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What Should STEM Education Look Like?: A Book Review of "Frameworks for Integrated Project-Based Instruction in STEM Disciplines"

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BOOK INFORMATION

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Introduction

> Students who experience only traditional instruction are taught to follow someone else's procedures without necessarily understanding them; to do repetitive, simple tasks with no larger purpose behind them; to work individually; and to obey authority. Project-Based Instruction, conversely, can prepare students to confront complex tasks through collaboration, productive struggle, inventiveness, creative problem-solving, and constructive cycles of feedback and revision (Petrosino et al., 2024, p. 157).

In their 2024 book *Frameworks for Integrated Project-Based Instruction in STEM Disciplines*, Anthony J. Petrosino, Candace Walkington, and Denise Ekberg paint a full picture of project-based instruction, referred to as PBI throughout the book. The authors note this method can also be named project-based learning, which many readers may be more familiar with. As they describe it, PBI is a tool that can address a wide variety of learning and social goals for students within STEM classrooms. While this book is relevant for most PreK-12 educators interested in PBI as an instructional approach within their classroom, it reads more toward an audience of curriculum developers and teacher educators. The authors offer a clear picture of what elements are necessary for quality PBI in STEM, but also include some history and context for PBI. The book also provides some suggestions for how to move forward with PBI, from the classroom to school districts and beyond.

As a former project-based campus leader and PBI teacher-trainer and a current pre-service teacher educator, much of this book affirmed my own experiences, though there were certainly historical and contextual implications new to me. Below, I provide a brief summary of this volume and then offer insights and connections I found most valuable for today's educational landscape.

Overview of the Book

The first chapter provides an overarching definition of PBI and then delineates how PBI compares to six other educational approaches (e.g., problem-based learning and case-based learning). From there, chapter two moves into a historical overview of the project method – an educational movement beginning in the 1920s United States that arose in opposition to education serving solely as a tool to provide students with "the basics." The project method emphasized "a philosophy in which learning facts that could be used later in life was secondary to learning as a part of life" (Petrosino et al., 2024, p. 17). At the center of the project method is the idea that students direct the learning to develop deep content knowledge, problem-solving skills, and the ability to transfer knowledge across various applications.

After exploring the history of the project method and its connections to PBI, chapter three explores six core components of what the authors refer to as "big P Projects" – projects that are classified as PBI. These are in contrast to "little p projects," which PBLWorks (n.d.) refers to as "dessert." Little p projects are designed to showcase learning after instruction, instead of driving learning throughout instruction. The authors then also briefly discuss the 5-E lesson model and its potential for daily lesson structure within a PBI unit. However, the authors nod to other models (e.g., the STAR Legacy cycle) that could also function well for day-to-day learning within a Project. Chapter four then provides teachers and curriculum developers with practical steps and suggestions for developing a Project plan.

Chapter five moves into what PBI could look like in three fields of STEM education – engineering, computer science, and mathematics. In engineering, PBI is related to the "maker" movement and the recent trend of "makerspaces." In computer science, the authors discuss how PBI could allow for interdisciplinary computer science applications, as well as challenging and rewarding problems for students to tackle. Finally, in mathematics, the authors relate PBI to other ideas in math education, including Jo Boaler's work on math education reform (e.g., *Experiencing School Mathematics (2002)*, *What's math got to do with it? (2015)*, and *Mathematical Mindsets (2016)*).

Chapter six addresses what it really looks like to implement PBI on a wide scale. The authors begin with one of my favorite lines in the entire book about the dangers of making PBI widespread: "A challenge is the danger of popularity, including the pendulum swing of reform initiatives and an expansion of dubious or shallow implementations" (Petrosino et al., 2024, p. 133). When scaling PBI, the core elements can easily be lost, no matter how well-intentioned the educators are. To address these concerns, the authors discuss an approach to training administrators, which includes providing information on the history of PBI and a demo for administrators to experience this method firsthand. Finally, the authors discuss assessment methods within Projects and the potential for the future of PBI within various STEM fields, as well as opportunities for technology integration within PBI.

What is STEM education for?

Having utilized and taught PBI (and similar approaches) for over a decade, reading this book resonated with my experiences and knowledge of the method. More specifically, I want to highlight some points of the book I found to be most impactful when it comes to education today and, potentially, an answer to the question "What is STEM education for?"[1]

The book provides one possible answer to this question in how PBI in STEM education can allow for the inclusion of equity and justice issues. In chapter five, when discussing potential inroads for PBI in various STEM fields, the authors incorporate profiles of a few specific instructors. One

[1] I borrowed this question from Dr. Paulette Evans (personal communication, February 21, 2025) in a recent training I attended about teaching the same undergraduate PBI ed prep course mentioned at a few points throughout this book.

instructor discussed how PBI has serious implications for the sociopolitical engagement of his students. The book even provides a list of goals for "Proposed Equity and Justice Projects for PreK-12 Science Education" (Petrosino et al., 2024, p. 127). These goals and the vignette also connect to a later section entitled "PBI and Issues of Equity, Diversity, and Access" (p. 157). While these brief sections are just one possible reason or opportunity for PBI, a greater discussion of these issues could offer a highly compelling answer to what STEM education is for.

The authors also elaborate on how PBI might offer a method for students to learn by serving their own communities. This "service learning" approach has strong possibilities to fulfill the principles of experiential learning that John Dewey (1938) set out, as the authors indicate. It also connects to the work of Nel Noddings (1992) and her emphasis on the need for centering care in education. As another answer to the question "What is STEM education for," I have seen that service learning, designed around students caring about each other and their community, has great success in building lasting knowledge and students' capacities to care for each other and the world around them.

PBI v Cookie-Cutter Curricula

I have taught in secondary math classrooms, both traditional and project/problem-based, for over 10 years. I have seen both the detriments of a test-based educational culture and the benefits of a more de-standardized project-based approach. So, whereas the nods of this book in the direction of "What is STEM education for?" were noteworthy to me, by far the most interesting portion of this book was a four-and-a-half-page section entitled "Challenges to PBI From Systems Steeped in the Modernist Tradition."

This section compares the needs of PBI in STEM with the checklist-driven reality of our current educational system, with its highly structured lesson plans, curricula, and standards. The book does not outright reject the streamlining of curricula to a "series of steps" (Petrosino et al., 2024, p. 139). It does, however, offer up a way in which the organic nature of PBI, being driven by community needs and student passions, can be incorporated into our educational system in a way that allows students to master STEM concepts while seeing themselves as powerful and passionate actors in their own education. In this way, PBI offers up an alternative to what Freire (1970/2000) termed the banking concept of education, where "knowledge is a gift bestowed by those who consider themselves knowledgeable upon those whom they consider to know nothing" (p. 72).

Overall Impressions

Frameworks for Integrated Project-Based Instruction in STEM Disciplines is a practical guide to PBI in STEM. This volume is informative, with depth on the history, methods, and applications of PBI, and it provides context for how PBI can be implemented in STEM classrooms with considerations for modern-day implementation. Though since the depth and context do seem to be more aimed at curriculum developers and teacher educators at the graduate and post-graduate level, I could imagine an educator in the field would also benefit from an accompanying workbook with practical approaches to implementing the stages of planning described in chapter four. No matter your role in education, though, the picture of PBI painted by Petrosino et al. (2024) is an optimistic one - "Our challenges may be great, but helping each other learn and grow can help us transcend the issues we face now and prepare us as we forge ahead into the future" (p. 161).

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