

# Evaluating the Prototype of a New Integrative Lab Module

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## Introduction

Modern industrial societies use a wide variety of Earth resources, often in astounding volumes. Unfortunately, their irregular distribution can cause conflict between nations and is the root of the large international trade in various critical resources, e.g. petroleum. At the same time, the extraction and use of many Earth resources often has adverse environmental consequences. Yet unless the human race decides to return to a pre-industrial state, we must produce these resources where they occur, not where we wish them might occur. Increasingly, citizens of a democracy are faced with issues of resource availability, extraction and use. To educate citizens about the geologic aspects of these issues, one of us (Myers) has long taught a course on Earth Resources. Although well received by students, Myers has long had concerns about how well the course prepared citizens to deal with these issues.

As part of a FIPSE<sup>1</sup> grant, Myers and Massey conducted an analysis of the tools (**literacies**) students need to turn the geologic knowledge of this course into geologic understanding and in the future to apply it systematically, rationally and effectively to a wide range of resource issues. Our analysis identified three literacies critical to this goal: 1) fundamental literacies to handle data, observations and fact; 2) technical literacies to master geologic principles; and 3) citizenship literacies to apply geologic understanding to specific resource problems. Our analysis also suggested the best place to provide the students with continuous and extensive practice with these literacies is in lab. Thus, we designed a new interactive lab module for the course and tested a prototype in the spring of 2005.

<sup>1</sup>U.S. Department of Education Fund for the Improvement of Postsecondary Education

## The Courses

GEOL3300: Earth Resources is an upper division course for both geology and non-geology majors. Historically, it has been a 50:50 mixture of majors and non-majors. The non-majors have come from such diverse disciplines as international studies, art, business, music and philosophy. In addition, there are students from more technical fields such as engineering, geography and the various sciences. This mix of technical and non-technical students provides a refreshing aspect to the course, but can create daunting pedagogical challenges.

The course covers all aspects of resources including energy, metals, water, chemical and industrial minerals as well as building materials. For each topic, the geologic processes that create the resource, the production techniques used for extraction and the impacts of the resource's use are all examined.

Because of the breadth of the topics and the desire to incorporate a more complete

- fulfills University Studies (general education) Earth Science and Global requirements
  - class is 50% geology majors & 50% non-majors
- traditional lecture-lab
  - one lecture section that meets three times a week for one hour
  - 2-3 lab sections with < 20 students
  - instructor, 1 TA
- 4 credit course
- 20-30 students per semester

and extensive treatment of the literacies into the course, Earth Resources will be split into two independent courses (Earth and Mineral Resources and Energy: A Geological Perspective) beginning in the fall of 2005. These new courses will maintain the format of the current course, but will cover each subject in greater depth.

## The Lab Module Prototype

As part of the course redesign, we have significantly revised the lab component. From the older course we have kept a number of characteristics:

- group learning
- peer instruction
- problem solving
- written and oral presentations
- repetition and practice

All of these are good pedagogical practices that have been shown to improve student learning.

To these we have added connections to real-life problems and situations. The extensive use of case studies promotes this connection. In addition, we will design the labs so that they build on previous work and so that the complexities of the lab increase throughout the course. In this manner, we will provide students with ample practice with the three literacies while providing them with a wealth of geologic knowledge.

The major new addition to the lab will be the introduction of an interactive lab module. A lab module will focus on a single resource issue but address it from three different aspects: geologic, economic and social. A single module will cover three weeks with each week addressing a different focus. The concept of the lab module can be illustrated by the lab we plan for gold.

### Gold Mining: Jewelry's Enduring Legacy

| week | focus     | subtitle                |
|------|-----------|-------------------------|
| 1    | geology   | Exploring for Gold      |
| 2    | economics | Is there Enough?        |
| 3    | society   | Who Will Mine the Gold? |

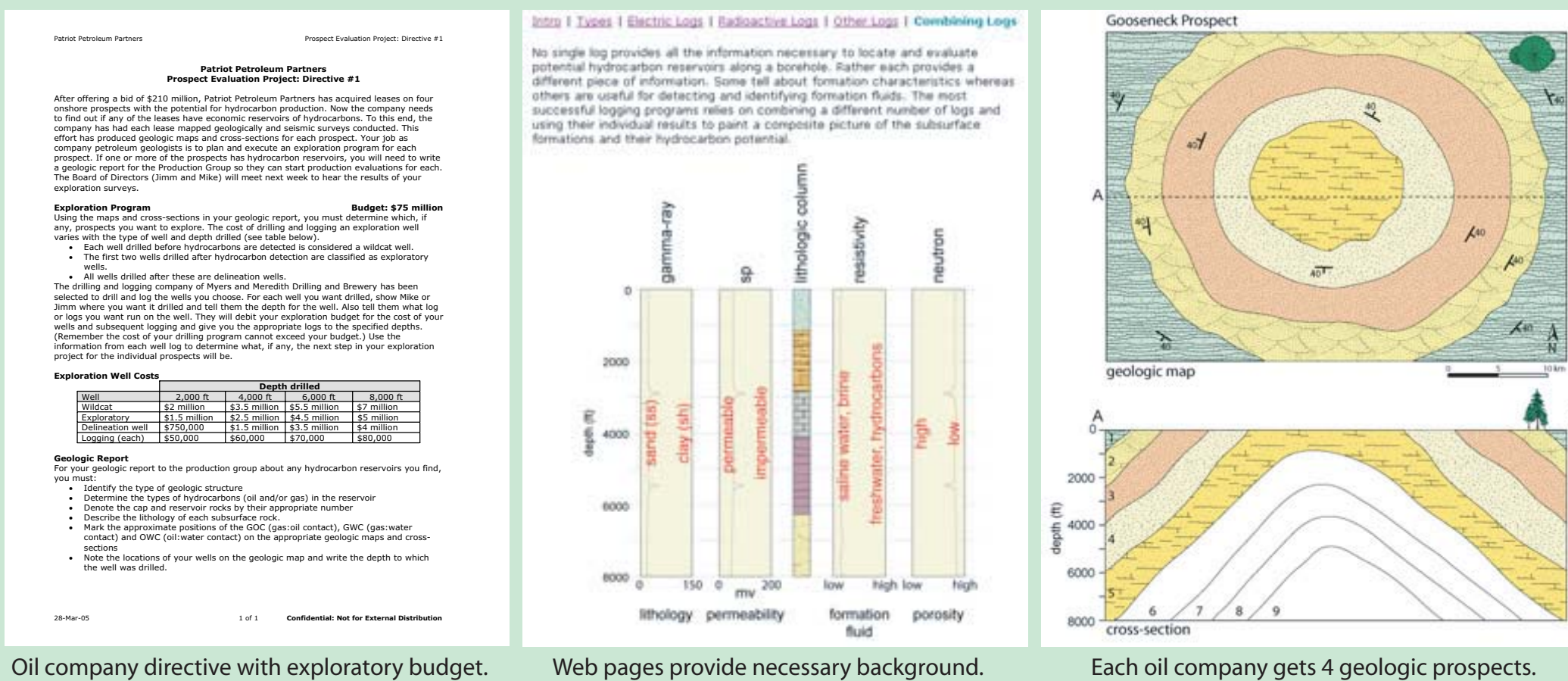
The lab module allows for significant exploration of a resource while explicitly focusing on the different literacies. In addition, the format is ideal for gradually building up the complexity of the literacies used as well as providing for continuous and extensive practice with them.

## The New Lab Module Components

### The Geology

The geology component of each lab module has students applying geologic principles discussed in lecture to hypothetical resource problems. In particular, they have to locate and assess several potential resources. They will give oral and written presentations.

For this lab, oil companies of 3-4 students are given four geologic prospects to explore for hydrocarbons. They use structural geology principles discussed in lecture as well as logging techniques learned from associated Web pages to design their own exploration program including hole locations, depths and types of logs.



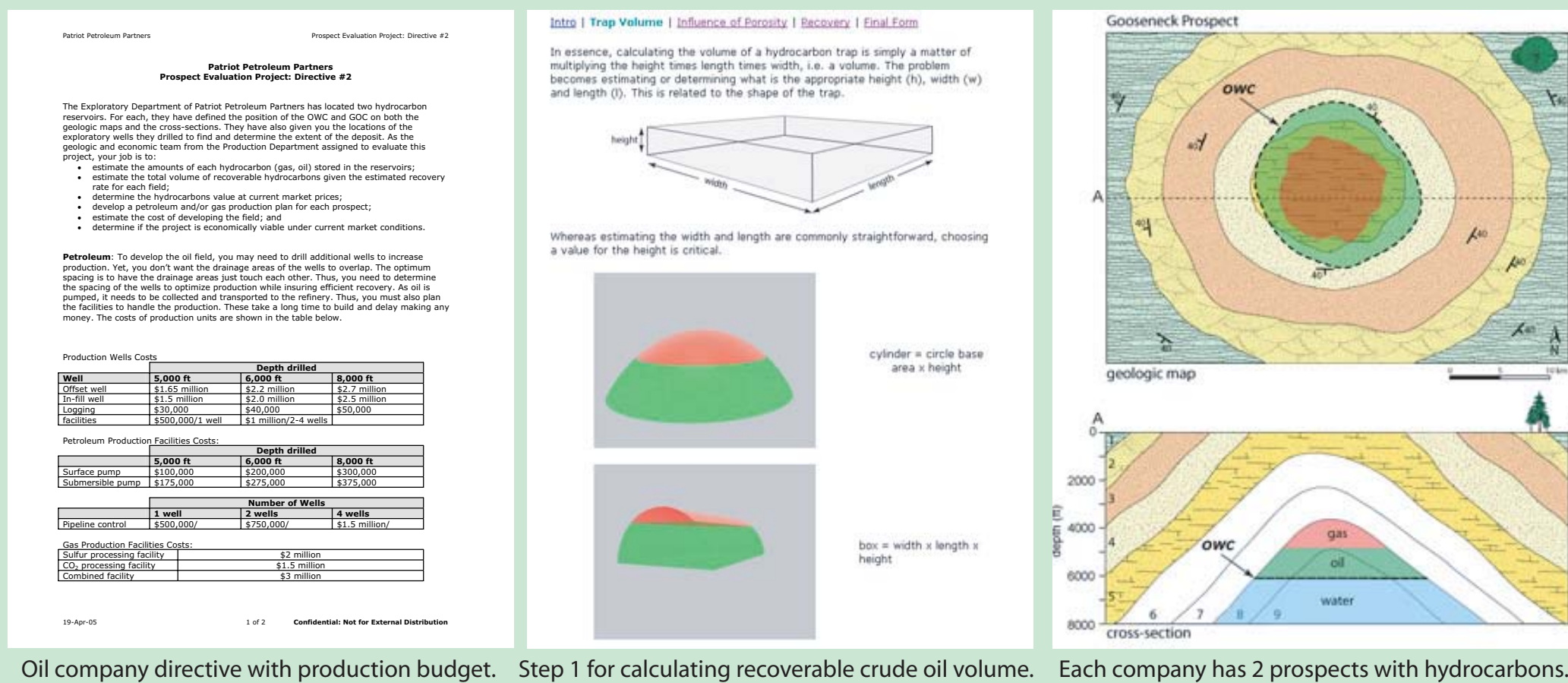
### Geologic Tasks:

- identify geologic structures
- determine types of hydrocarbons
- denote cap and reservoir rocks
- mark GOC, GWC and OWC positions
- locate exploratory wells

### The Economics

In this component, students conduct economic feasibility studies of their identified resource deposits. This activity uses fundamental and technical literacies extensively. In the next lab, each group will have to make an extract/do not extract recommendation.

Each oil company finds 2 prospects that contain various hydrocarbons. In this lab exercise, they evaluate the economic potential of each prospect. At the same time, they develop and cost estimate a production plan for each field. Based on these results, they must make an economic decision about drilling or not drilling.



### Economic Tasks:

- estimate recoverable hydrocarbons
- determine value at current market price
- develop hydrocarbon production plan
- calculate development cost
- make drill/no drill recommendation

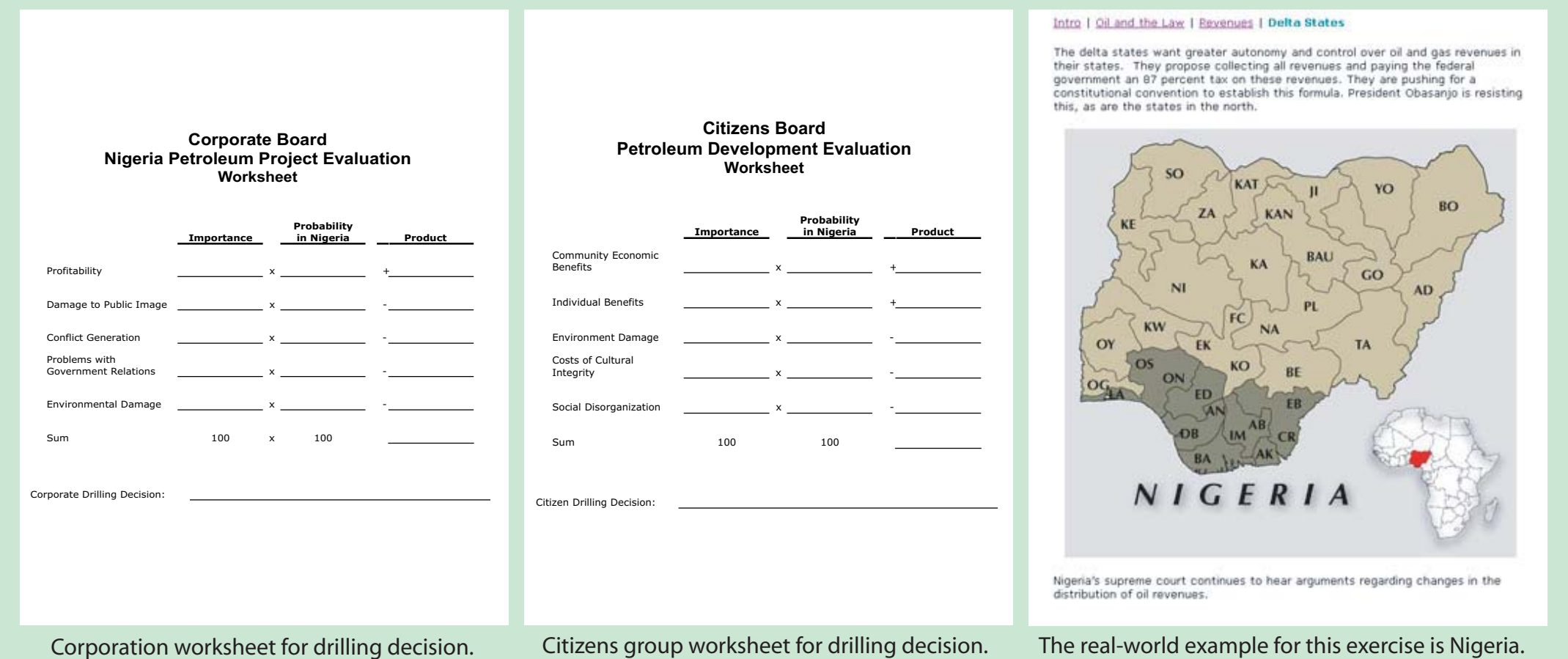
### The Social Impact

The last component of a lab module takes the extract/do not extract decision one step further. It considers the potential social impact of extraction on various populations living near the resource. It uses extensively the various citizenship literacies.

In the last part of the petroleum module, oil companies and citizen groups assign relative importances to five categories with negative or positive impacts. Using Nigeria as an example, they estimate each category's likelihood of occurring. For each group, this produces a drill/no drill decision, which can be negotiated.

### Social Tasks:

- assign categories relative importance
- assess probability of events happening
- complete worksheet & make drilling decision
- negotiate settlement between entities



## The Evaluation

To test the concept of the lab module, we kept the introductory labs from previous semesters, but developed one prototype lab module on petroleum (see schedule below). After running both types of labs this semester, we evaluated how the students viewed the two types of labs. Our evaluation consisted of classroom observations by Myers and Massey as well as focus groups conducted by Nelson and observed by Massey. Both forums indicated the new lab module is an effective teaching mechanism, at least from a student viewpoint.

| GEOL 3300: Earth Resources  |                 |
|---|-----------------|
| Department of Geology & Geophysics, University of Wyoming                                 |                 |
| Home   Log In   Glossary   Image Gallery   Calculator   Unit Converter   Email Instructor |                 |
| Lab Exercise Schedule   |                 |
| Assignment  | Week of, Points |
| 1. Quantitative Tools: Math and Units   | 24 Jan 05: 15   |
| 2. Maps: An Exploration and Production Tool   | 31 Jan 05: 15   |
| 3. Population: The Impact of Growth   | 07 Feb 05: 15   |
| 4. Systems & Cycles: The Interconnections   | 14 Feb 05: 15   |
| 5. Energy: The Forms of Energy  | 28 Feb 05: 15   |
| 6. Structural Geology: The Key to Finding Ore and Oil                                     | 07 Mar 05: 15   |
| 7. Petroleum: Finding and Developing an Oil Field (Geology)                               | 21 Mar 05: 25   |
| 8. Petroleum: Finding and Developing an Oil Field (Economics)                             | 11 Apr 05: 25   |
| 9. Petroleum: Finding and Developing an Oil Field (Impact)                                | 18 Apr 05: 25   |

## Classroom Observation

To assess the new lab module prototype, Myers observed all three labs of the petroleum module whereas Massey sat in on only the last component of the module. Some of our observations include:

- students were actively engaged in all aspects of the project;
- Web delivery of supporting material was successful - students routinely consulted the Web for information during their work;
- oral presentations were well received and peer pressure resulted in improved presentations throughout the module;
- engagement during these labs was much greater than during the earlier traditional labs.



The lab for Earth Resources is held in a computer classroom with thirteen computer stations and an instructor's station with projector. Each student has his/her own computer station and access to a printer and scanner.



To accommodate group work, the center of the classroom is occupied by a large table. This table is convenient for laying out maps, cross-sections and other papers as students work on their projects.

## The Focus Groups

To get an independent assessment of the new lab module prototype and a comparison of the integrated topic approach to the traditional stand alone labs, Jane Nelson of the Ellbogen Center for Teaching and Learning conducted focus groups with the two lab sections during the last lab period of the semester. The sessions took about 50 minutes each. Before the focus group, Myers and Massey prepared a set of questions about the module for Nelson to address during the focus groups.

The overall conclusion is that the students felt the new module is a much better way of learning about Earth resources. Specifically, the approach was more engaging and helped them remember topics better. Almost unanimously, the students felt all labs in the course should be taught using this new approach even though it encompasses more work for them.

Everything just kind of builds on top of one another, and that works really well. Because you can put your previous knowledge in with the next knowledge and not be as confused, and then with the next knowledge, and it's like "Oh, well that makes sense!"

I think it was more thought provoking too because one of us might have an opinion and someone else would bring another idea, and it would make you think of something, and so you could defend what you originally thought, but sometimes you could say, "oh, yeah, that makes sense," and then you would change your mind. So it was more thought provoking and made you look at those other points of view.

## Summary

- understanding the complexities of Earth resource issues requires mastering a set of literacies
- literacies fall into three classes: fundamental, technical, and citizenship
- to provide students with practice using these literacies on real Earth resource problems, we have designed a new interactive lab module
- a module spans three weeks of lab sessions and covers a single broad topic such as gold, petroleum, nuclear power, etc.
- each component of a module focuses on a different aspect of the resource, e.g. geologic, economic and societal
- class observations and focus groups suggest students like the module approach and recommend it for all labs in the course

To explore adequately different Earth resources, we developed the **lab module**, a lab package spanning 3 lab sessions. Each session focuses on a different resource aspect, (geology, economics and social impact). In spring 2005, we tested a prototype of the lab module using petroleum and Nigerian oil production. Classroom observations and focus group discussions revealed students preferred this approach to the traditional stand alone lab sessions. Based on student suggestions, the module effectiveness can be improved by providing an overarching introduction to each module. Although students had numerous suggestions for technical improvements, they almost universally felt the lab module approach improved learning while making connections to real world resource issues.