THE ESSENTIAL GUIDE TO PROJECT-BASED LEARNING:
AN EASY-TO-USE TOOL FOR CLASSROOM SUCCESS

Ellen Egley, Education Content Manager
STEM Jobs
The Essential Guide to Project-Based Learning
An Easy-to-Use Tool for Classroom Success
From your friends at STEM Jobs

We have heard from so many teachers who want to get away from “stand-and-deliver” instruction and create more student-centered classrooms - but don’t know where to start. We know that the vast majority of teachers care deeply about their students and want to create engaging lessons that inspire students and boost their creativity and problem-solving skills...they just need support to achieve that goal. That’s why we created this guide: to empower teachers to take the leap from traditional teacher-led instruction to student-centered activities with confidence and purpose.

We will start by defining project-based learning, discuss the benefits of this instructional practice, outline an implementation plan for your classroom, and close with some examples of project-based learning activities you can start using today. We sincerely hope that you find this information to be useful, and encourage you to share your successes and challenges with us online at edu.stemjobs.com or via e-mail at info@stemjobs.com.
What is project-based learning?

Project-based learning is an instructional strategy that changes the role of the teacher from fount of all knowledge to guide of student discovery. Project-based learning uses student-centered activities focused around solving real-world problems to integrate learning, help students make connections, and allow students to direct their own learning.

Students are assigned a task and are encouraged to work together to find a solution to a problem, create a product, or even design something that meets a specific need in the real world. Teachers guide students to appropriate resources, ask intentional questions to expand students’ ideas, encourage meaningful and productive struggle, and answer questions as students work through the task. Teachers do not give students the solution, limit them to one correct answer, or do the work for them.

Why is project-based learning important?

While worksheets certainly have their place in helping students practice specific skills, they do a poor job of helping students make connections between the different skills they have learned throughout the year. Many teachers think that “engaged students” are the ones making eye contact, taking notes, and raising their hands to answer questions frequently. These kids may be “good” students, but they are often just absorbing and regurgitating knowledge without internalizing it, relating it to other things they have already learned, or synthesizing it with their own ideas.

When completing project-based learning activities, students are required to pull from their personal experiences and prior knowledge to be successful. Students come to the task with different backgrounds and abilities, then rely on each other’s strengths and ideas to reach the goal of the activity. Project-based learning is an approach that allows for extreme differentiation, as students are able to find their own entry point for the task. This results in all students of all ability levels contributing to the group in meaningful ways.
This teaching strategy also helps develop students’ soft skills - those hard-to-measure skills like problem solving, critical thinking, communication, collaboration, creativity, and data analysis - that are required for 21st-century learners and future members of the workforce. We have never seen a worksheet that effectively develops soft skills.

- To become good problem solvers, students have to be given opportunities to solve authentic problems - not just word problems in math class.
- To begin to think critically, students must be given the chance to create something, reflect upon what they’ve done, hone it, make improvements, and start over when necessary. They also need situations in which they are able to hear other people’s ideas, share their own, and analyze which will contribute to the success of the project.
- To communicate effectively, students must be given regular opportunities to communicate informally with peers as well as delivering formal presentations. Project-based learning provides both - students must communicate their own ideas clearly within their group, then formally present their design or project to the rest of the class in a polished, concise way.
- To become effective collaborators, students must be given projects that require them to rely on the strengths, ideas, and abilities of others to make their project or design better. Too often, “group work” consists of one student doing all of the work to ensure a good grade while the other members sit back and watch them go. When properly implemented, students will want to contribute to the project, not just because of the grade at the end, but because the project itself is engaging and worthy of their attention.
- To develop creativity, students must be given the chance to think for themselves and see their ideas through to fruition. They cannot be treated like sponges who are filled with knowledge and then wrung out to get a good grade on a test, leaving an empty husk ready to be filled with facts from the next chapter in the textbook. They need to internalize their learning, connect it to their own personal experiences, construct true knowledge for themselves, and express that knowledge in a meaningful way that does not involve a number two pencil.
- To effectively analyze data, students cannot simply memorize formulas for mean, median, and mode and call it a day. Teachers need to provide them with situations in which they have to differentiate useful data from useless data, delineate correlation and causation, and glean actual meaning from a data set, then apply it to a real-world situation.

In project-based learning, there is also no single correct path to the correct answer, which many students find liberating and engaging. Realizing that the formula they learned last week isn’t the only thing they need to be successful on this week’s project can initially be jarring for students, but it encourages them to actually retain what they’ve learned in previous chapters, units, and even grade levels. Through project-based learning, many students stop seeing math and some of the sciences as a set of formulas, rules, laws, theorems, and postulates to memorize and apply, and start seeing them as beautiful subjects that are related, dynamic, and engaging. They begin to see how different concepts are connected and build off of one another. Too often, math is perceived as a series of instructions that must be followed, and allowing students to find their own path to the answer can drastically change that perception.
Unfortunately, this deviation from the “my way or the highway” methodology of many teachers can be intimidating for both green and seasoned educators alike. That teacher’s manual with its correct answers, scripts, and thorough explanations is a great source of comfort and confidence, and some teachers feel lost without it when they begin implementing project-based learning. To overcome the separation anxiety caused by putting down your answer key, first take a deep breath and let go of the misconception that to be a good teacher you must have all the answers. There is something extremely liberating about saying “I don’t know” to a group of students - and then setting out to find the answer together. Model lifelong learning for your students by showing them there are things out there - even within your own subject matter - that you don’t know yet, and that’s okay. As long as you take the next step and show your students a way to find the answer to their question, it becomes a learning experience for both of you. If you find yourself struggling with the idea of not having all of the answers, dedicate some extra time during the planning phase of each activity to the research and exploration of tertiary information. Try to anticipate some of your students’ questions and come prepared with at least a basic understanding of those answers.
How can I implement project-based learning in my own classroom?

Start small.
Students who are used to direct instruction may initially struggle with the independent thinking required to complete project-based learning tasks. They have become passive learners and rely on you to do the heavy lifting. Being an active learner requires some mental strength, so start out small to help them build their mental muscles.

As a teacher, trying to jump in and change every moment of every class period to use project-based learning can leave you feeling overwhelmed and ineffective. This instructional strategy requires less lecturing and more planning, so get ready for a shift in the way you prepare your lessons. Set reasonable goals and consider this adopting this timeline:

- Choose one 15-minute activity to conduct each week for the first month.
- In the second month, choose one class-length activity to implement, and continue to do a 15-minute activity each of the remaining weeks.
- In the third month, choose an activity that requires a few class periods to complete, while continuing to execute shorter activities the remainder of the month.
- In the following months, continue to implement both short and class-length activities.

Partner with colleagues from other departments (art, social studies, economics, etc.) to create a cross-curricular activities that take a week or so to complete.

Ask for help.

You don’t have to reinvent the wheel to start using project-based learning in your classroom. Lean on the experience and expertise of others who have been using project-based learning successfully in their own classrooms, whether they exist within your building, district, professional organizations, or even in online groups. Establishing a strong support network is necessary for any teacher, but it becomes even more important for those who are willing to try new techniques and step out of their comfort zones. Teachers are some of the most generous people in the world, so find other teachers you respect and reach out to them - chances are good that they will be willing to share their insight and successes with you.

Project-based learning also requires more resources to implement, so get parents and community organizations involved to donate supplies (nothing complicated is typically necessary - you’d be amazed what you can make with paper towel rolls and pipe cleaners!). Invite those same parents and community members to come into your classroom and sponsor a group’s project or be on the discussion or judging panel on presentation day. They will be happy to be involved in your students’ education, and your students will benefit from the networking experience and exposure to others’ ideas.
Make time for reflection.

Project-based learning can be ineffective unless there is time to break down and reflect on the project. The activity is not over when the last presentation ends! Skipping this step will leave you feeling like you have no idea what your students learned and students unsure of whether they got everything out of the activity they were supposed to.

For teachers, reflecting on a project after its completion is an important step that is often overlooked. Think about whether all students were engaged, which parts they struggled with, the role you played (dictator, facilitator, resource, etc.), classroom management issues you encountered, and the assessment method used. Did things go to plan? What went well? What happened that you did not expect? What would you do differently if you had a chance to do the lesson again? Did the assessment show that students learned what you wanted them to learn? What did students learn that you did not expect? Answering these questions after every project-based learning activity will help you grow as an educator, gain confidence in this new teaching strategy, and decide whether students are ready to move on to the next activity or lesson.

For students, reflecting on a project after its completion will help synthesize their learning and aid retention. Ask guiding questions to bring specific concepts to the surface and help students focus on the key ideas of the project. Have them reflect on the process itself - what went well, what they would do differently in the future, etc. A project journal can be a great tool to introduce with your first project-based learning activity, as it will help formalize the reflection process and allow students to see their own growth over time.
Examples of Project-Based Learning Activities

The Internet has made finding high-quality, easy-to-implement activities easier than ever before - but beware the poorly structured or impractical ideas touted by some websites. Quality project-based learning activities should address a real-world problem, be engaging for students, provide realistic tasks (avoid anything that suggests you build a wind tunnel on the roof of your school or purchase unsafe chemicals online), and be aligned to appropriate standards. The best activities will cross disciplines and challenge students to pull from different content areas to be successful - providing you with great opportunities to collaborate with faculty in different departments!

Here are some examples to get your own creative wheels turning:

**Short Activities**

**Challenge students to solve a math problem in more than one way.**

Once they’re done, have students share their methods and put every successful path to a solution on the board. Survey the class to find out how many students utilized each method and explain their reasoning. If you want, you can award small prizes (homework pass, bonus point, lollipop, round of applause - whatever will resonate with your students!) for the most creative or most visual method. There isn’t necessarily a “project” involved here, but fostering flexible thinking and breaking the “absorb and regurgitate” cycle will go a long way to prepare them for more difficult tasks in the coming months.

**Improve an existing product.**

Have students pick a product that they use often and identify the most frustrating part of its user experience. What changes would they make to fix the problem and what other issues might their “fix” create in the process? Again, students aren’t being asked to create yet, but you’re making progress in the creativity and critical thinking departments.

**Suggest an energy solution.**

Providing sustainable energy to our power-hungry citizenry is no simple task. Break students into groups and assign each group an energy-producing method (nuclear, solar, wind, hydro, tidal, wave, etc.) to research. Groups will then prepare and present the pros and cons of their method to the rest of the class, and the class will vote on the best method. If presentations are made using poster board or tri-folds, display the projects in a public area of the building so other students can see them. Extend the activity by taking a virtual tour of one of the facilities or setting up a Q&A video conference between your class and someone who runs or works at a local power plant.
Multi-Class Activities

Design a game.
Put students into groups and guide them as they build an original board, dice, or card game. Students will gain collaboration and organizational skills while applying probability concepts in a fun, engaging way. Add some creativity by having groups create marketing materials (think posters or short commercials) to promote their games to the rest of the class. Allow groups to play each other’s games and provide feedback about unclear directions or unforeseen complications that arise through gameplay.

Create a location-based game.
Bring a Cartesian-plane version of geocaching to your classroom by having students place a coordinate grid over a map of your building or campus and guiding their peers from one destination to another through clues that involve linear, quadratic, or exponential functions (whatever is appropriate for your grade level). Students should try to follow their own clues before exchanging with another group. Another fun, creative way to connect an abstract idea to the real world.

Build a solar oven.
This one may sound intimidating, but the main materials are pizza boxes and thermometers. Place students into groups and design their own solar ovens that capture the heat of the sun to perform a simple task, like melting cheese on nachos. Once the prototypes are complete, head into the sunshine and test them out to see which design is the most efficient - then enjoy some tasty nachos with your budding engineers.

Cost engineer a bridge.
We’ve all heard of students using balsa wood to try to create the strongest, lightest bridge design possible. This activity infuses a lot more real-world math by assigning every resource available to students a price - including their time. Give each building material a cost and decide how much each hour of your groups’ time is worth. Split students into groups, and make one student in each group responsible for accurately tracking how much they spend during the design, build, and testing phases of the project. When students present their final projects, they are competing to see who created the strongest bridge while effectively managing costs - just like in the real world.

There are also free lesson plans available at edu.stemjobs.com/lesson-plans that explore what a day in the life of a STEM professional is like. We even include the magazine article that the lesson connects to in the free PDF, so your students can read a fun interview with the professional before tackling the activity in your classroom.

Obviously there are a plethora of other ideas out there, so don’t allow yourself to feel limited to the ones we shared here! Find out what your students are passionate about and tailor a project to their interests. Reach across the hall and brainstorm with your colleagues. Contact local community members who work in STEM fields and have them come into your classroom to talk about what they do - then build your own PBL activity based on their duties.
Project-based learning can be intimidating at first, but the rewards are great for both you and your students. Follow our tips to make a smooth transition, but be open to the unexpected.

Learning is a journey, not a destination, so enjoy the ride with your students - even if you hit a bump in the road. Prepare to be amazed by what they - and you - are capable of.

More subject-specific resources can be found at the following links:

Middle School Science: http://edu.stemjobs.com/how-to-implement-project-based-learning-in-your-middle-school-science-classroom/


Economics: http://edu.stemjobs.com/project-based-learning-in-your-economics-classroom/

Author: Ellen Egley, Education Content Manager, STEM Jobs
Contributing Editor: Glen Zollman, VP STEM Jobs