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AUTHOR	Waterman, Margaret A.
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ABSTRACT

Case-based approaches are effective for teaching and learning science, encouraging student-directed collaborative learning and active engagement. This paper looks at using cases in science teaching and learning at the secondary and undergraduate levels and the impact these approaches have on teachers, students, curricula, and classroom organization. The particular focus is the medical school case model, also called Problem-Based Learning (PBL). The primary goal of the case group is to learn the underlying human biology within a realistic context rather than to make a medical diagnosis. The experience of 30 biology teachers working on case approaches during a 10-day course illustrates how an effort to create a new case-based strategy served as a nexus for faculty development and curriculum change in biology education. The group devised a new process of case development that blended case writing with discussion of educational goals, modes of teaching, curricular integration, and classroom organization. Several products were created, including a syllabus for a family development course on case teaching in biology; a model for curriculum development integrating case structure and student learning, classroom organization, teaching approaches and assessment; and seven second draft cases. Suggestions for additional research in cases or tools for educational change are provided. (Contains 11 references.) (ND)

Curriculum and Teacher Development in Biology via Case Writing

Margaret A. Waterman, Ph.D.
Assistant Professor of Biology andSecondary Education
Southeast Missouri State University
Cape Girardeau, MO 63701

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CURRICULUM AND TEACHER DEVELOPMENT IN BIOLOGY VIA CASE WRITING

Margaret A. Waterman, Ph.D.
Southeast Missouri State University

Cases and case-based approaches are attractive for teaching and learning science. With appropriate classroom structures, resources and teaching strategies, they can encourage student-directed collaborative learning and active engagement as students work on realistic problems. Since learning occurs around a particular realistic problem, there is greater likelihood that the learned material will be better retained and more easily applied to similar situations (Brown et al., 1989, Schmidt, 1983). These realistic problems are also a vehicle for helping students connect science to everyday life, to their own lives and decisions. As complex, ill-defined problems, cases are multidisciplinary, providing opportunities to integrate science learning with learning in the humanities and social sciences as well as across the sciences and mathematics.

Cases seem to be powerful tools for affecting not only how people learn, but also how they teach. I am most interested in their use in science teaching and learning at the secondary and undergraduate levels, and in the impact these approaches have on teachers, students, curricula and classroom organization. The model for using cases in science comes from the case-based, problem-based learning models developed at medical schools, where this model has been a well-publicized success (e.g., Tosteson et al., 1994).

The Medical Case-Based Model: Problem-Based Learning

The medical school case model, also called Problem-Based Learning or PBL (Barrows and Tamblyn, 1980, Schmidt, 1983), was first used at McMaster in Canada (Neufeld, 1974) and Maastricht in the Netherlands in the 1970's. At Harvard Medical School (where I was a medical educator for several years), these case discussions are one element of interdisciplinary courses built as a "hybrid curriculum" (Armstrong, 1991) in which lectures and laboratories remain important, but linked in content to the cases. The Harvard version of PBL is more readily adaptable to science teaching elsewhere because it has conserved these familiar elements yet recast them in a more student-centered approach.

In PBL the story of the patient drives the learning of human biology. In this approach, students work in groups of 8-10 with a "tutor," meeting two or more times per week to discuss a case based on a real patient. The case, written by course faculty, is a multi-part narrative, disclosed to students one page at a time. Students read the page of the case out loud, then spend an hour or so discussing the elements presented thus far in the case. They generate hypotheses, list their outstanding questions, and develop a "learning agenda." This learning agenda is a set of student-generated issues they have decided they need to learn more about before the next small group case discussion. The learning objectives for the case are revealed to students only after they have worked on a case for two days or more.

The primary goal of these case groups is neither to make the correct diagnosis nor prescribe the proper treatment, although this helps motivate these soon-to-be-physicians . Rather it is to learn the underlying human biology within a realistic context, and to understand the larger psycho-social world of the patient. The cases are multidisciplinary, the students work collaboratively, the teacher is a guide and facilitator, and the learning is student-directed within the framework of the case.

Already, the medical school model has been adapted for creating undergraduate and high school case-based science curriculum (e.g., Waterman, 1996, Reede et al, 1995; Duch, 1995, Grove, personal communication 1994). For the last several years I have been working on case based learning with groups of college biology faculty and high school teachers. In this work I have observed that these instructors focus not just on cases, but quickly ask larger questions, for example about assessment," coverage," course structure and organization, and integration across disciplines. By trying out cases, the teachers began to imagine changes to the ways they currently teach. One powerful example of this occurred last June at the BioQUEST Curriculum Consortium's 1996 National Science Foundation Undergraduate Curriculum Development Summer Workshop (Jungck and Soderberg, 1996). The story of a group of biology faculty working on case approaches illustrates how an effort to create a new case-based strategy served as a nexus for faculty development and curriculum change in biology education.

Cases as Tools for Change in Science Teaching - An Illustration

I joined thirty biology faculty members from the U.S. and Canada for the ten-day course, which had as a major component a group project. I wanted to explore case methods with biology teachers. I approached a couple of people and soon seven of us began to work on cases. My roles were complicated because while I was primarily a participant, I also taught a few sessions on cases during the course. It was important to me that my group not look to me for answers, but that we truly explored cases together.

The group decided on a goal of creating a 4-5 page document about using cases in biology teaching as the final product. The group members felt strongly that we wanted to work on our own individual cases and do some reading related to case learning. In the case writing workshop I had used a protocol for reviewing cases that the group wanted to adopt. The protocol includes the following steps:

1. Read a first draft of the case out loud to a reviewer who has not yet heard anything about the case.
2. The reviewer reacts by telling the author what he or she thinks the case is about. The reviewer and author do not engage in conversation yet, the author simply writes down what the reviewer says. This is a way for the author to see how the case is perceived by another, and a check to see how well the case matches the author's learning objectives.
3. The author then tells the reviewer what she or he thought the case was about.
4. The reviewer and author work together to reconcile the differences by rewriting the case.

The readings turned out to be only moderately useful, and we quickly abandoned them to work on the cases. In implementing the case review process we moved to having the entire small group be the reviewers instead of having a single reviewer. We also found that after listening to the case, the group members had many questions stemming from teaching with that particular case. These, we agreed, we would hold until completing step three of the protocol and providing general suggestions for improving the case. The group then engaged in extensive questioning and discussion, lasting upwards of two hours for each person's case. Here is an example of the kinds of questions the group members would pose and discuss:

> L.'s case about a declining bayou was told from three perspectives: an organism, a land developer, and a conservation agent. According to protocol, L. read her case to the group. The group responded by telling her what they thought her case was about, i.e., what students should learn by exploring this case. She wrote their ideas down. Then, L. shared what she thought her case was about, and the group worked with her on ways to make her case clearer.
>
> Next, the group began to ask each other questions stemming from this case. What do you think about anthropomorphizing an organism's point of view? Will it feed into student "misconceptions" about organisms? How would you structure the teaching of a three part case when you really need to know more than one perspective in order to make sense of the story? Do you think students will have trouble figuring this out? Where in your curriculum would you use this case? Why? What goes with it? What comes next? How do you fit this into your course logistically? Could students write one of the points of view as a sort of assessment or a learning exercise? What resources can students access as they explore this case? What sorts of open-ended science investigations could students do related to the case? Will this case help students make any connections across courses? How will you know if this is a successful case?

These instructors used cases to ask questions about student learning, about curriculum, about classroom organization, about how the story would connect to investigative science, and about integrated learning with other disciplines. The group thus devised a new process of case development that blended case writing with discussion of educational goals, modes of teaching, curricular integration and classroom organization.

The group created several products including a syllabus for a faculty development course on case teaching in biology; a model for curriculum development that integrated considerations of case structure and student learning, classroom organization, teaching approaches and assessment; and seven second draft cases. The members of this group were extremely interested in continuing to work together on case-based science learning, and created plans for electronic networking over the coming school year.

Research Agenda on Cases as Tools for Educational Change

For me as a researcher and teacher educator in science education, many researchable questions arose from this BioQUEST experience. What role did the case-based methods play in the actions of these teachers? How were the participating faculty affected by this effort? What sorts of changes in biology education (curriculum, instruction and learning) do cases help promote? What makes a good case? How can cases foster open-ended student-directed investigations? What are the teacher's roles with this type of teaching? What happens to subject matter "coverage"? In what ways do students learn with cases? What happens to traditional biology curriculum if cases (whose problems demand multidisciplinary solutions) are widely used, and if students also engage in case writing?

How to approach these questions, focusing on change and moving beyond mere description is less clear. Methodologically, the case study approach seems sensible, since I am interested in individuals and need to use multiple sources of evidence, such as interviews, document examination, surveys, structured tasks, journals and the like. The real question is, what sorts of evidence will most convince others that engaging in case-based methods is a tool for helping individual teachers develop new concepts of teaching?

The discussion in the symposium will focus on research approaches to these issues.

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Organization/Address: Biology Department, MS6200 Southeast Missouri State University Cape Girardeau, MO 63701	Telephone: 573/651-2381	FAX: 573/651-2223
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