Environmental SCIENCE for grades 6-12

A Project-Based Approach to Solving the Earth's Most Urgent Problems

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Foreword by John Larmer

It has been a long time coming, but it feels like education is undergoing some profound changes these days. We'll have to wait to see just *how* profound. Those of us who have been working for decades to change teaching and learning in schools have learned to be patient. Changing the education system in the US has been compared to changing the course of a container ship—it's a slow process, with no sharp turns.

The "factory model" of schooling has been with us for well over a century. Beliefs about what and how students should learn have been fairly fixed too. Beyond the basics of reading, writing, and math, students are traditionally expected to learn factual knowledge, for the most part. They often learn it by listening to a teacher, reading a textbook, or doing worksheets and memorizing for a test—and forget most of the information by the next week, or in a few months.

In recent years, though, to borrow a phrase my colleagues James Fester and Jorge Valenzuela use in the introduction to this book, "the stars have aligned" for change in education today. The system is opening up, with schools based on new models sprinkled around the country (and in the rest of the world, too). Technology is ubiquitous; it has changed the way people, especially young people, gain information, work, communicate with each other, and access the wider world. Students are less willing than ever to sit passively as a teacher dispenses knowledge; they want to learn actively and take on real-world challenges and problems. Even standardized testing, seen by many teachers as a barrier to changing instructional practices, is being questioned.

Part of the change we're now seeing in education is a greater interest in project-based learning. Why? Because PBL meets the moment. It engages young people and teaches them more than the basics, emphasizing depth over breadth, as well as the skills students must have to succeed today and in the future. Projects allow students to employ the tech tools they like and are skilled in using. PBL can even create a transformative sense of agency, when students see their work impact the world beyond the classroom. And let's not forget that PBL is good for teachers too, when they experience the joy that comes with seeing students excited by their learning.

Another moment we need to meet, of course, is taking care of our natural environment, an urgent matter. Young people know this all too well, and PBL gives them the opportunity to learn about and take action on issues they care about. For those students who have not had much direct experience with the natural world, projects that bring them out into it, or connect them with people who are taking action to save it, can heighten awareness and concern. Let's not teach students only *about* science; let's let them *do* science—our world needs them!

In addition to my long-time dedication to school change and PBL, I've loved the natural world my whole life. Growing up in California, I saw development spreading over open lands and air pollution increasing; experienced drought; and, more recently, had close calls with fires made worse by climate change. As a kid I loved visiting the High Sierras and later hiking in the redwood forests, and I think of those places as my cathedrals. This book brings together two things that are very important to me and to the authors. Thanks to James and Jorge for writing such a vital book for our times.

John Larmer is Editor in Chief at the Buck Institute for Education and coauthor of *Setting the Standard for Project Based Learning* (ASCD 2015) and *Project Based Teaching* (ASCD 2018).

Introduction

The Stars Have Aligned

Project-based learning (PBL) is not a new approach to education. The roots of this pedagogical model go back decades—even centuries according to some authors and practitioners. At the center is the idea of "learning by doing," an idea that educational reformer John Dewey continually discussed in his many written works.

While Dewey and others agreed that learning of all kinds benefits from an experiential, hands-on approach, there are some subjects that seem almost tailor-made for strategies like PBL, which emphasize inquiry into authentic challenges. One such subject is environmental science (ES). Like many other sciences, ES is especially conducive to approaches that emphasize an experiential basis, the use of observation, and real time spent connecting to the natural world.

The effectiveness of PBL has been extensively researched. Similarly, a substantial body of research supports the inclusion of ES as part of a broad-based science education. Educators who are passionate about both have shared anecdotal evidence of the successes they have seen and their students have experienced, but what was lacking was a long-term study demonstrating, with data, how one can support the other. But now, the evidence is finally available.

In early 2021, Lucas Education Research released two studies, conducted in partnership with the University of Southern California and Michigan State University, that provide compelling evidence that supports the kinds of hands-on approach to science education that PBL offers. The study, which involved over 6,000 students in 114 schools (Title I populations made up more than 50% of those observed) showed

How to Navigate and Use This Book

This book is organized into three parts; each part has three to five chapters.

Part 1: Background on PBL, NGSS, and ISTE Standards Alignment

Part 1 provides the necessary background on ES, PBL, the NGSS, and ISTE Standards alignment. ES is defined, along with its real-world and educational uses, especially in the context of science education. A high-level summary of the NGSS for non-NGSS schools and districts is also included along with an introduction to the main elements of the High-Quality PBL (HQPBL) framework. Essential aspects of project design and how they can best be leveraged and aligned to standards that support inquiry-based science learning are also discussed. Moreover, this section provides guidance in moving from a "teacher-centered" to a "learner-centered" classroom instruction model along with suggestions for overcoming challenges common to a project-based approach to learning.

Part 2: Environmental Science Projects

This section provides evidence that supports the use of PBL as an effective method for instructing students in ES through research and examples of how the discipline was taught successfully in the classroom. There are dedicated chapters for major topics in ES that align essential learning goals in the science discipline with activities that use technology. Examples of both middle- and high-school ES student projects are highlighted, along with best practices for student learning and how educational technology can be integrated to provide students with a real-world science experience.

Part 3: Strategies for Engaging Students in Environmental Science

Building off of the previous chapters, the chapters in Part 3 discuss the importance of engaging students in rigorous scientific inquiry, observation, and fieldwork during PBL units. Guiding principles, pertinent activities, practical strategies, and examples for doing so are presented to the reader. Additionally, the benefits of experiencing nature through fieldwork activities in projects are connected with social and emotional learning (SEL) to help learners develop mastery of the SEL competencies outlined by the CASEL framework. The final chapters guide teachers in examining the importance of having students create a call to action in projects to improve critical

Are you a PBL expert? Do you have the NGSS memorized? Don't worry, you don't have to! This first section of the book will orient you to the main elements that we feel need to be incorporated into the design of authentic and engaging project-based learning (PBL) focused on environmental science (ES), such as the Next Generation Science Standards (NGSS) and the ISTE Standards for Students and Educators. The foundation that will be laid out in this chapter will be drawn upon in later parts of the book as we illustrate what high-quality PBL looks like through project examples and the experiences of teachers engaged in the work. It will also provide insight into common challenges and problems of practice that first time PBL teachers often encounter.

CHAPTER 1: Environmental Science Introduction and Application. In this chapter, we provide a summary of the current state of ES education as a way to illustrate why well-designed PBL opportunities are important for all students to experience.

CHAPTER 2: The Intersection of ES and PBL. This chapter illustrates the connections between the elements of the High Quality Project-Based Learning framework (HQPBL) and the processes and practices involved in the study of ES.

CHAPTER 3: Aligning Authentic Projects to the NGSS and ISTE Standards. This chapter provides guidance on how to incorporate the ES standards outlined in the NGSS as well as the ISTE Standards into authentic project designs. This chapter also illustrates how proper alignment of these different standards and elements can lead to well-articulated learning goals for students.

CHAPTER 4: Designing and Facilitating High-Quality PBL. In this chapter we share valuable tips on how to get off to a successful start when transitioning to a learner-centered PBL practice. It also shares practical strategies for overcoming some of the most common challenges associated with designing and facilitating PBL experiences.