Student-Centered Learning: A Challenging Odyssey in PBL

George Watson
ghw@udel.edu

with contributions from Deborah Allen, Barbara Duch, Susan Groh, Valerie Hans, and Hal White

Institute for Transforming Undergraduate Education

University of Delaware

Fourth Annual Asia-Pacific PBL Conference
Hat Yai, Songkla, Thailand
December 12, 2002

www.udel.edu/pbl/4-APC-PBL
Delaware…

Dela where?
Who is here today?
Institutional Types Represented?

Show of hands, please:
Medical/professional/graduate
Undergraduate
High school and earlier

Teacher preparation and training
Responsible for faculty development
Class Settings Represented?

My courses regularly have:
- fewer than 20 students.
- more than 100 students.
Experience with PBL?

I use PBL in my classes and nothing else! as often as possible… as a novice practitioner.
Experience with Physics Instruction?

I remember my physics instruction fondly!

I cannot remember if I took physics. Who is Archimedes?
What I know best I have taught...

…the individuals learning the most in [teacher-centered classrooms] are the professors. They have reserved for themselves the very conditions that promote learning:

actively seeking new information, integrating it with what is known, organizing it in a meaningful way, and having a chance to explain it to others.

Huba and Freed, Learner-Centered Assessment on College Campuses: Shifting the Focus from Teaching to Learning, 2000
Comparison of Paradigms

Teacher-Centered

Knowledge is transmitted from professor to student.

Learner-Centered

Students construct knowledge through gathering and synthesizing information and integrating it with the general skills of inquiry, communication, critical thinking, and problem solving.
Comparison of Paradigms

Teacher-Centered
Students passively receive information.

Learner-Centered
Students are actively involved.
Comparison of Paradigms

Teacher-Centered

Emphasis is on acquisition of knowledge outside the context in which it will be used.

Learner-Centered

Emphasis is on using and communicating knowledge effectively to address enduring and emerging issues and problems in real-life contexts.
Comparison of Paradigms

Teacher-Centered

Instructor’s role is to be the primary information giver.

Learner-Centered

Instructor’s role is to coach and facilitate.
Comparison of Paradigms

Teacher-Centered
   Emphasis is on right answers.

Learner-Centered
   Emphasis is on generating better questions and learning from errors.
Comparison of Paradigms

Teacher-Centered

Focus is on a single discipline.

Learner-Centered

Approach is compatible with interdisciplinary investigation.
Comparison of Paradigms

Teacher-Centered
Culture is competitive and individualistic.

Learner-Centered
Culture is cooperative, collaborative, and supportive.
Comparison of Paradigms

Teacher-Centered

Only students are viewed as learners.

Learner-Centered

Instructors and students learn together.
Why PBL?
Characteristics Needed in College Graduates

High level of communication skills
Ability to define problems, gather and evaluate information, develop solutions
Team skills -- ability to work with others
Ability to use all of the above to address problems in a complex real-world setting

Recommendations from the Carnegie Foundation

Make research-based learning the standard.

Build inquiry-based learning throughout the four years.

Link communication skills and course work.

Use information technology effectively.

Cultivate a sense of community.

Boyer Commission Report
What is Problem-Based Learning?

PBL is an instructional method that challenges students to “learn to learn,” working cooperatively in groups to seek solutions to real world problems.

PBL prepares students to think critically and analytically, and to find and use appropriate learning resources.
“The principal idea behind PBL is that the starting point for learning should be a problem, a query, or a puzzle that the learner wishes to solve.”

Boud (1985)
What are the Common Features of PBL?

Learning is initiated by a problem.
Problems are based on complex, real-world situations.
All information needed to solve problem is not initially given.
Students identify, find, and use appropriate resources.
Students work in permanent groups.
PBL: The Process

Students are presented with a problem. They organize ideas and previous knowledge.

Students pose questions, defining what they know and do not know.

Assign responsibility for questions, discuss resources.

Reconvene, explore newly learned information, refine questions.
The Problem-Based Learning Cycle

Overview

Problem, Project, or Assignment

Group Discussion

Research

Preparation of Group “Product”

Whole Class Discussion

Mini-lecture

(Assessment)

Group Discussion
Authentic PBL

vs.

???
Outcomes?

Moving away from:

Are students getting the right answer?

Huba and Freed, Learner-Centered Assessment on College Campuses: Shifting the Focus from Teaching to Learning, 2000
Outcomes?

Moving to:

Can students demonstrate the qualities that we value in educated persons, the qualities we expect of college graduates?
Outcomes?

Moving to:

Can students gather and evaluate new information, think critically, reason effectively, and solve problems?
Outcomes?

Moving to:

Can [students] communicate clearly, drawing upon evidence to provide a basis for argumentation?
Outcomes?

Moving to:

Do [students’] decisions and judgments reflect understanding of universal truths[/concepts] in the humanities and arts [etc.]?
Outcomes?

Moving to:

Can [students] work respectfully and productively with others?
Outcomes?

Moving to:

Do [students] have self-regulating qualities like persistence and time management that will help them reach long-term goals?
The principal idea behind PBL is?

A. PBL challenges students to learn to learn.
B. Learning is initiated by a problem.
C. Student-centered work in permanent groups.
“The principal idea behind PBL is that the starting point for learning should be a problem, a query, or a puzzle that the learner wishes to solve.”

*Boud (1985)*
The principal idea behind PBL is?

A. PBL challenges students to learn to learn.
B. Learning is initiated by a problem.
C. Student-centered work in permanent groups.

Think/ pair/ share
Faculty Development in PBL
Institute for Transforming Undergraduate Education

ITUE was created in 1997 to promote reform of undergraduate education through faculty development and course design and to infuse the institution with a successful model of instruction.

Institute Fellows receive hands-on experience in employing active learning strategies and effective use of technology in their classrooms.
Features of ITUE

Faculty-led training and interactions:
- Week-long experiential workshop
- Special follow-up sessions
- Review and sharing sessions
- Brown-bag lunches

Faculty mentoring faculty:
- Leaders mentoring new Fellows
- Experienced Fellows mentoring new Fellows
- Experienced Leaders mentoring new Leaders
- New Fellows working in groups

A safe and collegial environment for learning
Week-Long Sessions

Education Reform and Active/Group Learning
Use of Technology

Experience It Yourself: Problem-Based Learning

Getting Started: The Syllabus

The Internet as a Learning Resource

Getting Started with Groups

Problems and Cases: Writing Material for Your Course

Internet Resources for Your Course

Assessment in a Student-Centered Classroom

Building a Web Site for Your Course

Models of PBL for Large Classes
January 13-14, 2003 (compressed session)
Intro to PBL and Problem Writing

June 16-20, 2003
Intro to PBL and Learning Communities

To be announced
UD PBL Campus Visitation Days

Education Reform
Professor by professor…
Trends and Directions in PBL at UD
Electronic Dissemination of PBL Materials
Characteristics of Good PBL Problems

Relate to real-world, motivate students.
Require decision-making or judgments.
Multi-page, multi-stage.
Designed for group-solving.
Initial questions are open-ended to encourage discussion.
Incorporate course content objectives.
Provide challenges for higher-order thinking.
But...where are the problems?

Typical end-of-chapter problems can be solved by rote memorization, pattern-match, and plug-and-chug techniques.

Good problems should require students to make assumptions and estimates, develop models, and work through the model.

A source of problems outside the commercial texts needs to be developed.
PBL Clearinghouse

An online database of PBL articles and problems. All material is peer-reviewed by PBL practitioners for content and pedagogy. All problems are supported by learning objectives and resources, teaching and assessment notes. Holdings are searchable by author, discipline, keywords, or full text. Fully electronic submission, review, and publication cycle. Controlled access by free user subscription, students excluded.
A Very Brief Tour of the PBL Clearinghouse

Logging in to the Clearinghouse.
Applying to be a user.
Searching and browsing the holdings.

www.udel.edu/pblc
Welcome to the PBL Clearinghouse, a collection of problems and articles to assist educators in using problem-based learning. The problems and articles are peer reviewed by PBL experts in the disciplinary content areas. Teaching notes and supplemental materials accompany each problem, providing insights and strategies that are innovative and classroom-tested. Access to the Clearinghouse collection is limited to educators who register via an online application, but is free and carries no obligation.

View sample problems and articles.

Enter your Clearinghouse Email-ID and password.

Apply to use the Clearinghouse.
Apply to become a Clearinghouse author or reviewer.

About Us
Read the Clearinghouse FAQ.
Question and comment form
Institute for Transforming Undergraduate Education
Problem-Based Learning at the University of Delaware
Teetering On the Brink of Extinction?

Driving slowly down a gravel road in southern Florida in the failing late-afternoon light, I was startled by the long tawny form, which loped across the road in front of the car. My glimpse was only a second or perhaps two at most and then it was gone...

(see complete text)
Problem Detail

Title: Crossed Circuits

Author: George H Watson
Department of Physics and Astronomy
University of Delaware
Newark, DE 19716
ghw@physics.udel.edu

Discipline: Physics and Astronomy

Target Audience: Introductory, non-majors

Keywords: circuits, electric energy, electric power, electricity

Length of Time/Staging: one class/all at once

Abstract: Two roommates argue about each others use of energy. Which roommate should pay a utility premium? How much extra?

Date Submitted: 10/2/2000

Date Published: 1/5/2001

Problem content: Problem Statement

Supporting Materials: Format of Delivery
Student Learning Objectives
Student Resources
Instructor Resources
Author's Teaching Notes
Assessment Strategies
Solution Notes

Add to my favorites
Crossed Circuits

"How long does it take you to dry your hair?" came Chris's scream from the kitchen. "I'm trying to concentrate on my physics homework!"

"Do you want the answer as a fraction of a year?" came Pat's retort from the bathroom. "Then you can have fun looking up the conversion to minutes in the back of your textbook!"

"You've been at it for at least 20 minutes. You know, you should have to pay extra toward the electric bill. I bet you spend an hour a day drying your hair. I think $5 extra each month would be about right."

"You've gotta be kidding me. With you and your night light burning all night long, I bet you use much more electricity than me! What are you afraid of anyway?"

"Yeah, but sometimes you fall asleep with your TV blaring. I bet that uses much more than my little night light."

"Oh, please! That only happens once a month. Your Winnie-the-Pooh light is on every night! Besides, how about your incessant showering. You take at least twice as long in the shower as I do. That must cost much more than running my hair dryer. What do you do in there anyway?"
Student Learning Objectives

Title: Crossed Circuits

Students learn that:

1. Appliances consume electrical power and that we pay for electrical energy.
2. Energy is the product of power consumed and the time over which it is consumed.
3. Electrical energy is commonly measured in kW-hr (kilowatt-hour) and energy charges are typically $0.05 to $0.08 per kW-hr.
4. Electrical heating typically consumes more power than lighting and other small appliances in the home.
PBL Clearinghouse

Currently there are more than 3000 registered users and 50 PBL problems.

Of the problems available, more than half are in physics, chemistry, and biology, but the number in other disciplines is growing steadily.

We are very interested in publishing adaptations of problems to other cultural/geographical contexts.

www.udel.edu/pblc
Problem-Based Learning and Physics: Developing problem solving skills in all students

The project is developing a database of problems, instructional models, evaluation tools, and web-based resources that effectively incorporate PBL across the content framework of introductory undergraduate physics courses. Materials are being collected and reviewed for a wide variety of introductory physics courses, for both science majors and non-science majors, across all levels of instruction and class enrollment.
A Day in the Life of
John Henry, Traffic Cop

At 13:20 on the last Friday in September, 1989 a frantic call was received at the local police station. There had been a serious automobile accident at the intersection of Main Street and State Street, with injuries involved. Lt. John Henry arrived at the scene 10 minutes after the phone call and found that two cars had collided at the intersection. In one car, the driver was unconscious and in the other car both driver and one passenger were injured.

After the emergency vehicles transported the injured to the hospital, Lt. Henry's responsibility is to investigate the accident in order to determine whether one of the drivers (or both) is responsible. With the severity of injury in this accident, the investigation is critical because there may be a fatality involved.

Questions:

1. What questions does John Henry have to answer in this investigation? What measurements does he need to take? What data should he collect? What other information does he need to record in order to aid the investigation? What physics principles will John Henry need to use in order to help analyze the data and answer his questions?

2. If two cars moving at right angles to each other collide, in what direction do you expect the cars to be moving after the collision?

3. What factors will influence the direction and distance traveled after impact?
A Day in the Life of John Henry, Traffic Cop

Refer to the attached sketch. Main Street, a thoroughfare, has a 45 mile per hour speed limit. State Street also has a 45 mile per hour limit, but has a stop sign on either side of the road. Vehicle 2, which weighs 5800 lbs, skidded for 24 feet before coming to a stop next to the utility pole, marked Dec#20. Vehicle 1, which weighs 2060 lbs, showed no skid marks after the impact and came to a rest next to the house on the corner. Looking at the impact areas of the cars, it was clear to Lt. Henry that the cars impacted at right angles, hitting the front right bumper of vehicle 2 and the front left bumper of vehicle 1. After impact, they initially were traveling in the same direction. Lt. Henry noted that the weather was clear and sunny, 69degF and the roadway was dry.

Before John Henry got any further in his analysis, he was informed that driver who was unconscious at the scene of the accident died at the hospital.

Questions:

4. Can you make an educated guess about which driver died based on the evidence so far? Justify your answer.

5. Why would John Henry note the weather and the condition of the road?

6. Why did vehicle 1 travel further than vehicle 2?
Weather & Road Conditions:
Clear Dry Asphalt, 69 deg.

- house
- stop sign
- unimproved shoulder
- 7'8" shoulder

POI-A
- ref point
- C
- D

- Dec #20
- 12'2"
- 22'

- house
- house
- house
Course Portfolios at Samford

O56. Reflective Practice: PBL Portfolios and the Scholarship of Teaching

    Eric Fournier

P38. Portfolios in Documenting PBL Courses.

    Clara Gerhardt
Facilities for PBL
Collaborative workspace

Flexible furniture in PBL classroom
Wireless Technology for Collaborative Learning

Instructions for the Wireless Computer Systems

The wireless collaborative learning project has been funded by the CTE program on Advanced and Emerging Technologies in Instructional Contexts. The faculty project leaders are:

- George Watson  
  Physics and Astronomy  
  Arts and Science
- Araya Debessay  
  Accounting and MIS  
  Business and Economics
- Carol Denson  
  Consumer Studies  
  Human Services, Education and Public Policy
- Beth Haslett  
  Communication  
  Arts and Science

Draft of proposal
Sample mobile wireless lab

Sponsored primarily by the Center for Teaching Effectiveness and User Services/Information Technology. Additional financial support has been provided by the Institute for Transforming Undergraduate Education, the College of Arts and Science, the College of Human Services, Education and Policy.

Photo courtesy of Paul Hyde/PRESENT.

www.udel.edu/pbl/wireless/
A complete Mobile Wireless Lab Solution from Gateway

In schools across the country, brick-and-mortar computer labs are becoming a thing of the past as wireless lab carts bring the lab to the students. Wireless networking gives you security, quality, speed — and significant budget savings. Eliminate the cost and hassle of hardwiring and increase valuable classroom space.

A Complete Solution Starting at under $21,000
price includes:
• 16 Bay Mobile Notebook Cart
• 16 Gateway Solo® 1150cs Notebook Computers (Intel® Celeron™ 650MHz, 12.1” HPA, 64MB RAM, 5GB Hard Drive, CD-ROM, Windows Millennium Edition)
• 16 Wireless Cards
• 1 Access Point with Wireless Card  
  (holds up to two wireless network cards, which support 20-30 users)
• 1 APC® Surge Protector

Gateway™
Wireless Laptop Carts
PBL moving toward Distance Learning?
National and International Partnerships
27 engineering educators and deans from northern France
Project funded by ALO/USAID

PBL in Peruvian Higher Education: Quality Science and Math Education for Future Public School Teachers

Collaboration with Pontificia Universidad Católica del Perú in Lima
Problem Based Learning

Pleasure By Learning

Education is changing for the twenty-first century, new educational paradigms have been emerging for decades and they are producing new trends and innovations with new teaching and learning strategies as a result. **Problem Based Learning** (PBL) is one of them; this approach is intended to produce **Pleasure By Learning** in students and to foster their intellectual curiosity and self-learning ability among others, ensuring a permanent approach towards knowledge and skill development in students.

Knowing, learning and sharing these PBL experiences with colleagues and friends from all around the world in the PBL-2004 Conference, will be a way to achieve the following statement declared by UNESCO: "Cooperation should be conceived as an integral part of the institutional missions of higher education institutions and systems".

Come and participate in Mexico, enjoy meeting colleagues and friends in a pleasant professional environment, which is at the edge of the educational world given by PBL.
PBL2004 International Conference
Pleasure By Learning

June 13-19, 2004
Cancun, Mexico

Website: www.cem.itesm.mx/pbl2004
E-mail: pbl2004.cem@servicios.itesm.mx

Please visit display during break!
Providing Research-Based Experiences for Undergraduates
Miscellaneous

Science Semester for Elementary Education Majors

Delaware Math/Science Partnership: Systemic Reform of Math and Science Education in the First State

Preparation of Training Materials for Course in Tutor Facilitation (show example)
Research on PBL at UD
PBL Outcomes at UD

Exposure to PBL improves number and quality of student-faculty interactions.

Structured focus groups re: PBL:
- increased comfort and inclusion in class.
- increased ability to consider, evaluate, and respect different points of view.
- improved communication and interpersonal skills.
- made course content more interesting.
PBL Outcomes at UD

Gains in critical thinking skills?
Inconclusive

Barriers to research on PBL at UD?
Many different models of PBL used (hybrids).
Absence of a PBL curriculum track.
Traditional Triad of Instruction:

- Students
- Instructors
- Curriculum
Problem-Based Learning

students

professors

real-world problems
UD PBL online

PBL at UD
www.udel.edu/pbl

ITUE
www.udel.edu/itue

PBL Clearinghouse
www.udel.edu/pblc

This presentation
www.udel.edu/pbl/4-APC-PBL