Gordon Davis

STEAM: INNOVATION LAB

The building of an Innovation Lab

ABSTRACT

STEAM - Innovation Lab

- What Does It Look Like
- Solving Relevant Problems
- Professional Development
- Time
- Space
- Practice

We are all familiar with the adage "give a man a fish and you feed him for a day; teach a man to fish and you feed him for a lifetime." Too often we are feeding our students instead of teaching them how to feed themselves. The disciplines that do that best are STEM-related.

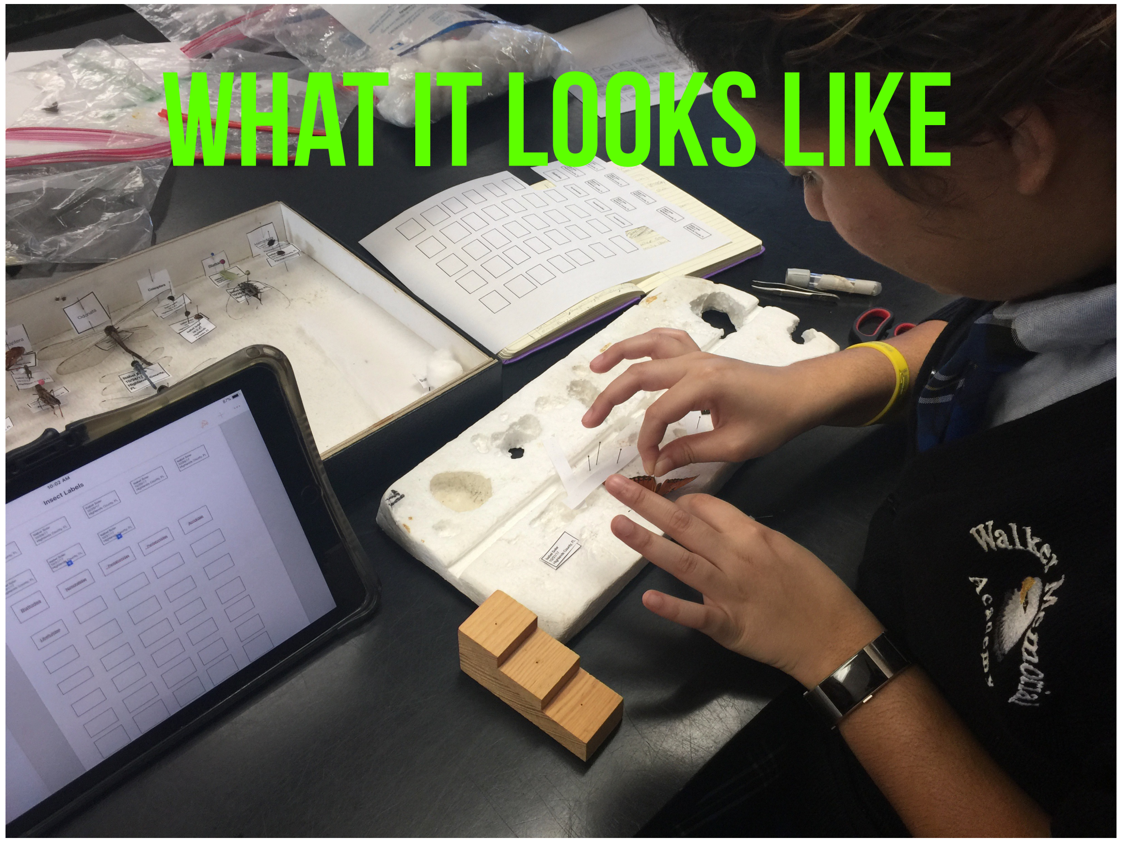
The activities are noisy, lots of movement, talking, asking questions, and of course - student engagement.

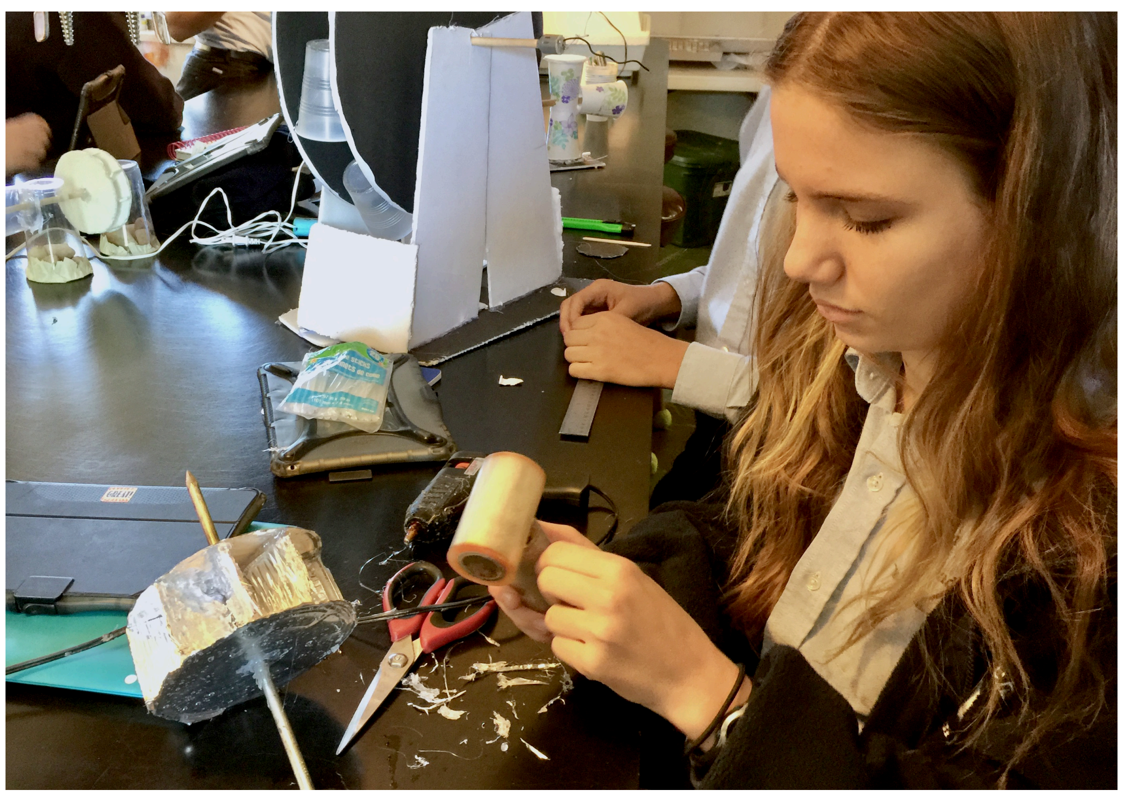
Facilitators are involved with the students, assisting, mentoring, probing, asking questions, giving guidance and of course - engagement.

Schedules are flexible to allow for large blocks of time for the participants to experience the exploration of the development and completion of the project.

Teachers are provided with time for collaboration with others to implement effective strategies within the school day. Professional development is encouraged from outside organizations to enhance educational growth.

The facilities are more-than adequate to accommodate the various practices students will employ in doing their projects.





If you're a new STEM teacher you may be wondering: "What should my STEM class look like? What should my students be doing?" If you're a veteran STEM teacher perhaps you are asking yourself: "How are my STEM classes coming along? What does an action-packed STEM class look like?"

Take a look at these things that may be going on in class during a STEM project. Keep in mind that all of these things won't be happening at the same time. Over the course of the STEM project, however, here's a sampling of things you should notice. And if you see these activities underway . . . Newsflash! You might have a STEM classroom!

Indicators of an Engaging STEM Classroom:

1. **The kids are awake in this class.** STEM classes feature student-centered activities that interest students. They aren't likely to get sleepy when they're involved in a project-based lesson that asks them to solve a real-world problem. They are up and moving as they gather materials, plan, construct, and test prototypes.
2. **Noise is welcomed and normal.** Kids are busy throwing out ideas for solving the problem. They're discussing and challenging each other's ideas. They communicate with fellow team members as they figure out how to design a solution for the challenge.
3. **Kids are working successfully in teams.** STEM kids don't sit in straight rows and listen, they work together in small teams. They follow a set of teaming tips to build social skills and team successfully, and they regularly self-assess their teamwork.
4. **Kids are in the driver's seat in this project.** They have control of their learning. STEM teams take responsibility for developing their own solutions for their engineering challenge. Kids are up and doing things – brainstorming, designing, creating, experimenting, and redoing. This is an action-packed class.
5. **Adults are wandering around in STEM class.** One might be a parent. Another could be an engineer from a local industry. (How important would that make your kids feel?) These adults have specific tasks and know ahead of time what their roles will be in the classroom. They act as a resource, and they observe, encourage, and ask questions to help kids figure out answers and solutions. The teacher also rotates to different teams of kids and provides guidance as needed.
6. **Kids are using digital technology.** They are researching information, entering data, and even illustrating results of their experiments on digital devices. They may be designing graphics for their prototypes, working on a project webpage, coding, and so on. And they may also be using non-digital technologies such as science equipment, math manipulatives, and other things created to meet learning needs.
7. **Girls are as actively involved as boys.** Girls rock in this STEM class! They come up with creative ideas, work well in teams, and stay engaged. Girls play leading roles in the STEM project. This STEM class is positioned to break traditional gender roles.
8. **Kids can explain how they are using science and math**. They see a purpose for the math and science they have studied this year as they use it in their STEM project. More importantly, they actually combine these subjects in order to solve the problem. No STEM learning in isolation!
9. **The classroom is a Safe Zone.** In STEM classes kids don't get upset when their prototypes don't work to solve the problem. Instead, they start redesigning to improve them. The teacher is positive and encouraging, and failure is not an issue. In fact, it's the way they learn to make progress.
10. **Kids mimic engineers.** They purposefully use a way of thinking that engineers use to solve problems (an engineering design process). Students demonstrate curiosity, innovation, entrepreneurship, and creativity. A STEM engineering challenge has more than one possible solution, and different teams are taking different approaches.
11. **Kids are effective communicators.** They use a variety of approaches – art, drama, speech, etc. – to describe their challenge and justify their results and/or recommendations.

What's more empowering than creating solutions to real-world issues? When students learn about local and global issues and then try to come up with possible solutions, they become independent thinkers and change makers. Whether they are designing a safer playground or building tools to address sustainability and food insecurity, their investment in the learning process often skyrockets.

Real problems provide rich learning opportunities since students must conduct research, hypothesize, create, test, analyze, revise, and synthesize. A great STEAM program brings the outside world into the classroom and challenges students to think critically, benefitting them as learners and as future professionals.

Here are some engaging projects that get your students thinking about how to solve real-world problems.

Preventing soil erosion
In this project, meant for sixth – 12th grade, students learn to build a seawall to protest a coastline from erosion, calculating wave energy to determine the best materials for the job. See the project.

Growing food during a flood
A natural disaster that often devastates communities, floods can make it difficult to grow food. In this project, students explore "a problem faced by farmers in Bangladesh and how to grow food even when the land floods." See the project.

Solving a city's design needs
Get your middle or high school students involved in some urban planning. Students can identify a city's issues, relating to things like transportation, the environment, or overcrowding — and design solutions. See the project here or this Lego version for younger learners.

Creating clean water
Too many areas of the world — including cities in our own country — do not have access to clean water. In this STEM project, teens will learn how to build and test their own water filtration systems. See the project here.

Improving the lives of those with disabilities
How can someone with crutches or a wheelchair carry what they need? Through some crafty designs! This project encourages middle school students to think creatively and to participate in civic engagement. See the project here.

Cleaning up an oil spill
We've all seen images of beaches and wildlife covered in oil after a disastrous spill. This project gets elementary to middle school students designing and testing oil spill clean-up kits. See the project here.

Building earthquake-resistant structures
With the ever-increasing amount of devastating earthquakes around the world, this project solves some major problems. Elementary students can learn to create earthquake resistant structures in their classroom. See the project here.

Constructing solar ovens
In remote places or impoverished areas, it's possible to make solar ovens to safely cook food. In this project, elementary students construct solar ovens to learn all about how they work and their environmental and societal impact. See the project here.

PROFESSIONAL DEVELOPMENT

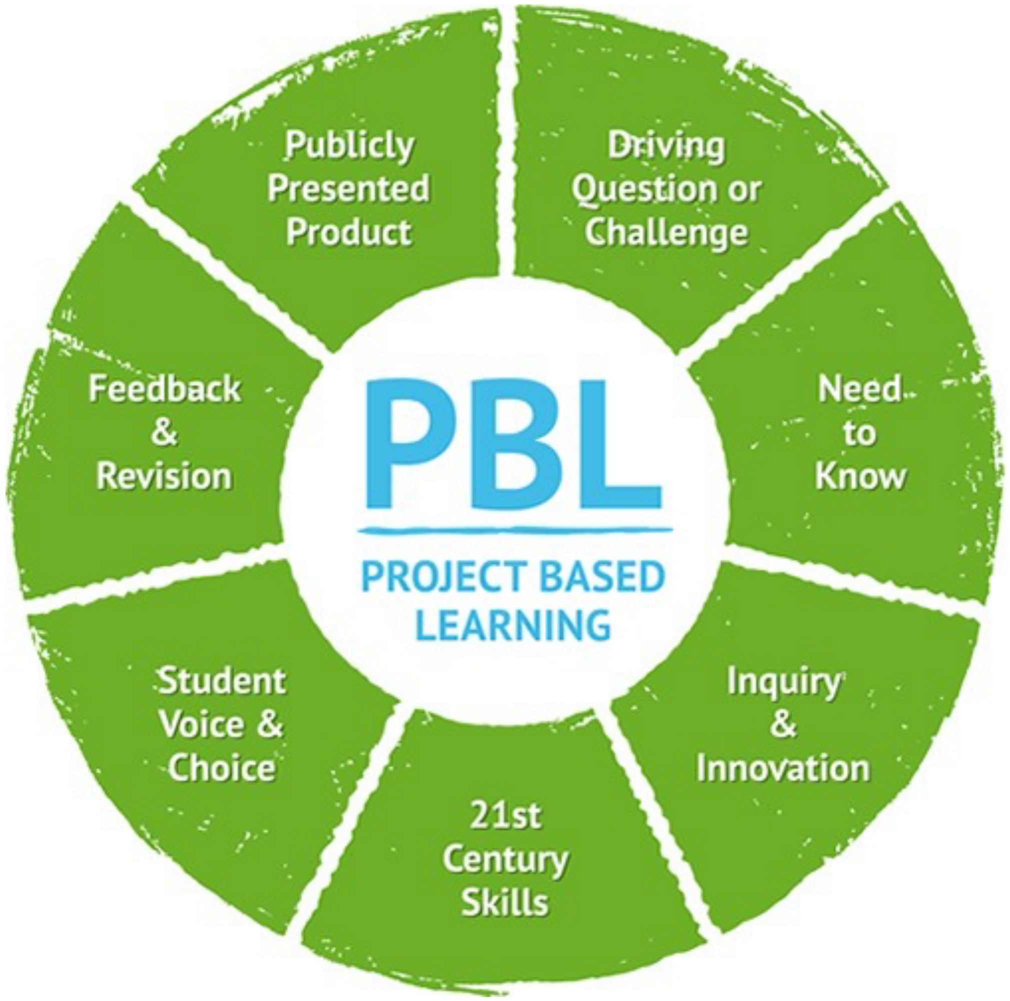
NSTA
National Science Teachers Association

Quality Teacher Support

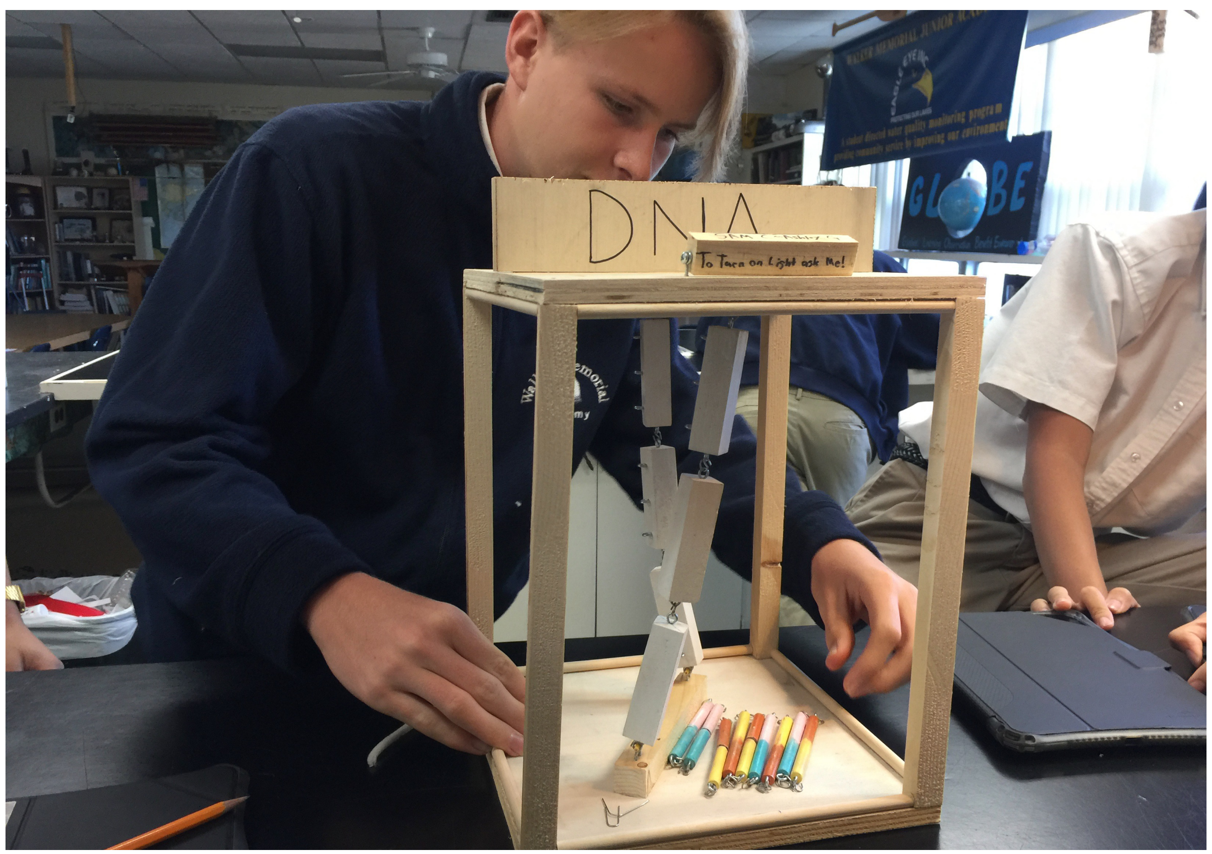
Whether your school holds ambitious dreams of fully integrating STEAM across all courses or simply creating STEAM learning opportunities wherever possible, the focus should be on ensuring that all students are exposed to the benefits of STEAM. But that can only be accomplished if teachers are given the resources and support that they need.

Making science, technology, engineering, and math more visual and creative leads students to see connections and expand their thinking vs. compartmentalizing each subject. It also shows students how versatile and valuable the arts are, and the many ways in which artistic skills are utilized in different technical professions. Developing STEAM projects requires much more thought. A great STEAM program must include the needed STEAM training to support teachers in seeing the possibilities of true STEAM integration.

Regardless of what your program's integration goals are, a successful STEAM program includes dedicated time for educators to tinker and collaborate on a regular basis. Through this devoted collaboration time, you'll often find that enthusiastic educators seem to spread innovation. Quality teacher support empowers those educators to inspire the whole team by building in designated times where they can develop programmatic goals, collaborate, share resources, and discuss challenges and progress made.



BIE
BUCK INSTITUTE FOR EDUCATION



Time to Explore, Design, Build, Iterate and Presentation

In our increasingly project-based world, there is a greater degree of recognition that content isn't learned or consumed in isolation. Ideally, learning is interdisciplinary and connected. Time constraints and stringent schedules can get in the way when thinking about how to create innovative ideas and divergent thinking. The Carnegie Unit, while still in full-force in many institutions, is starting to hold less and less weight and the focus is more on competencies.

1. Work Sessions. Big chunks of time wherein students can work on interdisciplinary projects are crucial. Even if working within a seven- or eight-period day, find ways to combine time when possible and allow for extended work sessions. If the day becomes too truncated, many complain that the effect is a "shopping mall high school" where students don't work on rigorous tasks due to the lack of concentrated and focused time. The constant transition between classes results in a loss of instructional time. One good example we've seen is Reynoldsburg High School, which has two facilities and four academies including eSTEM featuring triple blocks on big topics like Energy, Environment and the Economy.

2. Less Rigidity. Even if the school isn't operating under a block schedule or it doesn't have big chunks of student work time, the bell cannot be an inhibitor to student creativity. Schools ought to try to find ways to encourage students to persist when they are in the middle of a task or challenge and not penalize them for being late to another in those circumstances. This is particularly important for students who may need that extra time to grapple with ideas or master concepts. At Thrive Public Schools, a charter network with an elementary and middle school, Wednesdays are "completely flexible based on community and student needs. These days also end at 1:30 to provide teachers more professional collaboration time."

3. Time for Multi-Use Spaces. Maker-spaces, labs and playgrounds are becoming commonplace in schools that intend to create innovative and dynamic thinkers that are prepared for 21st-century life and jobs. Often, spaces that house powertools, 3-d printers or even just the latest computers are not omnipresent throughout a school and are located in 2-3 rooms. These learning spaces need to be used freely and frequently. If a student is working on designing an app, but "computer lab time" isn't until next week, inevitably their thought process is stunted. Schedules that promote active learning ensure that multi-use spaces are used often and are seen as places that students can go to when it makes sense in their respective projects or assignments–not "only when it fits in the schedule."
For our final point, perhaps most importantly…. (drumroll please) ADVISORY!

4. Advisory.. Advisory is key to personalizing the secondary experience for students. By the time students get to middle school, many already feel that they don't have a true course or path, nor do they have the support to help them find and navigate their way–enter strong advisory. Unlike counseling and advisory, the last two years of high school are to help you determine whether college or heading straight into work is the right choice. Advisory today includes a lot more. Advisory entails things like coaching on projects and teamwork or helping students get that extra 20 minutes of one-on-one instruction they need. Beth Brodie of Partnership for Change notes that a key function of the advisor is to ensure that every student has someone "who knows them well and supports them at school meetings and conferences.

A Space for Making

A makerspace is not solely a science lab, woodshop, computer lab or art room, but it may contain elements found in all of these familiar spaces. Therefore, it must be designed to accommodate a wide range of activities, tools and materials. Diversity and cross-pollination of activities are critical to the design, making and exploration process, and they are what set makerspaces and STEAM labs apart from single-use spaces. A possible range of activities might include:

- Cardboard construction
- Prototyping
- Woodworking
- Electronics
- Robotics
- Digital fabrication
- Building bicycles and kinetic machines
- Textiles and sewing

Designing a space to accommodate such a wide range of activities is a challenging process. Educators and administrators can help guide the process and generate the space that works best by researching, brainstorming and clearly articulating their needs, while keeping in mind inevitable changes in the future.

Some schools have chosen to incorporate makerspaces within multiple classroom spaces. This works well for many activities, particularly in elementary schools. As maker activities expand to require more tools, it makes more sense to create a dedicated makerspace that includes appropriate tools, work areas and materials.

Practices In the STEAM Innovation Lab

Relevant Problem Solving

Students must have the opportunity to learn and practice different skills in order to choose which ones to apply In designing the solution.

- Welding
- Woodworking
- Electronics
- Computer Coding
- Machine shop
- Cooking/Baking
- Sewing
- Video/Audio
- Photography
- Glass blowing
- Blacksmithing
- Auto Mechanics and Body Shop
- Fabrication
- Painting
- Ceramics
- Sculpturing
- Hydroponics
- Aquaponics
- Gardening
- Greenhouse

STEAM: A TIME A SPACE TO MAKE

All photos by Gordon Davis

Resources

- https://www.nextgenscience.org
- https://www.nsta.org
- https://www.engineeringforkids.com/about/news/2016/february/why-is-stem-education-so-important-/
- https://www.steampoweredfamily.com/education/what-is-stem/
- https://dschool.stanford.edu
- https://www.sfbrightworks.org
- https://www.hightechhigh.org
- https://www.davincischools.org
- https://www.pblworks.org
- https://www.edutopia.org
- https://stem.org