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*Project Lead The Way
White Paper*

PLTW
PROJECT LEAD THE WAY

The Cornerstone of Transforming Teaching and Learning

Activity-, Project-, Problem-Based Instructional Approach

Project Lead The Way has transformed traditional, teacher-led classrooms into collaborative spaces where students solve problems, think creatively, and apply their learning in real-world contexts. At the foundation of these hands-on learning experiences is PLTW's activity-, project-, problem-based (APB) instructional approach.

The APB approach helps students become active and engaged learners by creating student-centered learning experiences in which teachers act as facilitators, rather than lecturers. In this environment, students begin to lead their own discovery as they work through hands-on activities, projects, and problems that become increasingly open-ended as they progress through the curriculum and more challenging as they advance to higher grades.

Activities

Activities empower students to develop knowledge and skills they'll use to navigate a real-world project and problem. Activities are structured, hands-on learning experiences.

Projects

Projects help students explore a real-world challenge and make meaningful connections. Students draw on the preparation provided in the previous activities to identify and propose solutions.

Problems

Problems challenge students to apply what they've learned through the activities and projects. They reflect real-world challenges and are open-ended, with no one "right" answer.

The APB approach not only makes learning more relevant, but also empowers students to develop both technical and in-demand skills that are valuable and transportable across all industries. These skills — including problem solving, critical and creative thinking, collaboration, communication, and ethical reasoning — are critical to students' success later in life and are proven to be the most demanded and valued in the job market.[i]

This paper examines how the APB approach works, its impact on students, and what it looks like in the classroom. It also offers recommendations on how schools can harness the APB approach to transform their classrooms, empower students and teachers, and extend the learning experience beyond the walls of the classroom and school.

> **[APB] learning is well-suited to helping students become active learners, because it situates learning in real-world problems and makes students responsible for their learning.**
>
> **Hmelo-Silver, 2004**

How the APB Approach Works

Teachers set the stage at the beginning of each APB series by introducing students to the final problem they'll be challenged to solve. Then, students engage in a sequence of related hands-on activities and projects that build upon each other and become increasingly more open-ended. Throughout this process, students work together in teams to find solutions and develop new skills and knowledge. Finally, students apply what they've learned to find and propose solutions to the open-ended, real-world problem introduced at the outset of the APB.

Activities	Project(s)	Problem
Knowledge & Skill Acquisition	Meaning Making & Investigation	Application & Transfer

Well-Defined ⟷ Open-Ended

Essential features of the APB approach include student-centered learning, the teacher in the role of facilitator, collaborative learning experiences, application of learning to solve problems, meaningful feedback and assessment, and a scaffold of learning experiences across the APB series.

- **Student-centered learning:** This type of environment allows for students to share in the decision-making process, own their learning, and see the relevance of the subject.

- **Teacher as facilitator:** Rather than lecturers at the front of a classroom, teachers are trained as expert facilitators – or coaches – who guide outcomes by establishing an environment conducive to inquiry, creativity, and deeper learning.

- **Collaborative learning experiences:** Collaborative learning experiences promote problem-solving and critical-thinking skills by allowing students to "exercise, verify, solidify, and improve their mental models through discussions and information sharing."[ii]

- **Application of learning to solve problems:** Students apply the knowledge and skills they've gained through the activities and projects to solve open-ended problems.

- **Meaningful feedback and assessment:** Formative and summative assessments help students understand what they are doing well and what they need help with, and give teachers the information they need to guide each student.

- **Scaffold of learning experiences:** Supportive activities and projects, combined with guidance provided by the teacher, empower students to progressively build knowledge and skills to apply to solving an open-ended problem without much guidance.

This approach offers students opportunities to *learn by doing* – a research-backed philosophy that has guided problem-based learning for decades.[iii] In this setting, students are not passive recipients of knowledge, but rather, they are "actively gathering information, making observations, formulating questions, and then creating new ideas or solutions to answer their own inquiries. Critical thinking is embedded throughout the process."[iv]

Rooted in Research: How PLTW Develops APBs

Using research as a guide, PLTW develops APBs that are most effective for student learning. The evidence-backed tools in PLTW's toolkit include the constructivist learning theory, backward-mapping strategies, and the inquiry methodology. Drawing upon these tools and others, PLTW creates hands-on APBs that empower students to build and practice relevant skills.

THE CONSTRUCTIVIST LEARNING THEORY

Because knowledge is built over time and through hands-on experiences – not through teacher lectures or textbooks – PLTW applies constructivist principles as it develops APBs. Constructivist learning goals[v] include:

- Reasoning
- Critical thinking
- Retention, understanding, and use
- Cognitive flexibility
- Self-regulation
- Mindful reflection

Each of these learning goals can be observed throughout PLTW's activities, projects, and problems.

Activities empower students to gain foundational knowledge by reasoning, observing, and thinking critically about the skills they're learning. PLTW designs activities to help students retain knowledge, which is accomplished by fostering collaborative learning and reflection.

Projects give students the opportunity to reason and think critically as part of a team, as well as a chance to assimilate knowledge and skills as they make application to a realistic situation. PLTW designs projects to allow for deeper understanding of the content.

Finally, problems create a situation in which students must employ many skills, including reasoning, critical thinking, self-regulation, and metacognition – or thinking about their own thinking – to tackle a relevant challenge. Problems are complex and ill-structured; they are designed to make students question what they know and what they don't yet know.

This is when teachers are most likely to hear PLTW students exclaim, "I have an idea! Let's try this!" And when their ideas don't work out, that's when students learn to navigate through failed attempts. In these cases, students are challenged to reassess the situation, adjust their perspective, and try again using what they've learned.

PLTW applies the constructivist learning theory, backward-mapping strategies, and the inquiry methodology when developing APBs.

BACKWARD-MAPPING STRATEGIES

PLTW designs student learning with the end goal in mind: empowering students to thrive in an evolving world. With research as a guide, PLTW works backward by envisioning what students should ultimately be able to accomplish, and from there, building progressions of student learning.[vi]

First, PLTW curriculum experts conceptualize the ultimate problem. Then, they map a scaffolded learning experience of activities and projects that prepares students to develop what they need to know to tackle the problem. Throughout, PLTW's experts use a structured design process that weaves relevant standards and in-demand, transportable skills into a compelling sequence of learning experiences — an approach that makes the PLTW classroom unique. In other words, PLTW's APB sequences empower students to start at an entry level, and as they build relevant skills, they're able to transfer their learning to a whole new level.

THE INQUIRY METHODOLOGY

The APB approach also uses characteristics of inquiry-based learning as students engage in scientific and engineering practices to discover answers to questions or problems. In PTLW curriculum, the inquiry method is employed as students investigate the world around them, searching for explanations of natural phenomena or exploring ideas that lead to designing an effective solution to a problem.

An inquiry approach calls for active classrooms in which students learn by doing.

Whether addressing a scientific or engineering problem, students develop and implement the following[vii] practices:

- Ask questions (for science) and define problems (for engineering)
- Develop and use models
- Plan and carry out investigations
- Analyze and interpret data
- Use mathematics and computational thinking
- Construct explanations (for science) and design solutions (for engineering)
- Engage in argument based on evidence
- Obtain, evaluate, and communicate information

Inquiry-based learning finds its roots in constructivism, which calls for students to construct knowledge as they move through the learning process. Through this approach, students engage in teamwork as they work to reach decisions together through the sharing of knowledge.

The inquiry-based methodology leads to students' ability to "(1) formulate their own hypothesis to explain the event(s) or solve the problem(s); (2) collect data to test the hypothesis; (3) describe the conclusions; and (4) reflect new problems and think about any problem-solving process".[viii]

> "
> I think it puts our kids at a huge advantage. To me, the PLTW program is something I can tangibly hold up to our faculty, community, and board and say, 'Here's a great example of what we want [learning] to look like.' It's not just content, but the skills.

**Scott Beck,
Principal, Norman High School**

Impact of the APB Approach

The APB approach empowers students to own their learning, provides appropriate scaffolding, and prepares students to tackle real-world challenges.

1   Student Ownership

Students who own their learning are not passive spectators of their education, but rather active and engaged learners who can articulate what they don't know and what they still need to learn.[ix] To support student ownership of learning, PLTW designs student-centered learning experiences in which teachers act as coaches, rather than lecturers. In this facilitator role, teachers provide feedback and model good problem-solving strategies like following a design process. PLTW teachers also help students find solutions themselves by asking questions to drive student inquiry and exploration.

2   Scaffolding

Evidence suggests that when problems are posed with appropriate scaffolding, students are able to achieve higher levels of problem solving than they would otherwise.[x] With scaffolding, students are empowered to develop the skills, mindset, and toolbox they need to navigate a problem. Through PLTW's approach to this instructional technique, its programs are designed with scaffolding that helps students to think deeply, apply their learning, and overcome challenges. The APB approach targets the appropriate zone of proximal development – also known as the "sweet spot" of learning. By creating an environment in which learning is not too challenging, not too easy, but at just the right level of difficulty when given the right supports, students thrive.

3 Relevance

PLTW's APB approach gives students the opportunity to demonstrate evidence of their learning as they find solutions to open-ended, real-world problems. When immersed in such experiences, students learn both content and thinking strategies[xi], building knowledge, skills, and understandings they can apply to unique situations, rather than simply answering a question on a test. In other words, they're putting their learning into practice.

Posing a challenge that is relevant to the learner's world "effectively eliminate[s] the students' often-posed question, 'Why do we need to know this?'"[xii] As students are engaged in this approach to learning, they "must learn to be conscious of what information they already know about the problem, what information they need to know to solve the problem, and the strategies to use to solve the problem."[xiii]

As a result, "problem-based learning is well-suited to helping students become active learners, because it situates learning in real-world problems and makes students responsible for their learning."[xiv] Students "gain important knowledge, skills, and dispositions" as they work collaboratively to investigate open-ended questions.[xv] Additionally, a problem-based instructional approach can support students' development of transportable skills in research, reading, negotiation, teamwork, and written and oral communication.[xvi]

Notably, research has also found that "higher overall student ratings of [problem-based learning] predict science intrinsic motivation and ability beliefs, in turn predicting higher student interest in a future STEM career."[xvii] Similar connections were found with math intrinsic motivation or ability beliefs.

The APB Approach in Action

PLTW designs scaffolding that supports students' construction of knowledge and helps them reach new heights. Learn how PLTW uses the APB approach to scaffold student learning in classrooms across the PreK-12 spectrum:

- **Elementary School**
- **Middle School**
- **High School**

Elementary School
PLTW Launch
Matter: Floating and Sinking

Students develop an understanding of matter by examining solids and liquids through hands-on activities. They explore floating and sinking as they predict and observe what effect liquids have on different materials. Using the design process, students rely on their knowledge and skills of matter to sketch, build, test, and reflect on a design they have created that will float on water and keep items within the design dry.

Included in this PreK module's activities, projects, and problems:

Activity:	Explore Solid and Liquid Matter
Project:	Predict Floating and Sinking
Problem:	Build a Boat

ACTIVITY
Explore Solid and Liquid Matter
Students are introduced to matter through literature and whole-group discussion. They focus their exploration on two states of matter - solid and liquid. Students explore different solids and sort them based upon their texture. Students also go on a scavenger hunt to identify solid matter that has a specific texture.

PROJECT
Predict Floating and Sinking
Through a guided investigation, students explore floating and sinking. As they work through the investigation, they also predict and observe what effects liquids have on different materials and learn which materials float and which ones sink.

PROBLEM
Build a Boat
Students use the design process to sketch, build, test, and reflect on a model they create to float across water and keep a message dry.

Middle School
PLTW Gateway
Medical Detectives

Students play the role of real-life medical detectives as they collect and analyze medical data to diagnose disease. They solve medical mysteries through hands-on projects and labs, measure and interpret vital signs, dissect a sheep brain, investigate disease outbreaks, and explore how a breakdown within the human body can lead to dysfunction.

Included in this unit's activities, projects, and problems:

Activity:	Dissect a Sheep Brain
Project:	Create Educational Resources
Problem:	Locate the Source of an Outbreak

ACTIVITY
Dissect a Sheep Brain
Students create neuron models and perform a sheep brain dissection. They use their knowledge to explore symptoms as they relate to specific nervous system dysfunction and analyze evidence to identify the cause of the dysfunction.

PROJECT
Create Educational Resources
Students create educational resources to help their fictitious patient understand the medical condition.

PROBLEM
Locate the Source of an Outbreak
Students locate the source of a mysterious toxin that is endangering the health of a community. Students use a map of the community, patient histories, and lab data, then present their findings to help community leaders mitigate the outbreak situation.

High School
PLTW Computer Science
Cybersecurity

Students learn the technical aspects of a highly networked world and the risks to information we all share. They learn operating system and networking concepts, security frameworks, and packet analysis. They learn the types of malware that can attack systems on a network and how to secure and protect a system against them.

Included in this course's Unit 3 activities, projects, and problems:

Activity:	Command the OS
Project:	Find the Secrets
Problem:	Secure the Net

ACTIVITY
Command the OS
Students learn how an operating system organizes information using command line tools to manage and secure digital information. They learn about user and system processes and how malware spreads around a network.

PROJECT
Find the Secrets
Students perform a penetration test on a Linux-based operating system. They see evidence of an ongoing attack, find and remove unauthorized users, suspicious processes, and malicious files. They document their plan of action ahead of time and present their findings in a security update report.

PROBLEM
Secure the Net
Students are given an attack scenario and must identify the exploit, secure the system, and make improvements to prohibit future attacks.

Bring Learning to Life with the APB Approach

PLTW's APB approach has transformed the classroom experience for millions of students and thousands of educators across the country.

For students, it has brought learning to life by providing them opportunities to work collaboratively, identify problems, persevere through challenges, lead their own learning, and find unique solutions to real-world challenges. For educators, it has renewed their passion for teaching and brought excitement and enthusiasm back into their classrooms.

"The PLTW experience has completely changed my career. It's absolutely remarkable to see how engaged and excited the students are," says PLTW Master Teacher Sarah Schemanske. "The APB approach has been a huge benefit to my students, and by participating in the activities before getting to the projects and solving the problem, every student is able to have the same foundation. Every student is able to work from the same skill set. Every student walks away from the lesson feeling successful and feeling like they've really captured their learning and been able to apply what they've learned."

For schools and districts seeking to transform the classroom experience for their students and teachers, PLTW offers the following recommendations.

1 Choose the right experience.

Students need access to real-world, problem-based, applied learning experiences that empower them to become independent in the classroom and that transform them into active and engaged learners.

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> **The APB instructional approach presented the content to my students in a fun and captivating way, and neither they nor I wanted to stop!**
>
> **Whitney Smith,**
> **PLTW Launch Master Teacher**

By choosing a program that employs the APB approach, schools and districts can offer students the opportunity to demonstrate their creativity, overcome setbacks, build teamwork skills, work collaboratively to develop solutions to important real-world challenges, and more.

Such a program should:

- Support student ownership of learning;
- Offer appropriate scaffolding;
- Prepare students to tackle real-world challenges; and
- Provide teachers new tools and resources to engage and prepare their students.

2 Prepare your teachers to transform their classrooms.

A key component of the APB approach is providing students with the support they need to gradually build knowledge, skills, and independence over time. For the APB approach to be successful, it is "critically dependent on the instructor's scaffolding of students' active learning and knowledge construction".[xviii]

Teachers play an immeasurable role in the classroom, and professional development should provide them with the training, resources, and support they need to apply the APB approach and engage students in relevant, true-to-life learning.

Professional development experiences should:

- Help teachers build confidence to transform their classrooms with the APB instructional approach;
- Offer options and flexibility to meet teachers' varied backgrounds and learning styles;
- Challenge teachers to look at their classrooms in a new way and immerse them in the role of the student; and
- Provide ongoing support to ensure teachers can focus on inspiring, engaging, and empowering their students.

3 Measure the impact.

In the end, the goal of the APB approach is to help students gain the knowledge and skills they need to thrive in a rapidly evolving world. What students learn in the classroom should prepare them not just for college or a specific job, but for the many challenges they will face throughout their lives – and schools and districts must measure this.

Through a balanced approach that integrates both formative and summative assessments, students have multiple opportunities to demonstrate their knowledge and skills, which allows teachers to monitor student progress and modify instruction accordingly.

Students can show what they've learned by completing each activity, project, and problem; maintaining logs, notebooks, and portfolios that undergo assessment; and evaluating work through a range of tools, such as performance rubrics and reflective questioning.

In high school, PLTW students have a tool to prove their potential to employers, teachers, and higher education institutions. The PLTW Assessment is the first of its kind to measure both subject-matter knowledge and mastery of the in-demand, transportable skills students gain from APB learning experiences. Students who take the assessment receive a detailed score report that highlights not only what they *know*, but what they can *do* – key in measuring the impact of the APB instructional approach.

> **The learning is incremental, and PLTW provides the necessary training for teachers and scaffolding for students so that all involved feel comfortable taking risks and are not afraid to engage in the activities and curriculum.**
>
> **John Kocsis,**
> **PLTW Gateway Teacher**
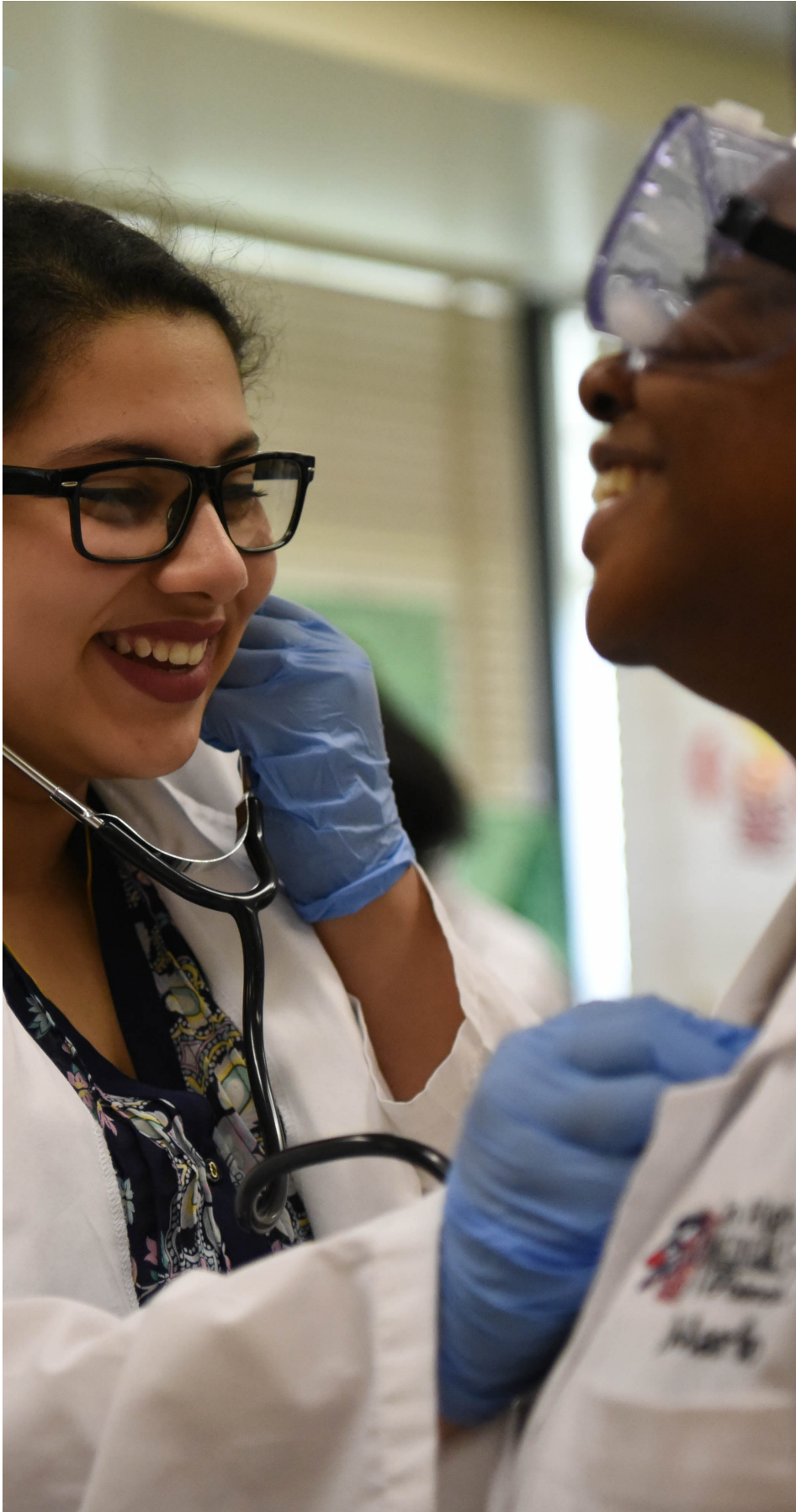
The impact of the APB instructional approach extends far beyond a single classroom, however. In many cases, it has reinvigorated the learning experience across entire schools, as teachers are intentionally finding more opportunities for student exploration. This means more student-to-student discussion and discourse, and less teacher-down instruction, allowing for creativity, collaboration, and problem solving in all subject areas.

Community members see the impact, too, as students take their learning beyond the classroom and engage with local businesses and organizations to solve real-world problems — such as designing a crosswalk safety sign, building a wheelchair for a rescue dog that's losing use of its hind legs, testing community water samples for E. coli, or programming an app for at-risk foster children to contact authorities in case of an emergency.

Through the APB approach, students discover that their learning isn't confined to the four walls of a classroom and, in fact, are empowered to continue their learning long after the last day of class. This is what makes the APB approach so impactful, and why it has become the cornerstone of transforming teaching and learning for thousands of educators and millions of students across the country.

> **Students, teachers, and parents all have that spark again — that spark being the thing that gets them talking and extending the learning far beyond the classroom.**
>
> **Kris Hahn,**
> **PLTW Launch Teacher**

About Project Lead The Way

Project Lead The Way (PLTW) is a nonprofit organization that provides a transformative learning experience for PreK-12 students and teachers across the U.S. PLTW empowers students to develop in-demand, transportable knowledge and skills through pathways in computer science, engineering, and biomedical science. PLTW's teacher training and resources support teachers as they engage their students in real-world learning. To learn more, **visit pltw.org.**

[i] The Power of Transportable Skills: Assessing the Demand and Value of the Skills of the Future. Project Lead The Way and Burning Glass Technologies, 2019, www2.pltw.org/TransportableSkillsReport.

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