Teaching through Problem-Based Learning to Increase Student Engagement and Understanding

Erika Wise
Marian University - Indianapolis, ewise@marian.edu

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“If I had an hour to solve a problem, I’d spend 55 minutes thinking about the problem and five minutes thinking about solutions.”

-Albert Einstein
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Computer Science 101 Instructors

Dr. Perry

Dr. Anderson
Today, we are going to learn how to replace a hard drive. Let's get started.

How to Replace a Hard Drive

Step 1: Gather the appropriate tools.
Step 2: Locate the battery.
Step 3: Remove the battery.
Step 3: Remove the cover of the laptop.
Step 4: Locate the hard drive.
Step 5: .....

Dr. Perry’s Class
How to Replace a Hard Drive

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Step 5: .....

So, I will just follow these steps and I will learn what to do. Great!
Rick, you did an excellent job learning the steps. Here is your quiz back.
Yay!! I got an A on the quiz!
Rick, I heard you learned how to fix computers. I need some help.

Can you replace fix my laptop? I think the motherboard needs to be replaced.
Uhmmm... Sorry, Mr. Smith. I can’t help you.
I have not learned how to do that yet.
Yay!! I got an A on the test!

Class, today we are going to troubleshoot these laptop issues.
Let’s think about these two questions.

1. What do we know?
2. What do we need to find out?
Yay!! I got an A on the test!

Dr. Anderson’s Class

Uhm…I am going to have to do some research and work with my team to come up with a list of possible causes.
Here is a list of what I know and possible problems.

Let's do a little research on what we know.

What do you two think is going on with the laptop?
Dr. Anderson's Class

Yay!! We fixed it.
Now we know how to figure out other laptop issues.

Great job coming up with a solution!
Mr. Smith, I heard you were having issues with your laptop. Would you like for me to take a look?
Problem assigned to illustrate how to use knowledge

Problem assigned

Identify what we know and need to know

Memorize Information

Told what we need to know

Learn and apply knowledge to solve context specific problem
Instructor-Centered Traditional Instruction vs. Learner-Centered Problem-based Learning
WHAT IS PROBLEM-BASED LEARNING?

- Inquiry-based instructional approach
- Introduced in professional training of medical students by Dr. Barrows in late 1960s
- Gaining traction in professional training of non-medical field and K-12 students
- Focus on investigation of real-world problems/scenarios
- PBL learners outperform traditional learners and retain knowledge and skills over a longer period of time
GOALS & PROCESSES OF PROBLEM-BASED LEARNING

- Learners are introduced to the problem first within the context of a complex real-world problem.
- Learning is driven by ill-structured, open-ended problems that have multiple possible solutions.
- Learners identify gaps in understanding to reach possible solutions.
- Learners engaging in self-directed research as individuals and in small groups.
- The instructor takes on the role of a facilitator to guide the learning process with scaffolds through the stages of the PBL cycle.
- Instructor becomes a resource rather than the giver of knowledge.
- Learners have the opportunity to integrate theory with practice.
BENEFITS

- Provides a bridge between declarative, *the what*; procedural, *how to*; and conceptual knowledge, *when and why*

- Support learning and sharpening metacognitive skills; *problem-solving, communication, collaboration, self-directed learning, and critical reflection*

- *Engages* and *motivates* indifferent and uninterested learners

- Solutions and learning process are *applicable* and *transferable* to the real-world

- Results in *deeper understanding*
CHALLENGES

- Fidelity to PBL process and goals
- Implementation of facilitation strategies
- Acceptance of new roles, instructor and learners
- Overwhelming and frustrating
- Teaching good collaboration and managing group dynamics
- Assessments
All inquiry, problem-solving, hands-on, authentic learning instructional models are not considered problem-based learning.
PROBLEM-BASED LEARNING PROBLEMS

- Open-ended, ill-structured, and complex
- Provide opportunities to examine problem from multiple perspectives
- Authentic and context specific
- Opportunity for multiple viable solutions
- Typology of Problems
  - Decision-making
  - Diagnosis-solution
  - Design problems
  - Policy analysis
  - Dilemmas
PROBLEM-BASED LEARNING STAGES

1. Clarify Problem Scenario
2. Examine Problem & Identify Facts
3. Generate Hypotheses
4. Identify Gaps in Knowledge
5. Engage in Self-Directed Learning/Research
6. Apply New Knowledge to Re-examine Problem
7. Consensus on Most Viable Solution
8. Report Solution/Reflect/Assess
<table>
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<tr>
<th><strong>Problem-Based Learning (PBL)</strong></th>
<th><strong>Project-Based Learning (PBL or PjBL)</strong></th>
<th><strong>Case-Based Learning (CBL)</strong></th>
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<tbody>
<tr>
<td>Collaboration, self-directed learning, critical reflection, and metacognitive</td>
<td>Collaboration, self-directed learning, and creativity</td>
<td>Develop critical thinking and reasoning skills</td>
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<td>Assess learning and provide feedback throughout the learning process; formative and summative assessment</td>
<td>Assess learning and provide feedback as a summative assessment</td>
<td>Asses learning after instruction; summative assessment</td>
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<td>Multiple possible solutions</td>
<td>End product/artifact, one shared goal for project</td>
<td>Work through reasoning for a known solution</td>
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<td>Facilitation strategies used elicit learning within ZPD and scaffolds support learning</td>
<td>Specifications for project and product guides learning</td>
<td>Instructional strategies derived mostly from Socratic questioning</td>
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<td>Collaboration key; inclusive for all learners</td>
<td>Collaborative and inclusive for most learners</td>
<td>Not inclusive of all learners</td>
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HOW TO GET STARTED

**Reframe or Create Course Questions**

*Recommendation:* Essential Questions by McTighe and Wiggins

**Micro-Lessons**

Introductory Activity or Flipped Classroom

One or two sessions, less than three hours

**Mini-PBL Unit**

Design scenarios and tasks based on taxonomy of PBL problems and aligned to goals and characteristics of PBL

Three or more sessions, engaged in five hours or more

**Essential to align with the goals and key characteristics of PBL**
### LEARNING ACTIVATION HANDOUT ON PROBLEM-BASED LEARNING

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RESOURCES


Additional *Project-Based Learning (PjBL)* resource mentioned by Dr. Jen Regelski in the PBL session. [University of Washington’s Knowledge in Action research project.](https://www.youtube.com/watch?v=-5omNEmWicU)
REFERENCES


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Strobel, J., & van Barneveld, A. (2009). When is PBL more effective? A meta-synthesis of meta-analyses comparing PBL to conventional classrooms. Interdisciplinary Journal of Problem-Based Learning, 3(1). Available at: https://dx.doi.org/10.7771/1541-5015.1046
REFERENCES


