

Writing Effective Problem-Based Materials



*Institute for Transforming
Undergraduate Education*

University of Delaware



PBL2002: A Pathway to Better Learning

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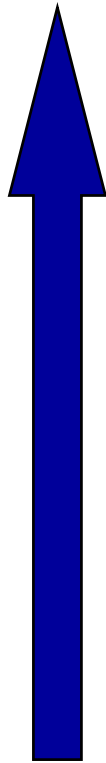


Good PBL Problems...

- **relate to real world, motivate students**
- **require decision-making or judgments**
- **are multi-page, multi-stage**
- **are designed for group-solving**
- **pose open-ended initial questions that encourage discussion**
- **incorporate course content objectives, higher order thinking**



Bloom's Cognitive Levels



Evaluation

Synthesis

Analysis

Application

Comprehension

Knowledge



Bloom's Knowledge Level

Memory; Recall of factual information.

Examples:

Who is _____?

When was _____?

Describe _____.

How did _____?



Bloom's Comprehension Level

Understanding; Interpretation.

Examples:

Demonstrate the meaning of ____.

Give an example of ____.

Translate that idea into everyday terms.



Bloom's Application Level

**Apply learning to new situation;
Generalization.**

Examples:

Apply the formula to this problem.

Teach your friend the meaning of ____.



Bloom's Analysis Level

Break down material and distinguish parts, relation to whole.

Examples:

Distinguish facts from unsupported assumptions.

Identify relevant issues in a problem.



Bloom's Synthesis Level

Put together elements to form a new whole.

Examples:

Design a web site for your course.

Write a play or story that illustrates ____.

How would you create ____?

What is the solution to the problem?



Bloom's Evaluation Level

Critique; Evaluate.

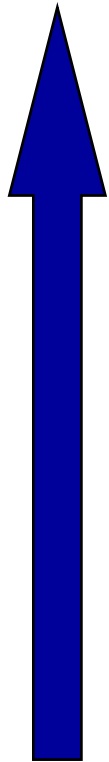
Examples:

**Assess a decision of the Supreme Court
in light of ____.**

**Write a critique of a scientific theory;
What are its strengths and weaknesses?**



Bloom's Cognitive Levels



Evaluation - make a judgment based on criteria

Synthesis - produce something *new* from component parts

Analysis - break material into parts to see interrelationships

Application - apply concept to a *new* situation

Comprehension - explain, interpret

Knowledge - remember facts, concepts, definitions



Important Considerations in Writing Problems

- **Level of course and maturity of students**
- **Role of problem in accomplishing course objectives**
- **Time frame**
- **Staging**
- **Availability and access to learning resources**
- **Use of prompting questions**



Step One: Identify Learning Objectives

Think of a learning objective in your course.

How do you usually address this learning objective? What kind of problem or activity do you usually assign?

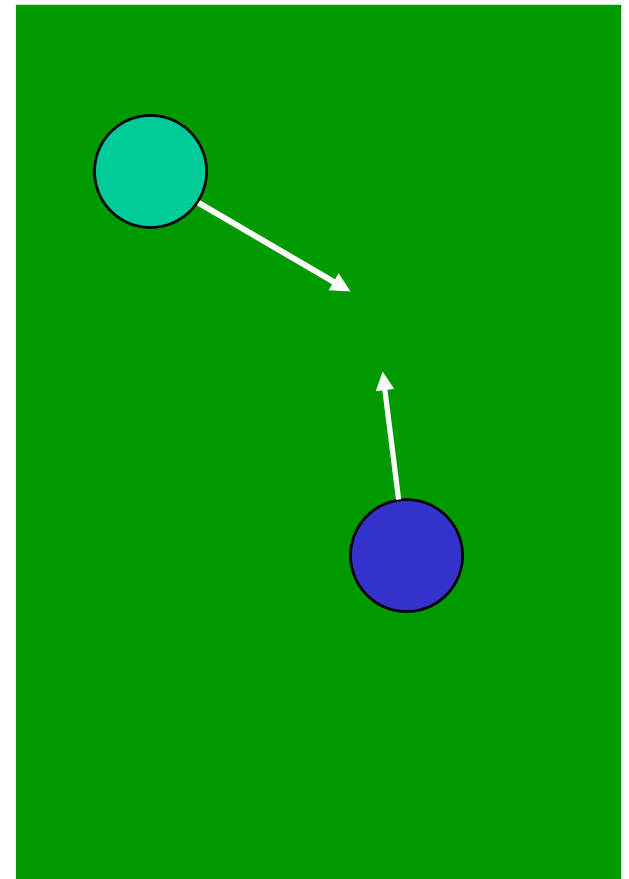
- Typical end-of-chapter problem?**
- A reading?**
- Other?**



Solving Problems Using Conservation of Momentum

Traditional examples:

- Pool balls colliding
- Bullets hitting blocks of wood





Traditional End-of-Chapter Problem



A 1500-kg car traveling east with a speed of 25 m/s collides at an intersection with a 2500-kg van traveling north at a speed of 20 m/s. Find the direction and magnitude of the velocity of the wreckage after the collision, assuming that the vehicles undergo a perfectly inelastic collision (ie, they stick together).

Serway and Faughn. 3rd ed. College Physics,
Saunders, 1992.



Understand Phenomenon of Plea Negotiation



Central concept in class on courts

- Most cases resolved through plea bargains
- Relates to other central course material
 - Attorney and litigant roles, charging, sentencing

Traditional approach

- Stand and deliver lectures
- Emphasis on facts of plea bargaining





Examples from Biology

Objectives: Compare and contrast the processes of respiration and photosynthesis, and connect these cellular events with their roles in global biogeochemical cycles

Traditional approach: Separate chapters on respiration, photosynthesis, and global energy and carbon cycles; for majors, often taught in separate semesters

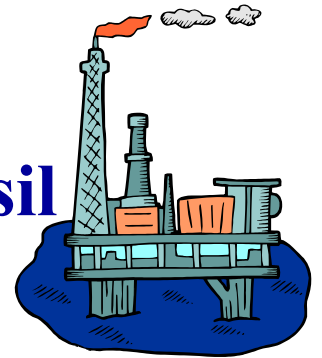


Traditional End-of-Chapter Questions

How is the energy flow through ecosystems related to the processes of photosynthesis and respiration?



What effect is the burning of fossil fuels and the clearing of forests having on the carbon cycle?
What is the possible consequence to the earth's climate?



Consider the summary equation for photosynthesis - how are the reactants used? How does each contribute to formation of the products? What role does sunlight play?



Step Two: Identify Real-World Context

Name a realistic application of the concept.

Outline a scenario.

Ideas:

- **Add story-telling to end-of-chapter problem.**
- **Add motivation, require students to go beyond rote learning, do research.**
- **Include decision-making.**
- **Other?**



A Real Traffic Accident

- **Based on police sketch**
- **Students need to make assumptions and approximate**
- **Information given gradually throughout problem**

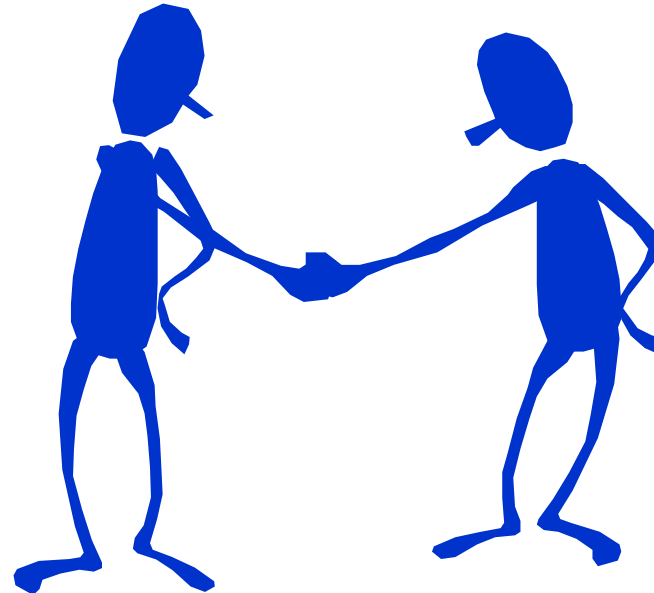


Plea Negotiation Problem



Students take on roles of prosecutor, defense attorney, defendant, and victim.

Students research issues and negotiate a case's resolution.





A Real Solution to Global Warming?

John Martin discovered that high nutrient, low chlorophyll (productivity) ocean waters are missing an essential micronutrient: iron. “*Give me a tanker full of iron, and I’ll give you another ice age.*”



Original decision: Should the government fund attempts to test the effectiveness of the “Geritol solution” at reducing the impact of excess CO₂ emissions?

Newest decision: Should for-profit companies be allowed to lease or own portions of the ocean to sell sequestered carbon? Who owns the rights to “the solution?”



Step Three:

Draft the problem

Outline the problem.

What will be on the first page?

Suggestions:

- **Good PBL problem has multi-page, multi-stage construction - leave students guessing!**
- **Not all information given in chapter or text - students look for resources.**
- **Challenge students to come to consensus, reach conclusions, and make judgments.**



John Henry - Traffic Cop

Stage 1: What questions need to be answered? What measurements, data? What physics principles? Then initial introduction to momentum.

Stage 2: Sketch given, some information given; students analyze and ask questions.

Stage 3: Outline procedure, make assumptions, Apply concepts.

Stage 4: Make judgment and rationalize decision based on physics principles





Activities Related to John Henry

- **Students summarize each stage before moving to next.**
- **Final stage written up by group with complete analysis.**





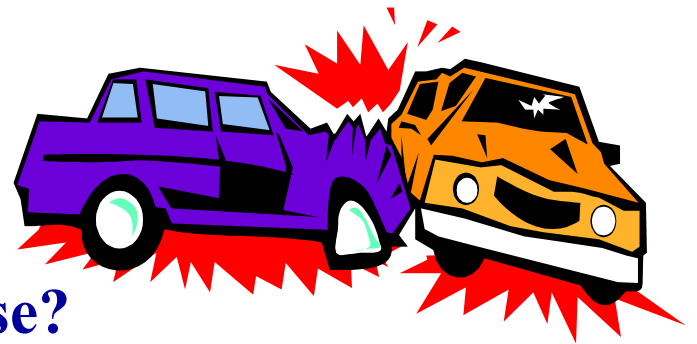
First Page of the Plea Negotiation Problem



Problem: Sam Sad drank an undetermined number of beers, then began to drive home. He ran a red light and hit another car head-on, killing one person and injuring the driver. The driver had a miscarriage shortly after the accident. Sam was arrested.

Questions for group discussion:

- What legal issues and evidence will be important?
- What do you need to learn to negotiate a resolution to this case?





Stages of Plea Negotiation



Stage 1: Students are formed into groups, learn about case facts

Stage 2: They choose roles, identify negotiation priorities and resources, research law

Stage 3: Prosecution team makes initial charge, and negotiation begins

Stage 4: Groups arrive at plea agreement, write up group report of negotiations



Activities Related to The Geritol Solution Problem

- **Based on a global environmental issues that continue to evolve**
- **Research into photosynthesis, carbon and energy cycles, marine ecosystems, global climate treaties - summarize each stage before moving to the next**
- **Make a concept map to tie biology concepts together midway through problem**
- **Discuss/debate issues in groups and whole class. Write a position paper on consensus decision**
- **Write a letter to the editor concerning position on “ownership” of the Geritol solution**





Reflections and Questions

