

USING CASE STUDIES IN SCIENCE TEACHING

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USING PROBLEM SOLVING IN SCIENCE TEACHING

(Chiappetta & Koballa Jr., 2006, p. 153)

- Authentic investigations: Potentially engages the students in “authentic investigations, develops their inquiry skills, and leads to a firmer understanding of the content under study.”
- Inquiry: Problem solving “can give students a feeling for conducting scientific inquiry.”
- Meaningfulness: Problem solving “can also make science course learning more meaningful for teenagers.”
- Relevance to students’ lives: Problem solving can involve “situations that are relevant to students’ lives and raise their doubt or uncertainty.” In this case, it can engage students in “investigations where they raise questions, plan procedures, collect information, and form conclusions.”

CASE STUDIES (Herreid, 1994, web version)

- Involve a problem to be solved: Typically written as dilemmas that give a personal history of an individual, institution, or business faced with a problem to be solved.
- Supply relevant information: Background information, charts, graphs, and tables may be integrated into the story, or may be appended to the story.
- Instructor’s goal: To help the students work through the facts, to analyze the problem, and then to consider possible solutions and consequences of the actions that might be taken.
- Require new teaching techniques for most instructors: It requires the instructor to learn teaching techniques that are not common in the science classroom. Most faculty must be shown how to write and teach from case studies.
- Flexible uses: The case study method of presentation is very flexible as a teaching tool.
- Teaches science processes: Teaches much more how the process of science works, rather than merely the content of science.
- Inductive process: The case study process is inductive, rather than deductive. The focus is on students learning through a joint, cooperative effort, rather than on the instructor conveying his or her views to students.
- Pre-existing materials: There are pre-packaged case studies in science in many

different sources – newspapers, magazines, novels, cartoons, videos, and TV dramas. For example, the motion picture “Jurassic Park” can be used to consider questions of scientific ethics and responsibility.

HISTORY OF CASE STUDIES IN OTHER FIELDS

(Herreid, 1994, web version)

- Business schools and law schools have traditionally used case studies to teach students about their fields.
- Medicine, psychology, and teacher education also use case studies.

WHAT MAKES A GOOD CASE STUDY IN SCIENCE TEACHING?

(Herreid, 1994, web version)

- Active Minds-on Learning: It uses learning by thoughtful doing.
- Develops Various Student Skills: It helps the development of analytical and decision-making skills, the internalization of learning, learning how to grapple with messy real-life problems, the development of skills in oral communications, and often team work.
- Strong appeal for students: It has strong appeal for many students who are turned off by traditional science courses oriented around a lecture format with a concentration on facts and content rather than the development of higher-order thinking skills.

HOW DOES AN INSTRUCTOR WRITE A CASE STUDY FOR A SCIENCE COURSE? (Herreid, 1994, web version)

The instructor must initially decide what materials he or she will provide to the students. This might be one paragraph or one page, or it might be several articles. It might also be one or more graphs and tables from a scientific article. Or it could be several articles focused around a single topic. The instructor might also create a series of questions to guide the students’ reading.

Decision or Dilemma Cases:

- Present problems or decisions that need to be made by a central character in a drama. Example: President Clinton trying to decide what to do about the logging industry and the spotted owl controversy.
- Short introductory paragraph: Sets up the problem to be considered and, possibly, introducing the decision-maker at the moment of crisis.
- Background section: Fills in the historical information necessary to understand the situation.
- Narrative section: Presents the recent developments leading up to the crisis that the central character faces.
- Exhibits: tables, graphs, letters, documents that help lay the foundation for a possible solution to the problem.

Appraisal Cases:

- Used to teach students the skills of analysis. Examples: The Valdez oil spill, or the possible effects of vitamin C on the common cold.

- The material is focused around answering questions like “What is going on here?”
- Often lacks a central character in the drama.
- Generally stops short of demanding that the students make a decision.

Case Histories:

- Usually are finished stories, and are generally less exciting than decision or appraisal cases. Examples: the Copernican revolution or “cold fusion,”
- They can serve as illustrative models of science in action.
- Usually provide plenty of opportunities for “Monday-morning quarterbacking.”

IN WHAT FORMATS CAN A CASE STUDY BE TAUGHT IN A SCIENCE COURSE? (Herreid, 1994, web version)

Common Approach: In almost all the formats there is a common approach. The instructor must have his or her objectives clearly in mind, must structure the presentation to develop the analytical skills of the students, and must be sure that student participation is maximized.

Discussion

- Students are presented with decision or appraisal cases.
- The instructor identifies, with the students’ help, the various issues and problems, possible solutions, and consequences of action.
- The instructor asks probing questions and the students analyze the problem depicted in the story.

Debate

- Opposed views: Debate is well suited for a case where two diametrically opposed views are evident.
- Moot court procedure: The moot court procedure is often followed. Two teams of students each prepare briefs on both sides of the issue. Just before the actual debate, they draw lots or flip a coin to determine which side they must each argue.
- Starting Procedure: The debate starts with the pro side presenting for five minutes. Then a member of the con side speaks for five minutes.
- Rebuttals: There is a five-minute rebuttal by a second speaker on the pro side, followed by a five-minute rebuttal on the con side.
- Summaries: This is then followed by three-minute summaries by each side.
- Audience Participation: Questions may be permitted from the audience (rest of the class). The audience should also be asked to evaluate the content and presentation of the debate.
- Sizes of teams: Team sides may be 3, or more, members each.

Public Hearing

- Real-life Examples: Public hearings are often used in the United States -- by the Congress, public agencies, and regulatory bodies. They are an ideal format to allow a variety of people to speak and different views to be expressed.
- Hearing Board: A student panel, role-playing as a hearing board, listens to presentations by different student groups.

- **Rules of the Hearing:** The hearing board (e.g., the EPA, FDA) establishes the rules of the hearing at the outset (e.g., time to speak, order of presenters, rules of conduct, regulations and criteria governing their decision-making).
- **Presentations:** This is followed by individuals or groups role-playing particular positions. Members of the panel often ask follow-up questions of the presenters.
- **Panel's Decisions:** After all the presentations are completed, the panel makes its decision or recommendations.
- **Duration of the Hearing:** The public hearing process may work well over more than one class period. This allows the entire procedure to play out, and the student preparations to be extensive.

Trial

- **Fascination:** Have inherent fascination because of their tension and drama.
- **Components:** Two opposing sides each represented by an attorney, with witnesses and cross-examination.
- **Summation:** Following the last witness, the attorneys for each side sum up their positions (in 3-5 minutes).
- **Student Position Papers:** Students can be asked to develop two position papers, one for each side of the dispute.
- **Student Reaction Papers:** At the end of the trial, all students are asked to write and hand in two-minute reaction papers answering: "Which plan do you prefer to resolve the issue and why?"

Problem-Based Learning

- **Medical School Model:** This has been used in medical schools for years. During rounds, experienced physicians pose problems to interns, residents, and students. McMaster University in Canada developed the method for its entire curriculum.
- **Faculty-intensive (?):** Uses one tutor for every five students. They stay together for the entire term, working through a series of cases. The cases are linked by some common area of study or progressive shift in complexity.
- **First Meeting:** The instructor presents a short written account of the patient with some symptoms and background. The instructors and students together try to identify the points they think they understand, and to determine those terms, tests, procedures, symptoms, etc. for which they need more information. At the end of this meeting, students agree on how they will divide up the responsibilities to search for the needed information in the libraries.
- **Second Meeting:** Students discuss their findings and share opinions. Their search for the correct diagnosis narrows it down. By the end of the class meeting, the students have determined what new information they need to uncover, and they go their separate ways to find it.
- **Third Meeting:** Students share their thoughts, data, and understanding. They try to reach closure on the diagnosis and treatment. Generally, the students will not find out the "real" answer to the problem, because the students' knowledge and understanding comes from the search for answers.

Scientific Research Team

- The essence of most scientific research is the case method.
- Scientists are constantly confronted by problems, questions, or dilemmas.
- Scientists usually have a large background of information which they can use to “solve the problem.”
- Scientists usually use some version of the hypothetico-deductive method where they ask questions, make hypotheses, make predictions, test their predictions by observation and experiment as they collect data, and make evaluations and draw conclusions.
- Students usually have dim and faulty understanding of these steps, although they can usually recite some version of “The Scientific Method.”
- Cases involving the above steps are valuable for students. The more the students take charge of the process, the more they are likely to appreciate what scientists actually do.

WHAT ARE SOME PLUSES AND MINUSES OF THE CASE STUDY APPROACH?

Pluses:

- Ideal to develop higher-order reasoning skills.
- Shows students how their classroom learning impacts the world, and is dependent on political and social currents.
- Spices up the course.
- Instructor and students become comfortable with the method when it becomes the predominate method of instruction.

Minuses:

- Is not the best way to present a large amount of facts, figures, and principles.
- When used occasionally, neither instructors nor students become comfortable with the method.
- Less information can be treated than in lecture or lecture-discussion format.
- When social issues are involved in a science debate, it is tempting for poorly-prepared students to concentrate on the opinion issues.
- Instructors must develop teaching skills that many do not now possess.

REFERENCES

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