PBL: Why? What? How?

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PBL: Why? What? How?
“Does 2 + 2 = 4? No! Because two cats plus two sausages is what? Two cats. Two drops of water plus two drops of water? One drop of water.”

Vasiliy Georgievich Bogin, as quoted by Clifford J. Levy

Engineering Estimation

• Think-Pair-Share
  When a student at your institution graduates, how many problems have they encountered and solved using a typical engineering problem solving (EPS) approach?

• Estimates by Juan Lucena (Colorado School of Mines):
  - Civil: 1400 – 2130
  - Electrical: 2000
  - Mechanical: 3290
  - Eng. Physics: 3000 – 5000
  - Chemical: 1100 – 2250
  - Petroleum 1700 – 2300

PBL: Why? What? How?
Table 1. Features of Common Inductive Instructional Methods

<table>
<thead>
<tr>
<th>Method Feature</th>
<th>Inquiry</th>
<th>Problem-based</th>
<th>Project-based</th>
<th>Case-based</th>
<th>Discovery</th>
<th>JITT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Questions or problems provide context for learning</td>
<td>1 2 2 2 2</td>
<td>4 1 3 2 4 4</td>
<td>2 2 2 2 2 2</td>
<td>4 4 4 4 4 4</td>
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<tr>
<td>Complex, ill-structured, open-ended real-world problems provide context for learning</td>
<td>4 1 3 2 4 4</td>
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<td>Major projects provide context for learning</td>
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<tr>
<td>Case studies provide context for learning</td>
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<tr>
<td>Students discover course content for themselves</td>
<td>4 4 4 4 4 4</td>
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<td>4 4 4 4 4 4</td>
<td>2 2 2 2 2 2</td>
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<tr>
<td>Students complete &amp; submit conceptual exercises electronically; instructor adjusts lessons according to their responses</td>
<td>4 4 4 4 4 4</td>
<td>2 2 2 2 2 2</td>
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<td>4 4 4 4 4 4</td>
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<tr>
<td>Primarily self-directed learning</td>
<td>4 4 4 4 4 4</td>
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<td>4 4 4 4 4 4</td>
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<tr>
<td>Active learning</td>
<td>4 4 4 4 4 4</td>
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<td>2 2 2 2 2 2</td>
<td>4 4 4 4 4 4</td>
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<tr>
<td>Collaborative/cooperative (team-based) learning</td>
<td>4 4 4 4 4 4</td>
<td>2 2 2 2 2 2</td>
<td>2 2 2 2 2 2</td>
<td>4 4 4 4 4 4</td>
<td>2 2 2 2 2 2</td>
<td>4 4 4 4 4 4</td>
</tr>
</tbody>
</table>

1 – by definition, 2 – always, 3 – usually, 4 – possibly


PBL: Why? What? How to … … implement?
**Figure 5. Factors in managing complex change (Thousand and Villa, 1995)**

Global Design Teams are international development-type projects that include an engineering design component coupled with experience in a real-world environment. GDTs raise global awareness by providing a global experience to students while making a positive humanitarian impact.

CONFIRMED PROJECTS (2011-2012)
• Basic Utility Vehicle (BUV), Cameroon
• Micro-Hydroelectric Power, Cameroon
• Irrigation Water Quality Assessment, India
• Hydrogeochemistry and Wastewater Treatment, Palestine
• Water Harvesting and Treatment, Colombia
• Water Harvesting, Lebanon
PBL: Why? What? How to ... ... investigate?

Area 1 — Engineering Epistemologies: Research on what constitutes engineering thinking and knowledge within social contexts now and into the future.

Area 2 — Engineering Learning Mechanisms: Research on engineering learners' developing knowledge and competencies in context.

Area 3 — Engineering Learning Systems: Research on the instructional culture, institutional infrastructure, and epistemology of engineering educators.

Area 4 — Engineering Diversity and Inclusiveness: Research on how diverse human talents contribute solutions to the social and global challenges and relevance of our profession.

Area 5 — Engineering Assessment: Research on, and the development of, assessment methods, instruments, and metrics to inform engineering education practice and learning.
• Of 885 empirical papers published 2005-2009 in English-language engineering education journals and conference proceedings, 67 (or 8%) papers had co-authors from two or more countries (Jesiek et al., 2011).

• In another study of 105 publications on PBL in engineering education, just four papers (or 3.8%) had authors from multiple countries (Beddoes, Jesiek, and Borrego, 2010). Two of these made international comparisons:

"The pedagogy of project-based courses is notoriously difficult to transfer but in today's global economy it is crucial to be able to teach innovation" (Skogstad et al., 2008, p. 367).

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**Table 2. Frequency of Authors’ Purpose/Objective in PBL Research Papers.**

<table>
<thead>
<tr>
<th>Purpose/Objective</th>
<th>No. of articles*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Describe and assess a PBL initiative</td>
<td>70</td>
</tr>
<tr>
<td>Present method for evaluating/assessing students</td>
<td>11</td>
</tr>
<tr>
<td>Identify challenges and investigate solutions related to PBL implementation</td>
<td>10</td>
</tr>
<tr>
<td>Study student behaviors, beliefs, roles, effectiveness during PBL implementation</td>
<td>10</td>
</tr>
<tr>
<td>Faculty/staff development and tools for implementation of PBL</td>
<td>7</td>
</tr>
<tr>
<td>Compare PBL outcomes with traditional pedagogy</td>
<td>5</td>
</tr>
<tr>
<td>Investigate relationship between learning styles/theory and PBL</td>
<td>3</td>
</tr>
<tr>
<td>International transfer/comparison of PBL initiatives</td>
<td>2</td>
</tr>
</tbody>
</table>

* Some papers were coded into multiple categories.


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**Cross-National Collaborative Trends**

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"The pedagogy of project-based courses is notoriously difficult to transfer but in today's global economy it is crucial to be able to teach innovation" (Skogstad et al., 2008, p. 367).
Scenario-Based Assessment in Engineering Education

Over the summer the Midwest experienced massive flooding of the Mississippi River. What factors would you take into account in designing a retaining wall system for the Mississippi? (Atman and Bursic, 1996)

- Typical attributes assessed: teamwork, problem solving skills, various aspects of design (problem-scoping, information gathering, consideration of context), “adaptive expertise,” global competency
- Comparisons of novices and experts, pre/post-experience studies


Realistic Assessment for Realistic Instruction: Situational Strategies for Engineering Education and Practice

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ABSTRACT
Annual cuts to prepare engineers for professional practice is an increasingly complex, diverse, and globalized world, leading stakeholders and institutions in many countries and regions are embracing active learning strategies and case-based education in their efforts to train the engineers of the future. Yet, realistic, outcomes-oriented instruction demands realistic assessment of student knowledge, skills, and abilities, which can be difficult and costly when it involves face-to-face observations of individual behaviors in naturalistic or simulated settings. Conversely, traditional forced-choice assessment methods are often more cost-effective and scalable, but may be overly reductionist and limited in their range of application. This paper responds to these assessment challenges by addressing the context and the materials for the construction and use of assessment tools.

1. INTRODUCTION
Engineering education has long faced the challenge of evaluating the quality of their students, teachers, and degree programs. However, their strategies for doing so have evolved considerably. Historically, the quality of engineering education was often defined and measured by the content of the curriculum and work assigned to students, with particular emphasis on technical knowledge and skills (9). But more recently, and especially in Europe, Australia, and the U.S., the focus of outcomes-oriented quality assurance mechanisms and instructional methods have brought student learning to the fore, while simultaneously legitimizing a wider range of target competencies for graduates. This new paradigm has helped shift concerns away from the “inputs” that feed the engineering education system, including measurement issues and constraints, toward the “outputs.”

As an employee in a large multinational corporation, you are temporarily assigned to your company’s branch operations in Shanghai, China. You are a member of a team consisting of three Chinese engineers, all at the same rank as you. Your team reports to an engineering manager, who is also Chinese. You are in a team meeting where your manager proposes a solution to a difficult quality control problem. However, you are concerned that the proposed solution will fail. Consider these possible actions:

a) Have the entire team approach the manager together.
b) Bring up your concerns in the meeting.
c) Set aside your concerns and follow the manager’s lead.
d) Discuss the issue with the manager later, in a private meeting.
e) Consult your Chinese team members about appropriate actions to take.
f) Discuss your concerns with a higher-ranking manager.

Which of these actions (a-f) would you MOST likely take? Why would you take this action? Please briefly explain.

Which of these actions (a-f) would you LEAST likely take? Why would you NOT take this action? Please briefly explain.