USING PROBLEM-BASED LEARNING IN THE STEM CLASSROOM

IMPROVING STUDENT THINKING THROUGH PROBLEM-BASED LEARNING

A Refreshing Reform to Traditional Methods of Teaching and Learning
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What is problem based learning?

Problem based learning, referred to as PBL, is a process that promotes learning through working together to solve a real life problem.
CHARACTERISTICS OF PBL

• 1. Problems are "real world" by design for students. In other words they can visualize the need to know the information in their future.

• 2. Problems "activate" prior-knowledge causing learners to "hook" new content on a former experience or existing information they have had exposure to.

• 3. Problems mimic ways in which new information will be applied later: either in a) assessment or b) practice.
WHAT ATTRACTS LEARNERS TO PBL?

The inquisitiveness of inquiry....
AT THE END OF THE DAY….

1. Students know what they know with confidence and are able to identify what they don't know or need to know.

2. Students can efficiently and effectively acquire new information and integrate it with existing knowledge.

3. Students can use it to advance towards problem solving

https://www.youtube.com/watch?v=IZS2MbxBGCM
WHY CONSIDER PBL AS OPPOSED TO TRADITIONAL TEACHING METHODS?

It facilitates engagement because...

• The learning is more “retrievable”
• The learning is more “relevant”
• The learner can apply the learning in similar situations
• The learning is “long-term” and embedded rather than dependent on rote recall.
• The learning is more exciting and more fun.

It promotes the development of lifelong learning skills...

• The learning places emphasis on meaning rather than memorizing facts
• Inquiry based PBL creates a higher retention of learning
• PBL develops deeper understanding
• Develops interpersonal, collaboration and negotiation skills
WHY IS PROBLEM BASED LEARNING IMPORTANT?

• Employers want employees that can collaborate, meaning work closely & cooperatively with others to solve problems and create new products and services.

• Colleges have been asked by companies to administer a new type of SAT test to senior college students, that determines how well a student can work with others.
TEACHER AS FACILITATOR

• Step back and let the students interact
• Let the students make mistakes. (Mistakes are good. Trial and error)
• Act as a facilitator NOT an observer
• The first couple of times students may experience difficulty. They are NOT used to learning this way.
• Be PATIENT
• Don’t give indication that they are heading down the wrong road based on their findings
• Don’t give too much information. Let them solve the problem.
GROUP DYNAMICS

• Every student has a role
• Roles will stay the same for the current PBL, but will change for every time a new PBL is done in the classroom
• Students are aware of the responsibilities for each role
• Groups change for every PBL
• Time limits are set to help keep students on track
PBL Job List

Materials Gatherer/Checker
This person is the only person from the group that may be up and around during the activities. They are responsible for gathering required materials for the group from the equipment table/area.

Scribe/Recorder
This person is responsible for documenting group findings.

Procedure Checker/Product Presenter—
This person makes sure that all instructions and directions are followed. Presents findings/solutions to class.

Reader/Ambassador
This person leads the group through the exploration part of the activity or lab, such as “Why did this occur?” “What happened?”, etc. This is the only person that speaks, addresses group concerns to teacher/facilitator.
ISSUES THAT CAN OCCUR

Dominating students
Quiet students
Socializing students
Students that don’t get along

Reminders to students:
All students will have a say. Everyone takes a turn to speak.
Accountability. Participation and contribution is part of the rubric.
In the real world they will have to work with some people they don’t like.
WHEN GROUPS ARE COMPLETELY STUCK

What’s missing? What would be helpful to know right now?
Does this relate to the problem you are working on?
Can you all agree that this is what the next step should be?
Can you tell me where your group is at right now?
Do you all agree with this information?
How do you know that?
Where are you stuck right now?
Engage your students
Let’s try a simple PBL
What is the process for today’s problem based learning?

• First, you will be given a statement of a real life problem that your group will be asked to solve.

• From reading this statement you will brainstorm together to make a list of “what we already know.”
What is the process for today’s problem based learning?

• Next you will brainstorm together to make a second list of “what we need to know” to solve the stated problem, a list of things you need to know but don’t know.

• Students often present the “already know list” or “what we know” and the “what we need to know” list or “what we do not know” list in the form of a T chart.
What is the process for today’s problem based learning?

• Finally, you will make a presentation of your solution, using some form of presentation media. Today everyone will be using a large sheet of chart paper as the presentation media.

• Before you begin you will also receive the rubric by which your presentation and solution will be graded.
The principal has given our classroom $198 to spend on new classroom supplies for this year. We must decide how to spend the money and make a formal proposal to him as to how we would like to spend that money and the reason why you feel those supplies are justified.

He has stated that he wants to be sure the money is not spent on supplies that are consumable and that we order items that will be used directly for learning that will take place this year.

| What We Know | What We Do Not Know |
The Steps

• Present the problem
• READER – reads the problem aloud to the group
• Students identify what they know from the information presented.
• Students identify what they do NOT know (additional information needed)
• As student teams ask the right questions, they can be offered additional materials. ex. Definition of a consumable, supply list, list of content for the year, calculator, etc.

• Students collaborate to decide the next steps
• Students take ownership
• Students understand that there may be more than one way to solve a problem (Engineering Design Process)
GOALS OF PROBLEM BASED LEARNING

1. In general, the goals in problem-based learning are two-fold:

   A. To promote deep understanding of subject matter content while ...

   B. Simultaneously developing students’ higher-order thinking

   (Ertmer & Simmons, 2006)
Why PBLs are a Great Way to Learn

Promotes higher order thinking skills
Can be tied to all subjects
Promotes collaboration
Real world application
Not just learning facts
Deeper understanding
Higher retention
Students learn to justify their decisions
Student engagement is high (warning: volume levels may be higher in your classroom)
PBL PROS & CONS

Benefits

• Problems are a vehicle for developing critical problem solving skills
• New information is acquired through self-directed learning
• Acquisition of a knowledge base coupled with Problem-solving practices helps to develop effective self-directed learning skills
• Develops team skills
• Teachers can see how students think, what they know and how they are learning.
• Student engagement and motivation improves because they are stimulated by the method

Barriers

• Changing an established curriculum to Problem-Based Learning
• May be limited to Math and Science and Technology versus all subjects
• No difference or harm in conventional test knowledge (i.e. scores)
• Creating teacher buy-in for the planning and prep that goes into PBL lessons
FACTS AND ORIGIN OF PROBLEM BASED LEARNING

Brainstorm of McMaster University of Canada

> Introduced as a specific instructional method central to their philosophy for structuring an entire curriculum promoting student-centered, multidisciplinary education and lifelong learning in professional practice. (Barrows&Tamblyn, 1980)

PBL quickly spread throughout the 1980’s-90’s

> During the 1980’s and 90’s, the PBL approach was adopted in other med schools and became an “accepted” instructional approach across North America and in Europe.

20 YEARS OF PBL EVALUATION STUDY

> A meta-analysis study concluded that a problem-based approach to instruction was equal to traditional in terms of test scores; however, the PBL students demonstrated better clinical problem-solving skills. (Albanese & Mitchell 1993; Vernon& Blake 1993)
PBL in Medicine and Beyond

• 60% of those surveyed by Wainhouse Research, the two soft-skills respondents said were important most often were “problem-solving and the ability to collaborate.

The Need for Problem-Solvers in the workforce

Their study also revealed that 39% of education stakeholders say their schools should be doing a better job of preparing students for the workforce.

Compliance vs. True Engagement

The GPEP report (Report of Panel on the General Professional Education of the Physician and College Preparation for Medicine made many recommendations for changes in medical education:

promoting independent learning and problem solving, reducing lecture hours, reducing scheduled time, and evaluating the ability to learn independently. (Muller, 1984)
ASSESSING FOR LEARNING: HOW DO YOU KNOW STUDENTS ARE LEARNING?
STRATEGIES TO PROMOTE THE TRANSFORMATION

What support do teachers need?

• To actively engage in the process as learners
• Not to be trained on PBL through lecture
• Time to collaborate and develop PBL methods and lessons
• Encouragement and flexibility

As Leaders…

• Learn with teachers actively and hands on about PBL
• Start with the end in mind
• Develop a team or committee that can support efforts of teachers and curriculum specialists as they create and collaborate
• Work to create the buy-in pervasively for all stake-holders
PLANNING FOR LEARNING…WHAT’S INVOLVED FOR PBL PLANNING?

• Creating a collaborative Classroom Culture
• Adjusting to changing roles (Teacher becomes facilitative, rather than directive)
• Success depends on the willingness and ability of teachers to change the way they control the class.
• Instructional scaffolds must be in place and may assume multiple forms depending on the learning environment: Scaffolds are key and accomplish 4 goals in PBL lessons:
  1. Initiating student inquiry
  2. Maintaining students’ engagement
  3. Aiding learners with concept integration and addressing misconceptions
  4. Promoting reflective thinking

(Ertmer&Simmons, vol.1, no.1, spring 2006)
HAVE FUN WITH IT…

It takes planning.
REINVENTING A PUBLIC HIGH SCHOOL WITH PBL

https://www.youtube.com/watch?v=Tlg-nsGi7V0
https://www.youtube.com/watch?v=5p3RAkRNLpU
• CERTL – The Center of Excellence for Research, Teaching and Learning (Wake Forest Baptist Health) www.certl.org
• www.problem-based-learning.org
• The Right Question Institute – www.therightquestion.org
• Ertmer&Simmons, vol,1, no.1, spring2006
Thank you for attending

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