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ABSTRACT

Teaching methodologies, such as Problem Based Learning (PBL), have arisen in response to educational research that has found evidence that even though lecturing may be the most prevalent teaching tool it is arguably the least effective way to facilitate student learning. It is important then, for methods instructors to give preservice teachers tools and strategies for use in the classroom. PBL is a tool that teaches cooperative learning, grouping of students, and an inquiry-based methodology for science instruction. This paper discusses the aspects of providing PBL instruction in a methods course. (Contains 26 references.) (MVL)

Using Problem-Based Learning in a Science Methods Course

by
James T. McDonald

USING PROBLEM-BASED LEARNING IN A SCIENCE METHODS COURSE

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Knowledge is the product of human beings in the state of continual negotiation or conversation. Education is not a process of assimilating the 'truth' but a process of learning to 'take in hand what is going on' by joining the 'conversation of humankind.' Collaborative learning is an arena in which students can negotiate their way into the conversation."
Bruffee, 1993.

Background

Teaching methodologies, such as PBL, have arisen in response to educational research that has found evidence that even though lecturing may be the most prevalent teaching tool it is arguably the least effective way to facilitate student learning. Meyers and Jones (1983) reported that (a) "While teachers are lecturing, students are not attending to what is being said 40% of the time, (b) In the first 10 minutes of lecture, students retain 70% of the information; in the last ten minutes, 20%, (c) Students lose their initial interest, and attention levels continue to drop, as a lecture proceeds, and most alarming of all, and (d) four months after taking an introductory psychology course, students knew only 8% more than a control group who had never taken the course" (p.14).

Knowles (1989) tracked the origin of the "modern day" school system back to the seventh and twelfth centuries. During that time, schools were established in cathedrals and monasteries in Europe primarily for the preparation of young boys for the priesthood. As a result of the teachers in these schools having as their principal mission the indoctrination of young boys in the beliefs, faith, and rituals of the Catholic Church, they evolved a set of assumptions about learning and strategies for teaching that came to be subsumed under the label "pedagogy," literally meaning the "art and science of teaching children." When public schools started organizing several centuries later, this model was the one that was used over the Socratic method or Dewey's (1963) constructivism. As a result, elementary, secondary, and higher education became frozen in that model.

It is no wonder that Schrank (1997) believes that the educational model, used by most schools, does not work because it is based on the belief that people learn through listening. As a result, school is not really about learning; it is about short-term memorization of meaningless information that never comes up later in life. In short, the school model was never intended to help people acquire practical skills; it was intended to satisfy interested observers that the knowledge is being acquired -- albeit for a short period of time.

Theoretical background

The historical underpinnings of problem-based learning (PBL) date back to the work of John Dewey (1963) at the University of Chicago Lab School and his commentary on experimental education. The writings of G. Polya (1988), while not specifically aligned with problem-based learning emphasize the need for metacognitive reflection on learned heuristics as a problem-solving tool. In Polya's model, students might review their steps to solving the problem, with an emphasis on extracting generalizable labels such as "visualizing" or "part-to-whole thinking."

Recognizing that Dewey's work could be used in medical school, Harold Barrows, a physician and medical educator at McMaster University in Hamilton, Ontario, Canada, wanted to develop methods of instructing physicians that fostered their own capabilities for reflection of school in ordinary life. While most medical schools, at that time, focused on providing knowledge, Barrows (1985) thought that this was just the first of three interdependent elements:

> (1) an essential body of knowledge, (2) the ability to use...knowledge effectively in the evaluation and care of patient's health problems, and (3) the ability to extend or improve that knowledge and to provide appropriate care for future problems which they might face. (p. 3)

Writings on higher-order thinking also allude to problem-based learning. Grounded in the 1980s, when thinking skills began to be emphasized, this model of problem solving teaches students to think inductively and deductively (deBono, 1976; Feuerstein, Hoffman, Miller, & Rand, 1980; Lipman, Oscanyan, Sharp, 1980; Resnick, 1987). It teaches students to think in the concrete and the abstract, moving through the stages of problem solving from novice to expert. Teachers use this model to develop rigorous thinking experiences for their students. While existing literature on higher-order thinking does not specifically refer to these experiences as problem-based learning, they certainly provide the cognitive basis for contemporary work in the area.

Writings on gifted education also represent early efforts in the area of problem-based learning. The roots of problem-based learning can be found in Parnes, Noller, and Biondi's work (1977) with the Creative Problem Solving Model, Torrence's work (1963) with the Future Problem Solving Bowl, and programs such as Olympics of the Mind and Renzulli and Smith's work (1979) with gifted education.

Brain research findings published by Caine and Caine (1991) mention that holistic models of curriculum are brain compatible. In addition, the research supporting the constructivist theory of learning (Brooks and Brooks, 1993), which argues that the learner constructs meaning in the mind by connecting prior knowledge to new learning, points toward problem-based learning as a viable curricular frame.

Barrows and Tamblyn (1980) defined this new method, problem-based learning, as "the learning that results from the process of working toward the understanding or resolution of a problem" (p. 18). They summarized the process as follows:

- The problem is encountered first in the learning sequence, before any preparation or study has occurred.
- The problem situation is presented to the student in the same way it would be present in reality.
- The student works with the problem in a manner that permits his ability to reason and apply knowledge to be challenged and evaluated, appropriate to his level of learning.
- Needed areas of learning are identified in the process of work with the problem and used as a guide to individualized study.
- The skills and the knowledge acquired by this study are applied back to the problem, to evaluate the effectiveness of learning and to reinforce learning.
- The learning that has occurred in work with the problem and in individualized study is summarized and integrated into the student's existing knowledge and skills (pp. 191-192).

More recent works (Delisle, 1997; Dixon-Krauss, 1996; Fogarty, 1997; Hedegaard, 1990; Lumsdaine & Lumsdaine, 1995; Vygotsky, 1986) have related the importance for students of all ages to work in groups, interact with one another, and work on purposeful learning, including PBL, while they construct knowledge together.

<u>The relevance of this work to science teacher education</u>

In the typical science methods course for preservice elementary teachers the issues of assessment, inquiry-based science, selection and adoption of science materials, cooperative learning, how children think, and questioning strategies, among others are addressed. Teachers of methods courses would like their students to confront some of these issues creatively and come up with viable answers to problems that are faced when teaching science in the elementary school. Problem-based learning is one of the instructional techniques that I have used to address these issues with my methods students.

The National Science Education Standards (NSES) (National Research Council, 1996) discusses the science courses that undergraduates take in preparation to be teachers. The NSES (1996) states, "Undergraduate science courses are a major factor in defining what science content is learned. These courses also provide models for how science should be taught" (p. 60). The NSES also posits "learning science through inquiry should also provide opportunities for teachers to use scientific literature, media, and technology to broaden their knowledge beyond the scope of immediate inquiries. Courses in science should allow teachers to develop understanding of logical reasoning" (p. 61). Problem-based learning allows students to use all of these resources while learning about how to teach science.

Instructing methods students about cooperative learning and how students should be placed in groups is difficult unless you model it for students during the methods course. Students in my course are placed in permanent groups that confront problems, conduct research about the problem, and pose alternative solutions both individually and in groups. Accountability is built in through peer evaluation, rubrics, and individual parts of the assignments. It is important for methods instructors to give preservice teachers tools and strategies for use in the classroom. PBL is a tool that teaches cooperative learning, grouping of students, and an inquiry-based methodology for science instruction.

Why change to PBL?

The author teaches courses where students are expected to develop their own perspective on key issues. Students should be learning knowledge in such a manner that they can make practical use of it. Science education should be no different. Clyde Herreid (2001) relates a conversation that he had recently with a colleague:

> "Are you saying that the undergraduate experience was disabling—debilitating?"
> "Yes, undergraduate teaching isn't just neutral—it's hurtful?" (p. 87-88)

This sums up my experience in a nutshell. This is what I felt I was doing to my students. My own reading in sociocognitive frameworks supports this feeling and may have led me to try PBL in my own classes.

Some researchers (Brown, Collins, and Duguid, 1989; Collins, Brown, and Newman, 1989; Rogoff, 1990) look at this type of learning as a type of cognitive apprenticeship, situated in a body of knowledge.

Brown, Collins, and Duguid (1989) emphasize the idea of cognitive apprenticeship:

> Cognitive apprenticeship supports learning in a domain by enabling students to acquire, develop, and use cognitive tools in authentic domain activity. Learning, both outside and inside school, advances through collaborative social interaction and the social construction of knowledge. (p. 39)

Collins, Brown, and Newman (1989) say that effective teachers involve students in learning as apprentices: they work alongside students and set up situations that will cause students to begin to work on problems even before fully understanding them. A key aspect of an apprenticeship approach to teaching involves breaking the problem into parts so that students are challenged to master as much of a task as they are ready to handle. In addition, teachers are encouraged to provide students with varying kinds of practice situations before moving on to more challenging tasks, allowing an understanding that surpasses the use of formulas.

Brown, Collins, and Duguid (1989) relate that cognitive apprenticeship supports learning in a subject domain by enabling students to acquire, develop, and use cognitive tools in authentic domain activity.

The term apprenticeship helps to emphasize the centrality of activity in learning and knowledge and highlights the inherently context-dependent, situated, and enculturating nature of learning. Apprenticeship also suggests the paradigm of situated modeling, coaching, and fading, whereby teachers or coaches promote learning, first by making explicit their knowledge or by modeling their strategies for students in authentic activity.

Rogoff (1990) relates that the notion of apprenticeship as a model for children's cognitive development is appealing

> Because it focuses our attention on the active role of children in organizing development, the active support and use of other people in social interaction and arrangement of tasks and activities, and the socioculturally ordered nature of institutional contexts, technologies, and the goals of cognitive activities.
> Although young children clearly differ from older novices in the extent to which they can control their attention and communication in their general knowledge, there is a useful parallel between the roles of young children and the roles of novices in general in apprenticeship. (p. 39)

The courses taught by the author prepare teachers, geologists, agronomists, and natural resource professionals. These courses are:

- Science methods for elementary education majors
- Exploring Teaching as a Career—the first education course for education majors.
- Environmental Geology/Soil-Air-Water Contamination

Something that all of these courses have in common are a variety of interesting, engaging issues to examine. Still, I found myself frustrated for several reasons:

- Students would not have command of the course material and could not apply the content.
- Students were not reading the background material for class sessions.
- The discussions in my class were teacher-centered. The discussion flowed through me. I knew the answers, had practical experience as a teacher and expected that the students would come around to my way of looking at issues. (For student excitement level using this method of instruction see Ben Stein's performance in *Ferris Bueller's Day Off.)*

The Transition to a More Effective Model of Instruction

My frustration stems from my desire to be an effective teacher at the university level and to teach preservice teachers and other preservice professionals. This frustration has motivated me to adjust my own attitude and seek other ways to instruct my students. Specifically I had to identify:

- Exactly what was not going well with my teaching and what was causing my frustration. These are the items mentioned in the previous section.
- Where I could get some help and support.
- What changes I wanted to make to my courses.

That help came from the Problem-Based Learning Group at Purdue University and being mentored by experienced PBL faculty in education and other disciplines. The first thing that I decided to do was to make an attempt at writing my own PBL scenarios. The next decision was to introduce PBL into the introductory education course.

The introductory course was taught in during the first summer module of 2001 just before attending the Case Study Teaching in Science workshop in June 2001. This course was six weeks in length including a week of field experience at an ethnically diverse school in Indianapolis. Since these students were aspiring to be teachers I thought that collaborative activities would model how they could manage small groups in the classroom. I had an experienced PBL faculty member come in to do some team building with the students, which included an opening activity (see the overhead that I used in the appendix of this paper). That faculty member also explained how he did team charters and used groups in his class. This seemed a good way to transfer some pedagogical knowledge to these beginning preservice teachers.

There are many key issues that are examined in this course but I decided to develop PBL problems out of three key issues: diversity, parent-teacher communications, and looking for a job. Rather then being as wide open as a normal PBL problem, my scenarios were more like guided discovery. I wanted students to use many resources to propose solution to the scenarios that were available like the Internet, the phone, or interviewing teachers. A librarian who belonged to the PBL group conducted a class session on how to do purposeful searches on the web and other library resources.

Students' reactions to these scenarios and the use of PBL during this course were mixed. Students thought that the PBL faculty member that was teaching the class was really the instructor rather than me. They wanted me to lead discussions and tell them what my perspective on the key issues was. Students also wanted me to tell them what they should know from the course reading. This led me to the conclusion that these students were uncomfortable with the new model of instruction. They were used to courses that made them memorize facts and did not challenge them to apply the knowledge to a science education context.

Elements of PBL Used in the Science Methods Course

Team Building

The concept of team building is essential to the success of using PBL in an undergraduate course. Students may not know one another and need you to provide that opportunity. The second day of the course I ask students how they want to be grouped. The answers range from a type of food to picking their own groups. Both methods have been equally effective for me.

Once teams of three to four students have been established I have them do the tower building activity that appears in the appendix of this paper. I provide each team with an equal amount of straws, tape, coffee lids, and index cards. Additional items may also be placed in the bag. The teams then have twenty minutes to complete the task. I am available to answer questions but do not tell them how to do anything. While the teams are working it is interesting to see members of the group assume different roles of director, doer, materials manager, etc. I have not assigned these roles, they have taken them on naturally.

The most important part of the activity comes when the activity is debriefed in a whole class discussion. This is essential especially for a group of preservice teachers. In order to debrief I asked them how the activity went and how they went about building the tower. I then relate the experience to Bloom's Taxonomy. It is remarkable how many of the students come up with higher order and critical thinking elements of building the tower.

Team building continues with each group constructing a team charter and the team profile. The team profile is done after each member of the team has taken two online personality tests and determined:

1. Whether they are a Type A or B personality (http://www.queendom.com/typea.html)

2. What type of role in a group they most gravitate toward: Thinker, Socializer, Director, or Relator (http://www.mentoru.com/pro/ac/asmt.asp?asmt=1)

The team profile can alert you to potential problems like having too many Directors who develop a conflict for the group.

Team Teaching

Librarians have been an exceptional resource when I want to share strategies for conducting research. Alexius Macklin, Information Librarian in the Purdue University Undergraduate Library uses PBL scenarios to have my students locate different types of information on professional organizations, assessment strategies, lesson plans, and other items that will encountered in the PBL problems. Each team gets a different scenario.

Many students have searched for items on the Internet but not many have learned to use research databases such as ERIC, PsychLit, etc. The session mentioned above conducted by Alexius Macklin helps my students to overcome this. When students hand in their responses to PBL problems they attach copies of the web sites where they have conducted their research. Each member documents how he or she spent their time researching aspects of the problem. If the students encounter some web sites that may not be "truthful," I go over how to evaluate web sites using a resource put out by the University of Wisconsin—Eau Claire Library named the "Ten Cs." (http://www.uwec.edu/library/guides/tencs.html)

Purdue University faculty who use PBL have also come in to explain different aspects of PBL to my students. Since I am new to PBL, I do not profess to know everything. This has worked out well so far.

Peer Evaluation

In order for groups to have accountability, I have team members evaluate one another as well as themselves after every project, lesson plan, or PBL scenario that they complete. The peer evaluation form (found is the appendix of this paper) is what students fill out). Any group member who receives a failing grade on evaluation fails the course. So much group work occurs in the course that it must have this fail/safe component.

Introducing Problem-Based Learning to Methods Students

Problem-based learning is introduced to elementary science methods students by conducting the tower activity [described above] and debriefing it in terms of cooperating learning, the roles that they took on (process skills and state standards [science habits of mind] are also part of the discussion). This activity is conducted during the first class period of the methods course. The debriefing happens immediately after the tower activity.

The most important feature of any scenario, activity, or project conducted is for each and every methods student to develop their own perspective on important science education issues that include teaching lessons, managing science, etc. Since one of the main points of emphasis in the methods course is science pedagogy, I have students do the "What is PBL?" activity (found in the appendix section of this paper). This introduces PBL as an instructional model, introduces the central features of PBL, and gives the students time to conduct their own research. Students have found several wonderful PBL sites that I was not aware of.

Students use PBL to explore several important science education issues (curriculum adoption, why teach elementary science, and multicultural/gender issues). This work is conducted in groups. Students use the scenario assessment guidelines (found in the appendix section of this paper) so that they have some structure when doing PBL assignments and to model how I want them to document their response to the various science education scenarios.

The very first scenario or case study that I use concerns the nature of science. I use the "interrupted case method" to present the "*Its Not Easy to Be Green*" problem in three stages. The interrupted case method allows students to build their knowledge of a subject and discuss their opinions with their peers. The students also conduct research prior to class when that becomes necessary. It is important to keep in mind that students come to the science methods course with different science content knowledge and differing ideas about the nature of science. This PBL scenario sparks animated discussion about a current event that illustrates how science is conducted around the world. This three-part PBL problem can be found at the end of this paper.

<u>Writing Problems</u>

Articles that students are reading for the course seem to work well for writing PBL problems. I started by writing problems that were too "guided" and not open-ended enough. The Janice Cole scenario (found in the appendix of this paper) would be an example of this. Problems that are larger than having a single teacher as a character have been much more successful.

The gender/multicultural scenario is a wide-open problem for which students can develop differing perspectives. Guided problems seem to produce similar solutions and the students get bored very quickly listening to the same solution for each group that reports its results.

I have identified these major themes for the course:

- assessment
- adoption of science materials
- nature of science
- cooperative learning
- inquiry
- safety
- professional organizations

A problem is developed for groups to investigate on each one of the major themes. This has helped me to focus their attention and limit what I attempt during the course of the semester.

Hints for Writing PBL problems

The media can be a rich source for potential problems or case studies. Any media source can be used for this purpose. In the introductory course I have used newspaper articles on standardized testing, Ritalin, ADD/ADHD, teacher shortages, and other subjects. Other media sources have been TV news, practitioner publications (Science and Children, Science Scope, The Science Teacher, Instructor), and science publications (Science News).

A problem-based learning mindset is needed when you search for a problem. This means that the subject of the problem or case study has to be rich enough so that students can develop their own perspective on the issue. Some other criteria for finding a viable topic might include:

- Problem-based learning criteria: is the topic interesting and appropriate for you to use.
- The topic should act as a "hook".
- Media as sources of science/society issues.
- Goal is to choose appropriate materials that also have a hook.

An example of a problem that meets all of the above criteria is a problem entitled "It's Not Easy Being Green" (see appendix).

Lessons Learned

It was a personal decision to implement problem-based learning in my class all at one time. I thought about starting slowly and then it became clear to me that students would need practice working together in their group and would get better with continued PBL instruction.

In introducing PBL into my course I have had to drop other elements that I used to incorporate into the class. Something had to go but some of those things were the cause of my frustration to begin with. My advice to anyone incorporating PBL or case studies into their teaching would be to go for it! It has been easier for me to refine things having gone about it in this fashion. (You can see how I use PBL in my class by going to: http://icdweb.cc.purdue.edu/~jimmc/365index.html.) I don't claim to know everything about PBL, but I am always willing to learn. I can say without hesitation that teaching is more rewarding and fulfilling since I made the switch.

Epilogue

Since its inception, the problems that have been presented to the students via the Science Teacher Challenge have met the test proposed by Duch (1996). The problems are truly related to the "real world" because a member of it is standing right in front of them. Students are definitely engaged in the problem and motivated to resolve it because they are all preparing for a career as a science teacher. They enjoy working on problems that they may one day encounter when in the shoes of the people who have visited the class as part of the Science Teacher Challenge. The problems have also met Duch's test in that they are (a) open-ended, not limited to one correct answer, (b) connected to previously learned knowledge in other classes, and (c) although not "controversial" they do elicit diverse opinions. Finally, the students tend to work on, what Duch (1996) calls Level 3 problems (at Bloom's analysis, synthesis or evaluation levels) because (a) they must look beyond the text and do research to discover new material to help them propose a way to resolve the problem as they understand it, and (b) there is more than one acceptable answer to the problem.

One of the most incredible Science Teacher Challenges was the one that was done for a local school principal, in an elementary school located near Purdue University. The principal agreed to tell the students about the school. She then went on to tell the students that the school was having a difficult time finding exemplary science materials. The proposals were reviewed by the principal to establish their ranking (for grading purposes). Her comments as to why she ranked the proposals the way she did, along with the criteria that were used, were then faxed to the instructor. The principal then visited the class to present the results to an excited group of students.

An unexpected benefit of the Science Teacher Challenge actually occurred simultaneous to working on this paper. While preparing to conduct a workshop for educators to demonstrate how they could make their curriculum more relevant to their students through PBL. It was decided to cap off the workshop by having the attendees work on a problem using the Science Teacher Challenge template. The time and location of the workshop made it difficult to invite a manager from a local bakery to share a problem with the attendees to simulate how the Science Teacher Challenge is done in the sales class. A problem would have to written instead. The very idea of having to write a problem from scratch was dreaded due the amount of time it had taken to write problems in the past, which was the impetus for creating the Science Teacher Challenge in the first place. It was soon learned, however, that having been exposed to the presentations made by Science Teacher people in class, as part of the Science Teacher Challenge, made it easier for me to articulate a problem for the workshop. In fact, it was basically drafted in a matter of 15 minutes and finalized in 30 minutes; a task which used to take one to two hours when first experimenting with PBL two years earlier. In effect, the instructor of record had learned how to write problems as a result of observing the challenges that have transpired in the sales class over the last three semesters.

In conclusion, the mistakes of educators past must be corrected so that students improve their critical thinking, as opposed to short-term memorization skills -- PBL is truly one of the best ways to do it. This paper has catalogued a technique, known as the Science Teacher Challenge, which was developed to reduce the amount of time it takes to write a problem that can be digested by students via PBL. As it turned out, the means justified the ends for two very important reasons. First, the Science Teacher Challenge was a means by which students were presented with an opportunity to solve problems that they too may face one day. Second, the instructor learned how to write real-world problems in a fraction of the time it used to take prior to developing the technique.

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1. Understand the Nature of the Problem

   a. How long has it been going on?

   b. What factors are contributing to the problem?

   -People, Methods, Facilities, Money, Resources

   -Are these factors under the client's control?

2. What then is the problem?

   a. Describe it in your own words

3. Do research to find out what others have done to solve the problem as you described it in step 2. Summarize what you have learned in a paragraph or two and be sure to cite references or sources.

4. Using the information gained in research and your own bright ideas brainstorm a list of ways the problem, as you have defined it, could be solved.

5. Do multi-voting to select the most viable means to solve the problem as you defined it. Show the votes.

6. Bring your case before the judge. Tell the client why the item you selected in step 5 will solve the problem as you have defined it!

Figure 1. Science Teacher Challenge Template

EDCI 365
Teaching Science in the Elementary School
What is PBL?

Purpose

The purpose of this assignment is to search the World Wide Web to find out more about problem-based learning. Use the links below to go to some sites that describe PBL and then search for some sites that are not included in the links below to add some information to what you have been able to find out.

Assignment

Write a 1-2 page typed paper about what you found out about problem-based learning. Be sure to address the following points in your paper:

* What is problem-based learning? How is it defined?
* How does problem-based learning differ from traditional methods of instruction?
* How is PBL constructivist in its philosophy?
* What is the role of the teacher in PBL?
* What is the role of the student in PBL?
* What other web sites did you find on PBL? What did you find out? (List the sites on a reference or works cited page.)
* What are your thoughts on PBL? How could you use it in your classroom? (Brainstorm and project. Choose a particular grade level.)

Links

Illinois Mathematics and Science Academy http://www.imsa.edu/team/cpbl/cpbl.html
Samford University http://www.samford.edu/pbl/pbl_main.html
Maricopa Center for Learning and Instruction
http://www.mcli.dist.maricopa.edu/pbl/problem.html
High Plains Regional Technology in Education Consortium
http://www.4teachers.org/projectbased/
North Central Regional Educational Laboratory
http://www.ncrel.org/sdrs/areas/issues/content/cntareas/science/sc3learn.htm
SCORE http://score.rims.k12.ca.us/problearn.html

EDCI 365
Teaching Science in the Elementary School
Scenario Assignment Guidelines

What I expect your group to hand in for the scenario assignment each time you do it is the following:

Group Responsibilities

1. Each group should hand in a typed response to the scenario including their plan for researching the problem. The response is providing your answers to the following:

    a) **Stage 1**: Encountering and Defining the Problem
        i. What do I know already about this problem or question?
        ii. What do I need to know to effectively address this problem or question?
        iii. What resources can I access to determine a proposed solution or hypothesis?
        iv. At this point, a very focused Problem Statement is needed, though that statement will be altered as new information is accessed and understood. Write out your Problem statement.

    b) **Stage 2**: Accessing, Evaluating and Utilizing information
        i. Once they have clearly defined the problem, access print, human, or electronic information resources. Ask the following questions as you look at resources.
            - Part of any problem is evaluation of the resource. How current is it?
            - How credible and accurate is it?
            - Is there any reason to suspect bias in the source?
            - When utilizing the information, you must carefully appraise the worth of the sources they have accessed.

    c) **Stage 3**: Based on the research/brainstorming you have done, determine some alternatives that to the problem. List out each of your alternatives. Briefly explain each alternative.

    d) **Stage 4**: Delegate responsibility. Divide up the workload among the members of the group. Identify which group member will do what task.

    e) **Stage 5**: Select one of the alternatives. Present in a one to two page paper why you selected this particular alternative and tell your solution to the problem. Turn in one paper for the whole group. Please put the names of all group members on the front page.

Hand in two copies of the assignment and email your typed responses.

Individual Responsibilities

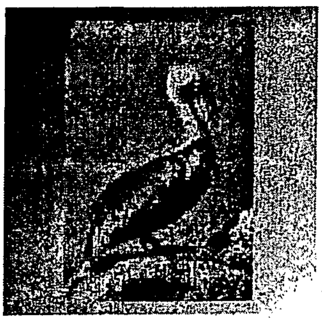
1. Each individual member of the group will hand in a typed one page or so summary of the work that they did on the problem along with documentation (printout of web pages, who you talked to on the phone, what you found in the library, etc.) Please put your name on this sheet. You need to do a thorough job on this. List the sources that you went to (citations for print sources, URL for web-based resources) and give reasons for choosing the resources that you did.

2. Attach this to the group response to the problem.

It's Not Easy Being Green
By Deborah Allen

(Based on presentation by F. Dinan and M. Hudecki at Annual Conference on Case Study Teaching in Science, 2000.)

Part 1



The first widespread use of DDT was in Italy during World War II-the clothing and bedding of allied troops and about 1.3 million civilians (including refugees) was dusted with DDT to control typhus spread by body lice. DDT offered promise as a safe yet effective insecticide with some saying "DDT will be the War's most significant contribution to the future health of the world.

Shortly thereafter, DDT was the insecticide of choice for many commercial agricultural applications, and since it was so highly potent as a contact insecticide, its potential in the control of mosquito-born malaria was soon recognized.

It was not until the 1960's that people began to publicly express concerns about the effect of DDT on the environment and its inhabitants, linking it to the death of birds and fish and other ecological disasters. DDT was banned in the U.S. in the early 1970's, and in other industrialized countries, it was gradually phased out in the mid to late 70's. Nevertheless, the World Health Organization (WHO) continued to endorse DDT for the control of malaria.

Discussion Questions:

1. What do you know about DDT, and why it caused such problems in the environment?
2. Why would the WHO continue to endorse the use of DDT?

It's Not Easy Being Green

Part 2

Environmentalists have never given up on the battle, however, to achieve a worldwide ban on DDT. "DDT is such a potent chemical that as long as it is used anywhere in the world, nobody is safe," said Clifton Curtis, director of the World Wildlife Fund's Global Toxics Initiative. "Because of their unique properties, POPs (*persistent organic pollutants*) pose a special kind of challenge that makes it impossible for any nation to remedy the problem by acting alone," asserts the WWF in public statement of policy on use of DDT and other chemical pollutants.

Now it appears that with the support of the United Nations and most major industrialized nations, environmentalists are nearing their long-standing goal at a time when malaria is re-emerging in most disease endemic countries. Beginning in the late 1990's, the United Nations Environmental Program (UNEP) has held a series to negotiate an international treaty that would lead to a legally binding global ban on the "dirty dozen" list of POPs, an environmental hit list that includes DDT. Would this ban, however, "reward First World environmental righteousness at the expense of the Third World," as many world health experts contend?

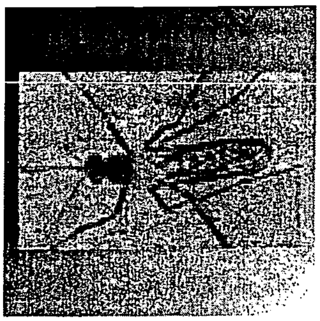
The issues that the UNEP must consider in negotiating a worldwide ban on use of DDT are complex, and are still the subject of hot debate.

Discussion Questions:

1. What issues need to be considered before banning DDT?
2. What groups would have an interest in deciding whether to ban DDT?

It's Not Easy Being Green

Part 3



On Sunday, 10 December 2000 diplomats and delegates of 120 countries approved a treaty allowing for the continued use of DDT in disease vector control. The delegates decided that DDT is a unique case, and whereas the other eleven environmental pollutants dealt with by the treaty were put on a list to be "prohibited or eliminated", DDT was relegated to a list to be "restricted". Countries wanting to use DDT would need to be registered on a DDT registry, and would be encouraged to develop and implement a plan for future action related to disease control and limiting use of DDT. The treaty also made provisions for an evaluation of the continued need for DDT for disease vector control (on the basis of available scientific, technical, environmental and economic information) at three year intervals.

Use the following questions to guide your preparation for the next class:

1. If you were the minister of public health in a malaria endemic country, what would you recommend for your country's plan for the control and/or eradication of the disease, looking 10 years into the future?
2. If you were the Secretary of the U.S. Department of Health & Human Services (or his equivalent in another industrialized country), what do you see as your fiscal or moral obligation, if any, to countries in which malaria is endemic?
3. If you were the Director-General of the World Health Organization, what malaria control strategy would your agency develop and endorse looking ahead 10 years?
4. If you were in a leadership role of an international environmental group, what action and/or recommendations would you make to the UNEP for future plans with respect to DDT?
5. If you were a parent of small children in a malaria-endemic country, what recommendations would you make to your country's decision makers?

EDCI 365
Teaching Science in the Elementary School

Reasons for Teaching Science in the Elementary School Scenario

Janice Cole is a new second grade teacher at Woodside Elementary School. Her principal has stressed how important it is for her to stress reading, writing, and math in her instruction to her students. The principal told her, "After all, these are the subjects that are covered on the standardized tests that we give in the spring. We want the students to do well on the tests." However, Janice likes teaching science and had some good experiences in her field experience for her elementary science methods class. She believes that science also needs to be taught. Janice wants to make a case to her principal and parents about the importance of science to her curriculum.

In your PBL group answer the following question: What do you think are reasons for Janice to teach science in the elementary school? Help Janice by coming up with some reasons for including science in her curriculum.

Steps to consider in your examination of the problem:

a) Define the problem as you understand it.
b) Do some research/brainstorming/talk to people to determine how you might solve the problem. Determine the key elements of their solutions.
c) Based on the research/brainstorming you have done, determine some alternatives that Janice has available to her.
d) Select one of the alternatives. Present in a one to two page paper why you selected this particular alternative and tell your solution to the problem. Turn in one paper for the whole group.

Deadline: Wednesday, September 10, 2001.

EDCI 365
Teaching Science in the Elementary School
Reasons for Teaching Science in the Elementary School Scenario
Assessment Matrix

Group members ____

____

Category	Well Developed	Acceptable	Poorly Developed	Not Addressed	Total
Definition of the problem. The problem is thoroughly identified and defined. Demonstrates that you understand the issues presented in the scenario.					
Research. Research documentation is attached to the scenario and each person in the group has shown what research they have conducted.					
Alternatives. After the research has been documented, alternatives have been outlined.					
Solution. The solution has been thoroughly posed and the reasons for choosing this alternative are clearly stated.					
Roles. Each person's contribution is clearly stated in the paper.					
General Appearance. Paper is complete, well organized, neat, and grammatically correct.					
Total					

Comments:

EDCI 365
Teaching Science in the elementary School

Gender/Multicultural Scenario

3. Now that you have read the Blake article, "Are You Turning Female and Minority Students Away from Science?" think about the following points and questions:

   1. The article was written in 1993. It had been hoped that research, legislation, and grants at universities and colleges that more female and minority students would want to become science teachers, engineers, scientists, or researchers. This is not yet the case.
   2. Is this a problem that needs to be solved?

4. Should this problem be solved? You have been appointed to a presidential commission to come up with some recommendations for resolving this dilemma. Your group is the education subcommittee of the presidential commission. What part should education play in this issue? What could elementary teachers do? Prepare a short report as a group to make recommendations to the President.

Follow the scenario assignment guidelines in the preparation of your response to the problem. There are both group and individual components of the assignment.

Deadline: Friday, October 12, 2001.

Peer Evaluation Form

Name ______________________________ Group Name ____________________

This is an opportunity to evaluate the contributions of your teammates to group projects during the semester. Please write the names of your teammates in the spaces below and give them scores that you believe they earned. If you are in a group of five people, you will each have 40 points to distribute. You don't give yourself points. (If you are in a group of four, you'll have 30 to give away. In a group of three, you'll have 20 points, etc.) If you believe that everyone contributed equally to group work, then you should give everyone 10 points. If everyone in the group feels the same way, you will all receive an average of ten points. Be fair in your assessments, but if someone in your group didn't contribute adequately, give them fewer points. If someone worked harder than the rest, give that person more than 10 points.

There are some rules that you must observe in assigning points:

1. You cannot give anyone in your group more than 15 points.
2. You do not have to assign all of your points.
3. Anyone receiving an average of less than 7 points will fail the course.
4. Don't give anyone a grade that they don't deserve.

Group members

Score

1.

2.

3.

4.

5.

Please indicate why you gave someone less than 10 points.

Please indicate why you gave someone more than 10 points.

If you were to assign points to yourself, what do you feel you deserve? Why?

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