“There was one time during class that I put a problem up at the board and got the entire thing correct. I was actually, in a way, disappointed because I feel like I learn better from my mistakes.”

“I like how it is focused on yourself figuring out the problem, rather than being told what to do. I am much more confident in my abilities in math and am now open to trying new approaches, which I think is a good thing. When I was presenting a problem that I wasn’t quite sure I had answered right, and with a little push from the class, the concept suddenly clicked in my mind. I was able to finish the rest of the problem quickly and felt good about my success.”

“Whenever I have a question about a problem I ask the question, why?”

“I think that presenting my solution is most useful because I am forced to participate and learn from other people.”

“You can see that everyone here wants to figure out how the problem was solved, instead of just getting something right, instead of just getting something right. There’s more of a desire to understand the concept that it covered.”

“My best description is that of a light bulb that could see where the rest of the problem might lead, and the concept that it covered.”

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USING PROBLEM-BASED LEARNING TO ENGAGE HIGH SCHOOL STUDENTS

March 3, 2012
Carmel Schettino
Mathematics Department, Deerfield Academy
## Common Core Standards for Mathematical Practice

<table>
<thead>
<tr>
<th>Eight Standards for Mathematical Practice</th>
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<tbody>
<tr>
<td>Make sense of problems and persevere in solving them.</td>
</tr>
<tr>
<td>Reason abstractly and quantitatively.</td>
</tr>
<tr>
<td>Construct viable arguments and critique the reasoning of others.</td>
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<tr>
<td>Model with mathematics.</td>
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<tr>
<td>Use appropriate tools strategically.</td>
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<tr>
<td>Attend to precision.</td>
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<tr>
<td>Look for and make use of structure.</td>
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<tr>
<td>Look for and express regularity in repeated reasoning.</td>
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Definition of Problem-Based Learning

An approach to curriculum and pedagogy where student learning and content material are (co-)constructed by students and teachers through mostly contextually-based problems in a discussion-based classroom where student voice, experience, and prior knowledge are valued in a non-hierarchical environment.

(Schettino, 2010)
The Classroom and Curriculum

- Physical Set Up of Room
- Student Presentation of Problems
  - Variety of methods
- Discussion of Solutions and Alternate Solutions
  - Keeping in Mind Classroom Values
  - Fostering the practice of Common Core Standards
- Technology Labs for Discovery or Enrichment
- Teacher Scaffolding of Learning Objectives
How is a class run?

- Previous nights’ homework presented by students
- Problems discussed by students
- Directed by teacher
- Summarized, final thoughts made by students, checked by teacher
- Computer labs, group problems done at board
- Assessment of learning
- Modeling of risk-taking is central
Why is this different?

- Problem-Based
- Discourse Driven by Students
- Spiraled and Parallel Topics
- Built on Prior Knowledge
- Student Construction of New Knowledge
- Multiple Representations
- Assessment Variations
- Ownership of New Knowledge via Journaling
Problem Purposes

- reviewing material from past courses
- triggering prior knowledge for an upcoming problem
- inspiring construction of new knowledge
- introducing new terminology
- practicing a new skill
- challenging the more able students (differentiated instruction)
- seeing the same new idea from a different representation
Algebra – Review Concepts from different perspective

On a number line, where is \( \frac{p + q}{2} \) in relation to \( p \) and \( q \)?

**Graphically:**

**Numerically**

<table>
<thead>
<tr>
<th></th>
<th>p</th>
<th>q</th>
<th>( \frac{p + q}{2} )</th>
</tr>
</thead>
</table>
| 1 | 3  | 2  | \[
3 + 9 = 12
\]
| 2 | 4  | 3  | \[
12 / 2 = 6
\]
| 3 | -5 | -1 | \[
Conceptually: Seeing it as the definition of Average
\]
A clock takes 3 seconds to chime at 3 pm, how long does it take to chime at 6 pm?
Work Page
Right Triangle Trig – Multiple Perspectives

To the nearest tenth of a degree, how large are the congruent angles of an isosceles triangle that is exactly as tall as it is wide?
Different Curricula

Phillips Exeter Academy Open Source Curriculum
http://www.exeter.edu/academics/72_6539.aspx

Illinois Math Science Academy
http://pbln.imsa.edu/

West Virginia Department of Education Search
http://wveis.k12.wv.us/teach21/public/project/MainMenu.cfm?tsele1=2
Integrating PBL in your Classroom

Low

“Problem of the Day”

High

Traditional Textbook supplemented with “Motivational Problems”

PBL Units

Whole Problem-Solving Curriculum
Given regular hexagon BAGELS, show that SEA is an equilateral triangle.

If the diagonals of a quadrilateral bisect each other, then the figure is a parallelogram. Prove that this is so. What about the converse statement?

The diagonals of a parallelogram always bisect each other. Is it possible for the diagonals of a trapezoid to bisect each other? Explain.
Work Page
Foster Active Learning

• Alternate generation of direction and agency

• Cognitive apprenticeship
  1) Modeling
  2) Coaching
  3) Scaffolding
  4) Fading

• Physical action from Everyone

• Authorship and Ownership of material

• Allowing, encouraging and validating discomfort
What is teacher repositioning?

• Physical repositioning
• Modeling with vulnerability
• Eliciting and initiating
• Content preparation
• Constructive response
• Expanded “telling actions”
• Creating *Authentic Assessment* in problem solving
The curriculum I use

Mathematics 225

1. A triangular plot of land has boundary lines of 45 meters, 60 meters, and 70 meters. The 60 meter boundary runs north-south. Is there a boundary line for the property that runs due east-west?

2. Let \( A = (1, 2), B = (5, 1), C = (6, 3), \) and \( D = (2, 5) \). Let \( P = (-1, -1), Q = (3, -2), R = (4, 0), \) and \( S = (0, 2) \). Use a vector to describe how quadrilateral \( ABCD \) is related to quadrilateral \( PQRS \). What is the length of this vector?

3. Let \( K = (3, 8), L = (7, 5), \) and \( M = (4, 1) \). Find coordinates for the vertices of the triangle that is obtained by using the vector \( [2, -5] \) to slide triangle \( KLM \). How far does each vertex slide?

4. The length of a vector is defined as the hypotenuse of the right triangle created by its components. The horizontal component of the vector \([-1, 7] \) is -1 and the vertical component is 7. What is the length of the vector \([-1, 7] \)? What is the length of vector \([a, b] \)? Some notation: the length of a vector is written as \( \|a, b\| \).

5. Let \( A = (2, 4), B = (4, 5), \) and \( C = (6, 1) \). Triangle \( ABC \) is shown at right. Draw three new triangles as follows:
   (a) \( \triangle PQR \) has \( P = (11, 1), Q = (10, -1), \) and \( R = (6, 1) \);
   (b) \( \triangle KLM \) has \( K = (8, 10), L = (7, 8), \) and \( M = (11, 6) \);
   (c) \( \triangle TUV \) has \( T = (-2, 6), U = (0, 5), \) and \( V = (2, 9) \).

These triangles are not obtained from \( ABC \) by applying a vector translation. Instead, each of the appropriate transformations is described by one of the suggestive names reflection, rotation, or glide-reflection. Decide which is which, with justification.
References


- Full PBL Geometry curriculum can be accessed at my website at www.carmelschettino.org
- PBL Special Interest Group Resource Site from the American Educational Research Association
- http://tinyurl.com/aerasigpbl