



STEMD<sup>2</sup>

# Module III: Problem-Based Learning

Unit I: Introduction to Problem-Based Learning

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## Problem-Based Learning Component of AISLM

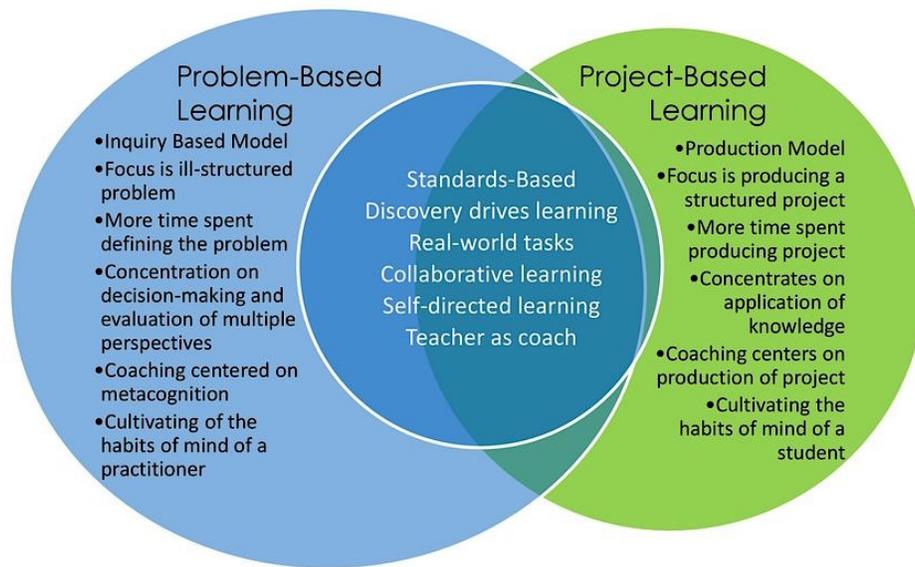
*I have always used projects in my teaching. I will admit, in hindsight, that not all of my projects were high-quality or worthwhile. They all had components in them that were good, but not all of them were as engaging as I had hoped they would be. It wasn't until I went to a training on problem-based learning (PBL) that it all came together for me. I realized that my projects had been missing something. I had been using most of the components of PBL, but not all of them. Once I finally started using PBL in my classroom, my students were more engaged and I felt like a much better teacher. But it was a process. Implementing PBL is a process that takes time and careful planning. The following section will help you implement PBL. After you read this, hopefully, you will see how beneficial and important it is to implement but be patient with yourself. Don't compare yourself to a teacher who has been using PBL for a long time. Ask their advice and start small and enjoy seeing your students engaged and successful.*

### An Introduction to PBL

Problem-based learning (PBL) is an educational strategy for instruction that is characterized by using real world-inspired problems to support content knowledge acquisition and problem-solving skills development. The Buck Institute, a leader in PBL training, defines PBL as “a teaching method in which students gain knowledge and skills by working for an extended period of time to investigate and respond to an authentic, engaging, and complex question, problem, or challenge” (pblworks.org). PBL in math classrooms is a student-centered pedagogy in which your students will collaborate to learn about mathematics through the experience of analyzing and solving a specific, real-world problem. PBL will help your students develop flexible knowledge, effective problem-solving skills, self-directed learning, effective collaboration skills, and intrinsic motivation. The following are key features of PBL.

- Learning is student-centered.
- Learning occurs in small student groups.
- Teachers are facilitators or guides.
- Real-world problems are the stimulus for learning.
- Problems are the vehicle for the development of practical problem-solving skills.
- New information is acquired through self-directed learning.
- PBL incorporates the 21<sup>st</sup>-century skills of communication, collaboration, creativity, critical thinking, problem-solving, and digital literacy.

It is important to note the difference between problem-based learning and project-based learning, two terms that are regularly used interchangeably. While they are related, problem-based learning and project-based learning are not the same things, but because they share the same acronym (PBL), they are easily confused with each other (see, Figure 1). For this training guide, PBL will refer to problem-based learning. However, the information provided can also be used to incorporate real-world project in your classroom. Your math students will benefit from solving real-world problems whether they are implemented in a cross-curricular project-based task or a math-focused problem-based assignment. As long as the assignments are based on challenging and socio-culturally relevant real-world problems your students will be engaged and experience success.



*Figure 1. Problem-based Learning vs Project-based Learning*

### *Steps for PBL Implementation*

Problem-based learning tasks are as varied as your imagination and the imagination of your students. For best results, you can break your project down into a series of problems or objectives that the students can solve throughout the process. Even with the endless variety of projects, the process for implementing PBL is consistent. If you break the project into smaller problems or objectives, the students will follow the same process to solve each step. PBL tasks are solved in five steps: engaging with the problem, exploring the problem, explaining the problem, elaborating possible solutions, and evaluating the final solution.

**First, your students need to engage with the problem.** Present the problem so that your students understand the context and purpose of the assignment. When you introduce a project, do it in a way that excites the students and engages their curiosity. The use of TED talks or YouTube videos about the problem or issue is a good way for students to engage with the problem and make it real for them. You can also bring in experts to talk about the problem.

**Second, your students further explore the problem.** Ask your students to review the case and analyze the different aspects of the problem based on their prior knowledge. Your students should research more about the problem to clarify their understanding. Your students should

then explain their understanding of the problem to one another and to the teacher. Formative assessment of PBL can take place at this stage as you assess the students' understandings and how they will use their prior knowledge to analyze a real-world inspired problem.

**Third, your students explain various hypotheses or possible solutions on how to solve the problem.** Your students' list of possible solutions should be research-based. Your students should list as many possible solutions as they can. This is a good time to teach your students how to properly function as a team. Each student can research and present their own ideas to the team. The teams should then analyze each proposed solution to choose the one they will use.

**Fourth, your students elaborate on their chosen solution.** Your students should build on their list of hypotheses and develop their solution scenario by applying their newfound knowledge. This is a good time for you to conduct another formative assessment on your students' ability to apply what they learned to their problem. The students should be able to explain how they arrived at their proposed solution and why it is the best solution.

**Fifth, your students will test, evaluate, and present their solution.** While this is listed as the last step, it is really the majority of the problem-solving process. Your students should work in a continuous cycle of sharing their ideas and solutions for feedback with their teachers and classmates and then making revisions based on the feedback. You should be using formative assessment continuously during this phase to help the students as they finalize their solution. Your assessments should be based on the session learning objectives. The final and vitally important step in PBL is to have your students present their solutions.

### *Developing a PBL lesson*

In PBL training the most common concern from teachers is that they don't know where to start when designing PBL. Honestly, this is where you get to let your creativity take over. Problem-based learning should be based on a real-world problem for which the students can develop a solution. The problem can be anything you wish or imagine. If you have no ideas, ask the students what problems they see in their world. Remember, the more meaningful the problem is to them, the more inclusive and engaging the lessons will be. The following suggestions for developing a PBL lesson are based on the seven elements of PBL recommended by the Buck Institute for Education ([pblworks.org](http://pblworks.org)). Use the following steps to develop your PBL lesson.

**Start with an open-ended, challenging, real-world problem.** The problem should be of interest to your students and one that can be solved in a variety of creative ways. Your students should be able to use their creativity and imagination to solve the problem but do so based on research and remain within project parameters. Ideas for PBL projects can be found in the resources section at the end of this chapter.

**Define the student roles for the PBL.** Each problem requires a different set of expertise. The teacher and students should define the roles for each group member before the group is assembled. It is important to note here that PBL groups are not the same as social networks that are fluid. PBL groups should be formed at the beginning of the project and remain consistent for the duration. PBL groups should function collaboratively like social networks, but they are more formal and not fluid. It is usually best to select 3-4 roles for each PBL task that will be used to form the group, but it can differ depending on the project. Encourage your

students to understand their strengths and weaknesses and which role they are best suited to fill. You can use personality tests to help them define their strengths and weaknesses. Then, allow students to choose their groups based on one another's aptitude for the required roles. It is important to emphasize that each student is still responsible for contributing to the final outcome, so they should work as a team on every aspect of the project. For example, if a project needs the role of engineer, the student best suited for that role would be the engineer. If the engineer creates a design, all of the group members should provide input and feedback on the design to improve the project. But the engineer would ultimately be responsible for ensuring the plan is submitted on time. The engineer would also help the other students with their roles in the project.

**The problem should require sustained inquiry.** The problem should be one where your students can research and build upon their research to solve. Every proposed solution should be further researched for benefits or possible tradeoffs or problems. This way your students will learn how to apply research in a meaningful way.

**Find a problem that is authentic and meaningful.** The problem should be one that is impacting the students' community, country, or the world. It should not have a pre-defined or easy solution. The best PBL opportunities allow the students to contribute to solve a real problem and help others.

**Learning should be student-centered.** Your students should have the freedom to make their own decisions about the project, their solutions, and their final products. You will present the problem and the parameters, but your students should drive the direction of their project and their solutions in light of the expectation.

**Incorporate reflection throughout the project.** Reflection is under-utilized in classrooms; when it is used, it is most often at the end of an assignment or unit. In PBL, reflection should be encouraged and used throughout the project. For every possible solution, your students should assess the benefits and drawbacks before moving forward.

**Solutions should be continually critiqued and reviewed.** Student presentation of the final solution is critical. Your role is to facilitate the presentation and provide feedback. Judge the solution, not the student. Use formative performance assessments to provide feedback. Help your students to view feedback as a positive tool for learning and making revisions to their solutions based on your feedback. Give students the opportunity to provide feedback to one another, too. Make it clear that student feedback is just as valuable as teacher feedback and should be taken seriously.

### Teacher Reflection 12

Do you already use PBL in your classroom? If so, what was the most challenging part of PBL for you? If not, what do you think will be the most challenging part of PBL implementation?