Using Investigative Cases in Geoscience

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"The investigative case-based learning approach is a method of learning and teaching that gives students opportunities to direct their own learning as they explore the science underlying realistically complex situations." - LifeLines OnLine Project, 2000.

Cases serve as springboards to student-designed investigations.

Students structure their own learning using the "story" of the case as a problem space. Although the case defines the general area of geoscience under investigation, students generate questions based both on their interests and prior knowledge that relates to the topic of study. Investigative cases are useful for lifelong learning because they are open-ended and draw from a broad range of situations in which scientific reasoning can be applied. Investigative cases necessarily shift the focus of student learning beyond the facts to include using scientific knowledge to frame questions and to answer them.

Cases engage students and faculty in collaborative problem posing, problem solving, and persuasion.

Instructors as well as students are collaborators in this process. As students pose problems, try to solve them, and present conclusions that represent their own findings to others, both the instructor and other students may serve as resources. This collaboration aids learners in defining potential strengths and weaknesses in the design of the problem statement and the investigation. The resolution (or clarification) of the problem and its presentation to other students as well as to the instructor extends opportunities for student practice in utilizing and evaluating scientific approaches to problem solving.

What is Investigative Case Based Learning?

The use of cases for teaching is as old as storytelling itself. It is instruction by the use of narratives - stories - about individuals facing decisions or dilemmas. Learners engage with the characters and circumstances of the story. They work to identify problems and to connect the meaning of the story to their own lives.

Cases have traditionally been used to teach decision making skills in professional education, as exemplified in the Harvard Business School case approach (Christensen and Hansen, 1987). More recently, cases have been used for learning medical science (Wilkinson and Feletti, 1989, Tosteson, et al., 1994) in a model called problem-based learning or PBL (Barrows and Tamblyn, 1980). PBL gives students opportunities to direct their own learning as they explore the science underlying realistically complex situations. Students work collaboratively to identify issues, to frame questions of interest to themselves, and then to identify additional information in answer to their questions.

Investigative Case-Based Learning (ICBL) (Waterman, 1998, Waterman and Stanley, 1998, Stanley and Waterman, 2000) is a variant of PBL that encourages students to develop questions that can be explored further by reasonable investigative approaches. Students then gather data and information for testing their hypotheses. They produce materials which can be used to persuade others of their findings. Students employ a variety of methods and resources, including traditional laboratory and field techniques, software simulations and models, data sets, internet-based tools and information retrieval methods.

Investigative cases draw from realistic situations in which scientific reasoning can be applied. Although the case defines a general area of geoscience under investigation, students generate specific questions to guide their study. Students investigate scientific problems that they find meaningful. In the process they also learn to:

- locate and manage information;
- develop reasonable answers to the questions;
- use scientific inquiry strategies and methods
- provide support for their conclusions, and;
- work on decision making abilities.

Investigative case-based learning methods incorporate problem posing, pro blem solving, and peer persuasion (Peterson and Jungck, 1988, Jungck et al., 2000). Instructors as well as students are collaborators in this three phase process, often providing additional insights and defining potential strengths and weaknesses in the design of the problem statement and the investigation. The resolution (or clarification) of the problem and its presentation extend opportunities for student practice in utilizing and evaluating scientific approaches to problem solving.

Why Use Investigative Cases?

Cases provide meaningful contexts for study.

Investigative cases enable students to use their prior knowledge and their own interests to choose a meaningful problem for study. Learners construct new knowledge based on what they already know (National Academy Press, 2000).

> **"Start with the student's experience . . . and relate the subject matter to things the student already knows."** (pp. 65-66)
> (Shaping the Future: New Expectations for Undergraduate Education in Science, Mathematics, Engineering and Technology" NSF, 1996.)
> **Learners come "to formal education with a range of prior knowledge, skills, beliefs and concepts. This affects what learners notice, how they reason and solve problems, and how they remember."** (p.10)
> (How People Learn: Brain, Mind, Experience and School. National Research Council, National Academy Press, 2000.)

Students learn geoscience in context as they employ scientific information and methods to investigate and resolve - at least partially - realistic, complex problems. When learning occurs around a specific problem, there is an increased likelihood that this learned material will be better retained and more easily applied to similar situations (Brown et al., 1989, Schmidt, 1983). While students may never face the exact problems under study, they gain experience using scientific approaches to work out reasonable solutions to situations that exist in their world. This experience is potentially transferable to the unique problems they will face in their own lives.

Cases initiate problem based learning for student-directed exploration.

In investigative case based learning, the case problem comes first in the instructional sequence.

> **"Build into every course inquiry (involving the student in asking questions and finding answers), the processes of science, a knowledge of what practitioners do, and the excitement of cutting edge research."** (p. 53)
> (Shaping the Future: New Expectations for Undergraduate Education in Science, Mathematics, Engineering and Technology" NSF, 1996.)

Learners use the case to brainstorm a set of questions they will try to answer. Students become more aware of what they know and what they need to know. They thus become more directed in their reading and more motivated in subsequent lectures, labs, and discussions. In fact, they are learning in just the way most of us learn - they have a problem or question first.

Cases require the development of skills necessary for collaboration and lifelong problem solving.

> **"Devise and use pedagogy that develops skills for communications, teamwork, critical thinking and lifelong learning in each student. . ."**(p. iii)
> ("Shaping the Future: New Expectations for Undergraduate Education in Science, Mathematics, Engineering and Technology" NSF, 1996.)

In the Harvard medical case-based PBL approach, students worked in groups of 8-10 with a "tutor." The group met regularly to discuss a case based on a real patient or situation. The figure on the left was drawn by a medical student to illustrate a typical session (Atebara, 1987).

Students read part of the case out loud, then discussed the elements presented thus far in the case. They generate hypotheses, list their outstanding questions, and developed a learning agenda -- issues they agreed to pursue before their next meeting. This phase of case study is one in which students are actively engaged and working together to brainstorm issues, share what they know, and develop their plans for learning.

The "instructor" has several roles (though to the student eye it may seem he does little): facilitates discussion, helps students explore their thinking and reasoning without leading them, and helps with group dynamics. The chalkboard belongs to the student during case discussions. Students take on roles we commonly think of as teacher roles: deciding what to focus on, developing questions, leading the discussion, using the board to keep notes, make drawings, or list learning issues. During case discussions, students are actively engaged in interpreting the case, proposing problems and possible solutions, brainstorming, and using resources. (Note: Resources to support student learning are frequently in the room - books, images, models, etc. In this 1987 figure, what is noticeably missing is the ubiquitous computer, computer tools and simulations, and access to the Internet!)

Cases are complex and require multidisciplinary approaches.

There is a tendency for learners to compartmentalize content and process knowledge by discipline - an unintended result of declaring a major and the resulting stepwise curricular approaches in undergraduate education. This is diminished as students draw from multiple resources in the sciences, mathematics, social sciences, and other disciplines to work with the case.
In addition to these benefits for learners, investigative cases also provide **flexibility for instructors**.

Flexibility of Investigative Cases

Adding investigative cases to your teaching portfolio provides flexibility in addressing your teaching concerns. Cases need not be formal and can range from a mini-assignment to semester long explorations.
For example, a case could be introduced at the start of lecture with a short discussion (5-10 minutes) for generating a Know/Need to Know chart on the board. (See ICBL Strategy 4: Pose Specific Questions) Students share their prior knowledge and experience, while at the same time identify what they need to learn more about. This pre-assessment strategy might then be tied into a lab or field assignment.

Cases can be used for a variety of instructional objectives:

- Pre-assessment
- Assess content
- Set context for a regular lab session
- Introduce the need for a specific lab technology
- Provide common background for independent research reports
- Address multicultural perspectives
- Consider historical incidents
- Introduce modeling and simulation
- Assess data interpretation
- Introduce experimental design
- Prepare students for a field trip

Investigative case example:

In an introductory science course, a new instructor faces the dilemma of structuring the class to provide critical knowledge and skills in geoscience to prepare the majors, yet wishes to provide relevant learning experiences that are valuable in personal and professional lives for the non-majors as well.

Let's look at the environmental science case **Holy Starbucks!** (Stacey Kiser, Lane Community College, 2001) to see how the use of an investigative case can address this concern.

The DEQ reports that the Willamette River contains measurable levels of caffeine. Water samples were taken from Harrisburg downstream from the Eugene water treatment plant and upstream from the city of Corvallis water intake facility. Data indicates the caffeine levels are increasing from year to year.
Local fishing groups are concerned about the potential impact upon food species for migrating salmon fry. "If the caffeine kills their food sources" stated an anonymous official, "then the salmon are going to be awful hungry when they get to the sea".

Some possible learning issues from the caffeine water quality case: source of caffeine found in rivers, salmon fry diet in this part of the Willamette River, effects of caffeine on the food species and on the fry, and identification of management strategies address caffeine in the river.

How to Use Investigative Cases with Examples

Practicing scientists define problems, develop methodologies and strategies to investigate those problems, and present their findings to persuade other members of their community of the reasonableness of their findings.

Investigative case based learning strategies involve a corresponding three phase process based on problem posing, problem solving, and peer persuasion. (For more information, see the BioQUEST 3P's approach to science education.)
Each phase of ICBL and key strategies are listed below. The links lead to further explanation of these strategies and application to an environmental science case ***Goodbye Honeybuckets*** which was developed at a LifeLines OnLine workshop.
You may find the Case Analysis worksheet (Word 23.5 kB) helpful in guiding you through this process.

Phase I. Problem Posing: Analyzing a Case

- Introduce the case
- Recognize potential issues
- Identify major themes
- Pose specific questions via Know/Need to Know analysis

Phase II. Problem Solving: Investigating the Questions

- Obtain additional references/resources
- Define problems further by sharing views and concerns
- Design and conduct scientific investigations

Phase III. Peer Persuasion: Supporting Methods and Reasoning

- Produce materials that support understanding of the conclusions

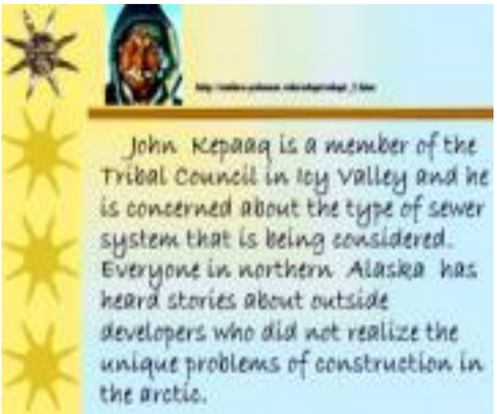
ICBL Strategy 1: Introduce the Case

Begin by providing a copy of the case to individuals or by projecting the case for the group.

Next, ask a student volunteer to read the case out loud while the others read along silently. This gets everyone "on the same page" and is a surprisingly productive case-learning method. Reading aloud lets students know that they will be verbally involved in this process. Plan on 2 minutes for this step, and it can be done in small groups or by the whole class.

Case: *Goodbye Honeybuckets* Author: Lana McNeil, College of Rural Alaska, Nome (2001)

"More than 20,000 rural Native residents in Alaska live in communities without running water and where homes, local government offices, commercial buildings and even medical clinics use plastic buckets for toilets --euphemistically called "honey buckets." The waste from these toilets is often spilled in the process of hauling it to disposal sites and these spillages have led to the outbreak of epidemic diseases such as Hepatitis A. "
(An Alaskan Challenge: Native Village Sanitation, US Congress, 1994)



Even in 2001, there are still villages without a municipal sewer system. John Kepaaq is a member of the Tribal Council in Icy Valley and he is concerned about the type of sewer system that is being considered. Everyone in northern Alaska has heard stories about outside developers who did not realize the unique problems of construction in the arctic.
Icy Valley is a village of about 200 people who know what it is like to live with permafrost, darkness, and long cold winters. John wants to be sure that the sewage system proposed for their village is appropriate for the cold temperatures and safe for the tundra environment.
Note: John Kepaaq and Icy Valley are fictitious, but the problem is real.

ICBL Strategy 2: Recognize Potential Issues

Ask students to spend 2-3 minutes silently reading the case again. This time they should be noting words or phrases that seem to be important to understanding what the case is about. If students have a printed copy of the case, they might underline these phrases. Otherwise, they might jot down ideas and questions about these phrases.

Example of selected phrases (bold) in *Goodbye Honeybuckets* for further discussion.

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ICBL Strategy 3: Identify Major Themes

Initially, it is helpful to think about the case as a whole and see what underlying themes students identify. Ask the class to consider the question: "What is this case about? Then take 5-7 answers from the class. Don't be surprised at the variety of themes associated with the case! This step, while brief, alerts students to the complexity of the case.

For *Goodbye Honeybuckets*, students suggested the following as major themes:

- tundra ecology
- health issues in rural Alaska
- arctic climate
- multicultural perspectives
- sewage treatment
- groundwater and permafrost
- Alaska geology

ICBL Strategy 4: Pose Specific Questions

A productive way to generate questions is to ask students to use a chart listing what they know and what they need to know. If students are working in a group (recommended), this might be done as a group discussion. One student could record for the group while questions, facts and issues are raised. For a case like Goodbye Honeybuckets, 10-15 minutes of class time should suffice. A brief, whole class discussion of identified questions allows the instructor to assess prior knowledge and enables students to hear each others' ideas.

Closure on this strategy: The Know/Need to Know method usually leads to a long list of questions, and there will not be time to pursue them all. Ask each group to identify 3-5 key questions about which they feel it is essential to know more.

Student responses to the Know/Need to Know analysis for *Goodbye Honeybuckets*:

Know:

- Alaska is cold.
- There are long nights or long days depending on the season.
- Sparsely populated.
- Permafrost makes it difficult to dig.
- There are reindeer in the tundra.
- There is oil in northern Alaska.
- Sewage treatment systems are common in the "lower 48."
- Different sewage treatment systems exist, such as lagoons, outhouses, septic tanks, city sewers.

Need to Know:

- How do honeybuckets work (emptying, storage, recycling)?
- What is the environmental impact of current system?
- Why isn't there a municipal sewage treatment system in the village?
- What is a tribal council? How does it work?
- What is the tundra? Where is it? What lives there? How long is winter?
- What are the seasons like in Alaska (e.g., temperature differences, precipitation, sunlight, wind)?
- What is the soil chemistry and composition?
- What is permafrost, really? How does it affect sewage treatment?
- What are the problems of construction in the arctic?
- How can the tundra be hurt (appropriateness and safety of construction methods)?

Selected key questions for *Goodbye Honeybuckets*:

- What are the major limiting factors due to tundra climate and soils and why?
- What are the feasible sewage treatment methods and why?
- Are there other considerations for successful construction in the arctic we should be considering and why?

ICBL Strategy 5: Obtain Additional Resources

No matter what type of question learners pose, it is likely they will use additional resources to help them develop a reasonable answer.

Resources may include textbooks; other library materials; results of computer simulations; results of lab or field research; articles from professional journals or popular press, data sets, maps, emails, websites or other electronically based resources; pamphlets from organizations; interviews with experts; information from museum exhibits, etc. Ask students to list 3-4 potential resources as they wrap up the case analysis. Extended informational research may be assigned independently.

The instructor may decide to make some resources available by putting them on reserve in the library, bringing them to the classroom, or creating a web page with some relevant links.

Resources for the *Goodbye Honeybuckets* case might include:

- the earth science text
- relevant maps
- informational web sites (see below)
- an Excel spreadsheet on seasonal fluctuations for arctic ponds by location
- notes from an interview with a builder/architect familiar with the arctic
- access to a climatological database on the tundra.

Note: The case author had students consult with local Tribal elders to learn about traditional methods of waste treatment.

Selected web resources for *Goodbye Honeybuckets*:

- American Academy of Environmental Engineers, Grand Prize for the Alaska Native Tribal Health Consortium, 2003 winning project
- Article on methanogenic bacteria sustainability in low temperature environments http://www.intas.be/catalog/961-2045.htm
- Environmental preservation rehabilitation and enhancement workshop http://ccee.oregonstate.edu/workshops/cold_regions/preservation.htm Lots of background data on sewage problems in tundra.
- Geophysical Institute Alaska science forum article: If you build it (a wetland), they (pollutants) will stay http://www.gi.alaska.edu/ScienceForum/ASF13/1301.html If you plant wetland plants around lagoons, this helps mediate the leaching of toxins.
- Global environment outlook, Sanitation and Waste. A site from Mexico commenting on Alaskan and Russian waste treatment problems. This is truly a global problem!
- A map of tundra regions worldwide http://www.windows.ucar.edu/tour/link=/earth/images/tundra_map_big_jpg_image.html
- Tundra bio-geo processes concept map http://zoology.okstate.edu/zoo_lrc/biol1114/study_guides/softboard/concept-maps/FireIce-Tundra.HTM

ICBL Strategy 6: Define Problems

"One of the greatest challenges in biology is to frame appropriate and productive questions that can be pursued by the technology at hand. You have probably had a great deal of experience in solving pre-posed problems, such as those found at the end of textbook chapters. However, if you were asked to go into a lab or out in a field and pose a research question, you will find that this is often difficult to do without some practice..."
(The BioQUEST Library IV: A Note to the Student. 1996)

Students will better define problems and frame specific questions to investigate as they learn more about the case. At this point it will be important for them to consult with others, most likely members of their group or other classmates. Talking about ideas and plans with peers is an important step in refining problems. This can lead to different perspectives that might help shape good research problems. Such conversation and collaboration is a hallmark of the work of scientists.

Why are some research questions considered better than others? What are the cultural, personal, and political biases that influence what questions are posed and how they are posed?
(The BioQUEST Library IV: A Note to the Student. 1996)

Setting aside time for students to share ideas in lab or class or asking students to meet outside of class or online are good strategies. *Note: The case author met with students (via telephone!!) once a week and shared ideas in a class meeting.*

Examples of problems defined for *Goodbye Honeybuckets*.

After learning more about the arctic and tundra from lectures as well as library and web sources, and after completing a lab on soil types, students proposed the following problems for further investigation:

- comparisons of climatic conditions in various biomes
- drainage in arctic soils
- temperature effects on decomposition
- temperature effects on relevant microbes
- role of microbes in decomposition

ICBL Strategy 7: Design and Conduct Scientific Investigations

Students are encouraged to use available laboratory, field or computer tools and resources. Scientists often begin by synthesizing pieces of existing information into a new theoretical framework (work which may be accompanied by repeated experimental designs as was done by Watson and Crick in modeling DNA). Students might locate or generate data sets, conduct interviews, as well as gather ideas from their reading, library research, and from laboratory and field activities.

The instructor may play an active role here by introducing specific lab activities, equipment, or methodologies, or by introducing students to simulations, datasets or modeling programs that relate to key questions raised by the case. It is up to the instructor to decide how open-ended he or she wishes the investigations to be.

Note: Many of the faculty we work with introduce lab and field activities they have used before in the course, but now ask students to design their own experiments by altering variables or methods.

Examples of investigations for *Goodbye Honeybuckets*:

- Preparing climographs enable students to more quantitatively characterize tundra conditions by comparing the climatological differences between biomes. Raw data for Barrow AK, Peoria IL, and Aswan Egypt are available at Feedback Mechanisms and Atmospheric models, Lab 2. Summary of Additional Biomes. http://www.woodrow.org/teachers/esi/1999/princeton/projects/modeling/lab2app_b.html

- By comparing decomposition at different temperatures in soils containing different amounts of water (especially focusing on amount of saturation), students can better describe the problems of various strategies for waste management in the tundra. For published results on temperature and moisture effects on decomposition in different soil types go to http://svc237.bne113v.server-web.com/crc/ecarbon/publications/nee/chapter13_tempandmoisture.pdf

ICBL Strategy 8: Produce Materials to Support Conclusions

"Research is not complete, no matter how many experiments have been conducted, no matter how many puzzles have been solved, until peers outside of a research team are persuaded of the utility of the answers. Persuasion is a social process and an essential one for you to experience in order to understand the nature of scientific theories and paradigm shifts. Communication in the science community is an active process full of controversy and debate. The productive side of science involves open criticism of the methods and conclusions made by a research group. This controversy and debate is important to the creation and acceptance of new scientific knowledge."
(The BioQUEST Library IV: A Note to the Student. 1996)

Before learners are ready to present their conclusions, ask them to identify multiple ways for others to view and review their work. The group should consider their preferences as both presenters and reviewers.

Traditionally we ask for term papers or lab reports, but the possibilities for alternative supporting materials are vast: posters (scientific, public service, etc.), videos, booklets, pamphlets for the general public, consulting reports, artwork, designs for new technology, scientific publications, newspaper stories, editorials, or new case studies for example. When students review each others products they can engage in the kind of discussion and possible controversy about differing methods and results that is common in scientific discourse.

"... you must confront the issue of closure in research. How do you know when you have a "right" answer? When is research done? Scientists do not arrive at a final answer; usually research is abandoned for a variety of reasons, including time, resources, and most importantly when the scientific research team is "satisfied" with their conclusions, that is when the solution is "useful" for some purpose."
(The BioQUEST Library IV: A Note to the Student. 1996)

A short list of student products for *Goodbye Honeybuckets*

- a scientifically based public presentation on the problems and solutions to arctic waste treatment
- an evaluation of an existing sewage treatment facility in the arctic
- a marketing report on the potential efficacy of composting toilets in Icy Valley
- a health alert brochure for rural Alaskans to be peer reviewed
- output from a modeling or simulation activity
- a web-based poster session of class experimental results.

Assessing the Use of Investigative Cases

Be sure to assess all that you want students to learn!

The way in which students are tested is the most significant factor in how they will approach learning in a course. Be sure to include assessments of the students' skills in identifying questions, resources, investigative methodologies and argumentation as well as their knowledge of the science concepts.

There are many informal opportunities to assess the performances of students who use investigative cases. You may make observations of individuals and groups at work, evaluate the quality of problem solving approaches, or ask specific questions about process so students identify and assess the strategies employed by their group. You may find it helpful to gather information from students on how they view learning with cases. Here is a sample student survey (Word 24 kB).

Reflecting on your teaching experiences with investigative cases will help you evaluate their effectiveness in the classroom and consider ways to improve investigative case-based learning materials and methods for future courses.

Activities students engage in as they work on their investigations:

- participation and contribution to work in groups
- identification of issues
- development of questions
- proposal of investigations
- location of resources
- carrying out investigations
- production of materials
- presentations

You may wish to ask if your students are:

- actively acquiring information about an appropriate topic within this problem space?
- re-organizing this information?
- using strategies to select resources beyond text materials?
- using a problem-oriented approach? (Is there a question for investigation?)
- collaborating with other individuals in problem posing or problem solving?
- choosing among alternative approaches to solve problems?
- negotiating, arguing, or attempting to convince others?
- generating graphs, tables, charts, or other graphics?
- presenting conclusions
- presenting evidence to support their conclusions?
- generating further questions as a result of this activity?

Opportunities for assessment of student products (in bold) include:

- observing students at work with a task check list to include general items such as "**Communicates** clearly" and/or specific items such as "Successfully **rotates molecule in Protein Explorer**"
- evaluating the end product students create such as a **brochure** on their **case question** that targets a specific audience
- using a case-based exam asking students to individually analyze the same case and generate **questions**, identify **what they need to know**, carry out **an investigation**, and/or **participate in a community outreach effort**.)
- requiring **peer evaluations** of a presentation such as a **poster** session or an in-class **debate**
- requesting a **group self-evaluation** such as **assignment of group points** to individual members for their contributions
- including traditional examination questions for **responses** that cover the content and process objectives of the cases

Assessing the Case for Teaching

Did the case work? Faculty need to reflect on their own practice. Not only is investigative case based learning just one of many excellent approaches you may use in your classroom, but some cases work better than others. It is helpful to assess teaching with investigative cases by answering questions about how well specific objectives were met and by considering class interactions. You may find the Faculty Assessment Form for Investigative Cases (Word 28.5 kB)a good way to get started.

Note: If you are considering adopting and adapting an existing case, there are some questions below to help you make a decision.

Some questions to ask once the case has been used:

- How well does the case work as a learning tool with students?
- What were stumbling blocks for the students?
- Were the students led "down the wrong path" by anything in the case?
- Was the time allotted for case study adequate?
- Were the students able to generate questions that they could investigate?
- Was there a problem with the questions? (too vague, difficult, long)
- Did student discussion generally address the objectives of the case? Were there any other important objectives that should be included?
- Were the students able to locate useful additional resources? Were the resource materials and readings useful?
- How well did the case study fit with other elements of the course (lectures, labs, discussions, recitations)?
- What worked especially well?

If you are reviewing an existing case for use in your course, consider the following:

- What is the case about?
- What are some of the potential learning issues I want to address with the case?
- Are the issues central enough to the case for me to use this case?
- Can I easily modify the case?
- How difficult or obscure are the issues in the case?
- Will these be issues my students will care about?
- Is the case open-ended enough for students to go beyond fact finding?
- What do I see as possible areas for investigation?
- What product might I ask students to produce?
- Is the case too short or too long for the time I have available?
- What sorts of learning resources might be needed for this case? Are they accessible?
- If I use this case, what lectures/labs/discussions might I want to change, add or eliminate?

Note: This kind of analysis may be a great starting place for writing your own cases.

Additional Implementation Issues for Investigative Cases

Implementing investigative cases successfully may require careful planning. It is best to begin with a short case experience. Among the decisions you have to make are adapting or writing the cases, addressing the learning goals and objectives of the course, considering class size, working with your course structure - a not entirely logistical consideration - and preparing students to use case study approaches which may be unfamiliar.

It is sometimes helpful to look at how other instructors are using cases. You might consider attending an ICBL workshop. Please feel free to contact us directly with questions.

Preparing Students for Cases and Collaborative Learning

Instructors need to introduce students to case study approaches, especially to collaborative group work. Address student concerns by providing access to specific information on what to expect with case-based learning. Having an assessment plan to share with your students is recommended.

You may find Student Notes for Using Cases (Word 37.5 kB) helpful to have on hand as well. You may access this at http://serc.carleton.edu/files/introgeo/icbl/CaseUserNotes.doc

Implementation hints:

The first time you do a case, choose a familiar, but compelling topic. Students are more likely to engage in the issues and generate questions about the case.
Don't be afraid to give explicit directions, such as:

- "We begin by having one person read the case out loud. Who would like to do this?"
- "Are there any words you don't know?" Or "what do you think this case is about?"
- "It will help you later if one individual acts as scribe and writes down the ideas (on the chalkboard). You might want to keep track of facts, questions, issues, and proposed answers to the problem."
- "We have 10 minutes left and you need to plan for next meeting. What do you see as key issues you'd like to work on?"

Students may find guidelines for how to act during discussions helpful. Have printed guidelines such as:

- "Don't interrupt one another" ...
- "Don't attack people personally, focus on ideas"...
- "Each person must contribute to the group. There are many ways to do this."

General advice books on college teaching like McKeachie's Teaching Tips (1994) or Barbara Gross Davis "Tools for Teaching" (1993) will be useful for developing such guidelines, as will colleagues in disciplines that regularly use discussion (psychology, english, history, education, philosophy).

Considering Class Size

Geoscience classes come in all sizes - 5, 50, 150, or 500 students with enrollments tending to be highest in beginning courses. The courses may be face to face or virtual. Different types of objectives can be accomplished by implementing case-based learning in different sized classes.

Large Class Size

In very large classes, cases can be introduced as short introductory experiences that initiate a topic, serve as an assesssment of prior knowledge, or they may lead into lab or recitation time. The case is briefly presented, perhaps as a short video segment. Choosing cases with a well defined problem space helps in large lecture settings.

Students in larger classes can do meaningful case work by forming smaller groups of up to 10 students if there is room to move around, or in very large classes they may form groups of 2-4 students sitting near one another. It helps to assign responsibility to individuals for reporting on the progress of short periods of work accomplished by these groups. It is possible to break up large classes into smaller groups, but the instructor needs a high tolerance for noise while a large group of students, working in near-neighbor groups, discusses a case. To help groups begin to develop investigations, sometimes additional instructional support may be necessary in large classes. This can be provided by faculty working in teams, graduate students (if available) and advanced undergraduate teaching assistants.

Peer interactions are enriched by the prior knowledge, experience and interests that the larger number of students bring to the process of investigative case based learning.

Small Class Size

In smaller classes, there is a real advantage for students in learning how to work together on cases and investigations. Group size can vary more, often in the range of 4-8, and it is easier for the instructor to get around to all groups and interact with each. Investigative case-based learning works well when further investigations in the lab or field are manageable for faculty and institutional resources. Student products required of the case learning experience are also not as limited as they are in large classes. Longer term individual case projects are more likely to be an option with smaller classes. A number of undergraduate institutions have set up workshop or studio style introductory science courses that result in smaller sized classes designed specifically to take advantage of cooperative and collaborative learning in science. Such arrangements are well suited to ICBL.

Online Classes

In virtual classes, cases can be introduced electronically to individual students. It is helpful to promote the formation of student groups that will work together online. Using web-based simulations and models, web-accessible data sets and other web-based resources enable authentic investigative activity.
With the advent of broadband accessibility and new digital technologies like the Access Grid, classrooms in the future may routinely incorporate virtual learning strategies. Investigative cases will be useful in these distributed learning settings.

How Do Investigative Cases Fit into Courses?

The use of investigative cases may lead to changes in a course syllabus. It is not unusual to have to delete, rearrange, rewrite or add other components like lectures or labs. You have a number of questions to ask before bringing cases to your students. When does the course meet? How often? How long? For what purposes? What kind of space is available for teaching? Can small groups work together in the classroom? in lab? When would you fit in cases?

Here are some suggested "prototypes" for incorporating investigative cases:

- Traditional - 3 hours of lecture, 2-3 hours in lab, fit cases into these
- Option A - Two blocks per week "workshop" style with some time for case work
- Option B - Combine lecture and case work, sandwiching lab
- Option C - Start case on Fri., work on in lab, finish next Fri. You can, of course, create your own shedule to fit your institution and students.

Resources for Investigative Cases

Online Resources for Cases in Science

- Investigative Cases collection at BioQUEST: http://bioquest.org/icbl
- Cases Online http://www.cse.emory.edu/cases/index.cfm Many for high school
- National Center for Case Study Teaching in Science: Clearinghouse for Case Studies in Science
  http://sciencecases.lib.buffalo.edu/cs/collection/
- LifeLines OnLine: Environmental Science/Ecology cases
  http://bioquest.org/lifelines/cases_ecoenviro.html
- Sim-Bio 2: Modeling and Simulation with Biosphere 2 Scenarios
  http://bioquest.org/simbio2.html
- PBL Clearinghouse: A collection of problems and articles to assist educators in using problem-based learning.
  https://primus.nss.udel.edu/Pbl/

Online Resources for Problem Based Learning:

- University of Delaware Problem Based Learning
  http://www.udel.edu/inst/

- The PBLI is a group of teachers and researchers involved in PBL and active in faculty educational development at Southern Illinois University.
  http://pbli.org/core.htm
- Journal of Chemical Education: About Teaching with Problems and Case Studies
  http://jchemed.chem.wisc.edu/AboutJCE/Features/TPCS/

Online Resources for Case-Based Learning with Calculus:

- Project CALC: Calculus As a Laboratory Course
  http://www.math.duke.edu/education/proj_calc/index.html
- Case Studies in Calculus
  http://math.dartmouth.edu/~m3f00/csc.html
- Reform Calculus Resources
  http://barzilai.org/archive/
- Visual Calculus
  http://archives.math.utk.edu/visual.calculus/

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