The Nature and Applications of Problem-Based Learning in Tertiary and Workplace Education

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Dela where?
The Way It Was...
1973

scientific calculators,
graphing calculators,
laptops,
PDAs
tablet PCs,
gigabytes and gigahertz,
ubiquitous computing

2007

Computation and Calculation
The Way It Was...
1973

- e-mail,
- voice-mail,
- chatrooms,
- FAX,
- cell phones,
- text messaging,
- instant messaging,
- blogging,
- wireless connectivity

2007

Communication and Collaboration
The Way It Was...
1973

Online Information:
- web catalogs,
- networked databases,
- Britannica Online,
- online newspapers,
- course websites,
- CMS and LMS,
- podcasting,
- wikis

Collections and Connections
An important question:

Given the amazing advances in technology

and the dramatic change in the environment of our students,

Can we afford to continue teaching the way we were taught?
Digital Immigrant teachers assume that learners are the same as they have always been, and that the same methods that worked for the teachers when they were students will work for their students now.

But that assumption is no longer valid.

*Digital Natives, Digital Immigrants*, by Marc Prensky
First, an exercise:

1. Individually, write down five words or short phrases that come to mind when you think of: 
   **Student-Centered Learning**

2. In pairs or small groups, select three “most important”.

3. Finally, report out just one.
Responses:

1. Interactive
2. Critical thinking
3. Team approach
4. Integration
5. Experiential
6. Facilitator
7. Participative
8. Self-directed learning
Responses:

1. Research
2. Active learning
3. Everybody learns
4. Learner-oriented
5. Challenge program
6. Group discussions
7. Student-led
8. Motivational
9. Personal relevance
What I know best I have taught...

...the individuals learning the most in the typical classrooms are the teachers there. 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
explaining it to others.

Page 35, Huba and Freed, *Learner-Centered Assessment on College Campuses: Shifting the Focus from Teaching to Learning*, 2000
What is Problem-Based Learning?

“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)*
“...careful inspection of methods which are permanently successful in formal education...will reveal that they depend for their efficiency upon the fact that they go back to the type of situation which causes reflection out of school in ordinary life. They give pupils something to do, not something to learn; and if the doing is of such a nature as to demand thinking, or the intentional noting of connections; learning naturally results.”

John Dewey (1916)
What Is PBL?

PBL is a learning approach that challenges students to “learn to learn,” working cooperatively in groups, to seek solutions to real world problems.
What Is PBL?

PBL prepares students to think critically and analytically, to find and use appropriate learning resources, to communicate effectively, orally and in writing, to work well as members of a team.
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.
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.

Investigate learning issues.

Reconvene, explore newly learned information, refine questions.
PBL: The Process

Resolution of Problem;
(How did we do?)
- Integrate new Information;
- Refine questions
- Reconvene, report on research;
- Research questions; summarize; analyze findings

Presentation of Problem
- Organize ideas and prior knowledge
  (What do we know?)
- Pose questions (What do we need to know?)
- Assign responsibility for questions; discuss resources

Next stage of the 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).

PBL: A Real Traffic Accident

- Based on police sketch
- Students need to make assumptions and approximations
- Information given gradually throughout problem
A Day in the Life of John Henry, Traffic Cop

Part 1.
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) are 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?
A Day in the Life of John Henry, Traffic Cop

Part 2.
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, 69° 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?
Part 2. (contd.)
John Henry has to determine whether the driver of vehicle 2 ran the stop sign and/or if the driver of vehicle 1 was speeding. Outline a procedure that Lt. Henry can use to answer these important questions. Be sure that your reasoning is sound, since he will have to testify in court on the evidence.

Question:

7. Does John Henry have all the information he needs to determine the velocities?
A Day in the Life of John Henry, Traffic Cop

Part 3.
Lt. Henry used a drag sled to determine that the coefficient of friction between the tires and road was 0.60. He can't use the drag sled to determine the coefficient of friction between the tires of vehicle 1 as they roll over the roadway and grass.

Questions:

8. Does he need this information? What procedure can he use to find out this information?

9. Using your outlined procedures, find the velocities of the two vehicles just prior to impact and estimate the coefficient of friction between the rolling tires of vehicle 1 and the roadway and grass. Be sure to state any assumptions that you make and justify them.

10. During the collision, which vehicle delivered the greater force of impact? Justify your reasoning using physics principles.

11. How can Lt. Henry determine the speeds of both vehicles just before they applied their brakes? What further information will he need?
Typical Medical School PBL Problem:

Patient arrives at hospital, ER, physician’s office presenting with symptoms X, Y, Z

What questions should you ask?
What tests should you order?

Physician interviews patient, receives results of tests

Differential diagnosis
Preferred therapy

High Degree of Authenticity
Medical School Model

Dedicated faculty tutor
Groups of 8-10
Very student-centered environment
Group discussion is primary class activity

A good choice for
Highly motivated, experienced learners
Small, upper-level seminar classes
Floating Facilitator Model

More structured format: greater degree of instructor input into learning issues and resources

Group size: 4-6

Instructor rotates through groups: Asks questions, directs discussions, checks understanding

Other class activities:
- Groups report out
- Whole class discussions
- (Mini-)lectures

A good choice for
Less experienced learners
Classes of all sizes
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

Quality Assurance in Undergraduate Education (1994)
Wingspread Conference, ECS, Boulder, CO.
Other Reasons for Using PBL?

Students learning to communicate in a common language.
   International Islamic University of Malaya

Innovation and thinking ‘outside of the box’.
   Republic Polytechnic, Singapore

Student engagement; learning ‘how to learn’.

Inquiry-based approach, bringing research-like approach to thousands of students.
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)
Problem-Based Learning Cycle

Overview/Assessment

Problem, Project, or Assignment

Mini-lecture (only when needed!)

Whole Class Discussion

Preparation of Group “Product”

Group Discussion

Research

Group Discussion
PBL is...

“...a process of acquiring understanding, knowledge, skills and attitudes in the context of an unfamiliar situation, and applying such learning to that situation.”

- C. E. Engel, University of Newcastle
PBL is...

“...an innovative approach to organizing learning and teaching that address learning outcomes through the students’ active involvement in problem-solving and sharing of the solutions they identify.”

From promotional flyer
PBL is...

“...a system that encourages critical thinking and stimulates the analysis of ideas and consensus-building – all critical skills needed in the global environment and the modern workplace.

From promotional flyer
John Dewey…

“True learning is based on discovery, guided by mentoring, rather than the transmission of knowledge.”
UD PBL online

PBL at UD
www.udel.edu/pbl

PBL Clearinghouse
www.udel.edu/pblc

Watson homepage
www.physics.udel.edu/~watson

This presentation
www.udel.edu/pbl/jamaica