tool for formative assessment. ■

## References


American Association for the Advancement of Science. (1989). *Science for all Americans: A Project 2061 report on literacy goals in science, mathematics, and technology*. New York, NY: Oxford University Press.

Are purifiers/distillers slowly killing you because of environmental changes? [Advertisement]. (2005, December). *Popular Science, 267*(6), 141. http://www.johnellis.com

Bissell, A. N., & Lemons, P. P. (2006). A new method for assessing critical thinking in the classroom. *Bioscience, 56,* 66–72.

Bloom, B. S. (1956). *Taxonomy of educational objectives. Handbook 1: Cognitive domain.* New York, NY: Addison Wesley.

Browne, M. N., & Freeman, K. (2000). Distinguishing features of critical thinking classrooms. *Teaching in Higher Education, 5,* 301–309.

Buffington, M. L. (2007). Contemporary approaches to critical thinking and the world wide web. *Art Education, 60,* 18–23.

Cheung, C., Rudowicz, E., Kwan, A. S. F., Yue, X. D. (2002). Assessing university students' general and specific critical thinking. *College Student Journal, 36,* 504–525.

Facione, P. A. (1990). *Critical thinking: A statement of expert consensus for purposes of educational assessment and instruction. Research findings and recommendations.* Newark, DE: American Philosophical Association.

Goodbye Dolly. (1999, August). *Discover, 20*(8), 10.

Gorman, R. M. (2003, April). Launching a war on sleep. *Discover, 24*(4), 12.

Herreid, C. F. (2004). Can case studies be used to teach critical thinking? *Journal of College Science Teaching, 33*(6), 12–14.

Jones, A. (2007). Multiplicities or manna from heaven? Critical thinking and the disciplinary context. *Australian Journal of Education, 51,* 84–103.

Miles, J. (2005, June 14). Genetic screening—sorting bad from good. *The Advertiser (Adelaide),* p. 21.

Morgan, W. R. (1995). "Critical thinking"—what does that mean? Searching for a definition of a crucial intellectual process. *Journal of College Science Teaching, 24*(5), 336–340.

National Research Council. (1996). *National science education standards.* Washington, DC: National Academies Press.

Paul, R. W. (1992). *Critical thinking: What every person needs to survive in a rapidly changing world.* Santa Rosa, CA: Foundation for Critical Thinking.

Pithers, R. T., & Soden, R. (2000). Critical thinking in education: A review. *Educational Research, 42,* 237–249.

Selim, J. (2003, August). Food for thought. *Discover, 24*(8), 14.

Smith, G. (2002). Are there domain-specific thinking skills? *Journal of Philosophy of Education, 36,* 207–227.

Svitil, K. (2005, August). Autism gene found on chromosome 17. *Discover, 26*(8), 15.

Swartz, R. J. (1997). Teaching science literacy and critical thinking skills through problem-based literacy. In A. L. Costa & R. M. Liebmann (Eds.), *Supporting the spirit of learning: When process is content* (pp. 117–141). Thousand Oaks, CA: Corwin Press.

Tyser, R. W., & Cerbin, W.J. (1991). Critical thinking exercises for introductory biology courses. *BioScience, 41,* 41–46.

Terry, D. R. (2007). *Using the case study teaching method to promote college students' critical thinking skills.* Unpublished doctoral dissertation, University at Buffalo, The State University of New York.

van Gelder, T. (2005). Teaching critical thinking: Some lessons from cognitive science. *College Teaching, 53,* 41–46.

Yadav, A., Lundeberg, M., DeSchryver, M., Dirkin, K., Schiller, N. A., Maier, K., & Herreid, C. F. (2007). Teaching science with case studies: A national survey of faculty perceptions of the benefits and challenges of using cases. *Journal of College Science Teaching, 37*(1), 34–38.


***David R. Terry*** (terry@alfred.edu) *is an assistant professor in the Education Devision at Alfred University in Alfred, New York.*