What is Rigorous Project-Based Learning?

Position Paper

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Introduction

Project-based learning (PBL) is an increasingly popular way for teachers to facilitate academically rigorous learning experiences that also prepare students to apply content knowledge and skills beyond the classroom. In building a K-12 evidence base for PBL, Lucas Education Research (LER) aims to use research to improve teaching and learning by fostering consensus around what makes PBL rigorous. More than the passive collection of research data, LER takes a hands-on, community-based approach to studying and improving the effectiveness of PBL. Shaped by a larger PBL community of researchers, school and district leaders, teachers, and students, rigorous PBL stems from a shared need to improve PBL practice and develop capacity to spread evidence-based best practices. In this way, taking rigorous PBL to scale is more than a requirement of the research, but a product of the community LER is intentionally building around it.

Developing shared understandings and practices for rigorous PBL should alleviate many of the current challenges in designing and implementing projects. While many teachers regularly create high-quality projects, the complexity and time-consuming nature of curriculum design can make it a challenging endeavor to take on alone. Similarly, projects can tend to become fun activities separated from academically rigorous content learning as opposed to a cohesive set of project learning experiences. In a recent national survey of AP Government and AP Environmental Science teachers, 70 percent of teachers reported that one of the most noteworthy challenges was difficulty finding well-designed projects that also aligned to course content. The majority of these same teachers also responded that incorporating a PBL approach would have a positive impact on student learning. This paints a frustrating picture of the field: teachers who desire an engaging way to teach rigorous content but who do not have access to the resources, time, and supports to make this possible. This may be due in part to a dearth of examples of well-designed projects, as well as a lack of clarity among researchers and practitioners about what constitutes PBL. The lack of clarity and consensus can result in implementation with varying degrees of academic rigor, curriculum materials derived from competing design principles, and a consequently uneven evidence base for PBL effectiveness.

The important lesson is that PBL practice should not be isolated from PBL research. While PBL implementation does not always necessitate a dedicated PBL research network, rigorous PBL requires a supportive community that shares evidence-informed practices. LER encourages planned variation throughout a PBL research network, synthesizing lessons learned across different research partners, and exploring what is required to scale and sustain effective PBL.
implementation. This process of building evidence for rigorous PBL aims to establish consensus around design principles and definitions while also detailing the ways in which local context influences projects. This LER position paper is a starting point for this conversation.

**Defining “Rigor” in Project-Based Learning**

Rigorous PBL occurs when authentic, meaningful, and coherently designed project experiences are central to deep and comprehensive content understanding. As Edutopia highlights in its “Five Keys to PBL”, while projects should be fun and engaging, they should also be “core to learning”. For this approach to be rigorous, content-driven projects must be purposeful and authentic, enhanced by meaningful and supportive interactions, and implemented using evidence-informed practice (see Figure 1). It is not enough for students to complete project tasks related to content at the end of a course. Instead, projects need to be built backwards from significant learning goals that also involve real-world connections and a public audience. The learning process must offer an engaging, authentic context for investigating relevant questions in a way that also builds on the strengths, voices, and resources of all learners. This greatly depends on strong teacher facilitation that supports critical thinking, problem-solving, language development, diverse learning needs, and social and emotional learning. The multidimensional nature of extended, collaborative projects builds in multiple opportunities for deepening content understanding, revisiting concepts through different scenarios, and demonstrating knowledge in varied ways.

While many of these elements are part of general best practice, LER hopes to articulate a clear common framework to promote academic rigor in PBL. This focus on rigor is complementary with related efforts that articulate essential project design and instruction elements (such as the Gold Standard PBL model by Buck Institute for Education). There is also great synergy between rigorous PBL and "deeper learning", which the William and Flora Hewlett Foundation defines as "a set of competencies students must master in order to develop a keen understanding of academic content and apply their knowledge to problems in the classroom and on the job." A rigorous PBL framework requires synthesizing the PBL landscape, which is described in a recent LER-commissioned literature review (Condliffe et al, 2015). The review updates the well-cited Thomas (2000) paper, highlighting the curriculum, instruction, and assessment principles for PBL research and design and clarifying the distinction between “doing projects” (Thomas, 2000) and learning through projects. Condliffe and colleagues report the need for flexible, dynamic principles that are adaptable to local contexts and clear PBL models that can be used to assess quality implementation. LER frames the conversation to connect PBL practice with PBL research, explicitly investigating and supporting how “fixed” elements of a PBL model are adapted through high-quality implementation.
Purposeful and Authentic Project Experiences

Rigorous PBL is purposefully designed to consist of a cohesive and coherently sequenced set of experiences that are both core to learning and authentic and relevant to students. In rigorous PBL, “projects carry the full subject matter load of the course. They are not sporadic activities or culminating activities that come at the end of an instructional sequence, nor are they lively interludes inserted periodically into traditional recitation” (Parker & Lo, 2015, p. 4). The Buck Institute for Education differentiates purposeful project experiences from busy work and “dessert projects” that are easily completed with little planning or research (Larmer, Mergendoller, & Boss, 2015). This is aligned with recent moves toward standards and assessments where students must deeply understand concepts and apply knowledge in different scenarios. The rationale and context for the project must also be authentic in terms of making explicit connections to real-world practices used by the disciplinary community and by the wider community where students live, as well as personally meaningful to the student (Polman, 2012). In this way, authentic projects can promote a sense of civic purpose and engagement, which can be especially powerful when projects result in genuine products for an authentic audience. This is consistent with research demonstrating that students learn most effectively when learning takes place in authentic, real-world contexts (NRC, 2007).
Challenging driving questions or problems provide an important framing for project activities. For example, the Knowledge in Action Project designed by the University of Washington includes three Advanced Placement (AP) PBL courses where 5-7 projects structure all content. Project tasks and activities derive from driving questions, which purposefully map to master questions such as, “How can we live more sustainably?” creating a coherent flow of information. Students take on roles in simulations and reflect on different dimensions of the master question, highlighting real-world connections for becoming more civically engaged. This encourages motivation and transfer of content knowledge, as found in How People Learn (Bransford, Brown, & Cocking, 1999).

**Driven by Rigorous Content**

Design principles cited in the PBL literature highlight the need for projects to be inseparable from content, targeting significant learning goals and promoting construction of knowledge (Condilffe et al, 2015; Thomas, 2000). Well-designed projects should maximize exposure to “big ideas specified in the learning goal”, with a variety of ways for students to “confront and resolve conflicting ideas” (Darling-Hammond et al., 2008, p. 214-216). Projects give students opportunities to revisit questions, ideas, and problems throughout their PBL experience, “which is key to deepening their evolving understanding of course topics” (Parker et al, 2013, p. 1433). Encouraging the use of multiple methods and solutions to a challenging problem also allows students to leverage skills such as critical thinking, problem-solving, and collaboration (Larmer, Mergendoller, & Boss, 2015).

Rigorous PBL is also an opportunity to combine content and skills across multiple academic subjects, preparing students for interdisciplinary applications where information is increasingly integrated. The Multiple Literacies in PBL Project from Michigan State University and University of Michigan, for example, integrates science, literacy, and math to meet both Common Core and Next Generation Science Standards in the upper elementary grades. In addition to a focus on science, language and mathematical literacy, learning technologies are used as tools to explore the driving questions through multiple avenues of disciplinary integration. Rigorous content is framed not only by disciplinary core ideas and significant learning goals, but also by how content is used in practice, which can motivate students and increase interest in subjects like science (Blumenfeld et al, 1991, Krajcik & Czerniak, 2013).
Enhanced by Meaningful and Supportive Interactions

Rigorous PBL relies on social interactions that connect to who students are as people and also facilitate their continuing learning and development; in short, they must be both meaningful and supportive. Developing meaningful interactions requires a positive school and classroom culture that values student and community contributions. Rigorous PBL environments provide students with the opportunity and space to leverage their strengths, speak their minds, act on their ideas, and make decisions that are relevant to them. As Darling-Hammond (2008) states, “Students should be encouraged to be authors and producers of knowledge” (p. 216). Families and larger communities are important contexts and interconnected networks where learning occurs, and classroom learning is enhanced when there is space to develop and exchange diverse “funds of knowledge” (Gonzalez, Andrade, Civil, & Moll, 2001).

Social and emotional learning competencies and skills are essential to this interactive and reflective learning process. They must be integrated and supported explicitly in the context of disciplinary core ideas and practices. For example, the ninth grade English/Language Arts PBL course, Composing Our World, led by University of Colorado at Boulder and Colorado State University focuses on SEL elements most essential to developing literacy practices. Their emphasis on collaboration, empathy, and reflection help students understand diverse perspectives, communicate ideas, revise work, and adapt products for different audiences. Professional learning experiences develop these same competencies in teachers, which supports effective PBL implementation. SEL integration in PBL furthers a student-centered approach to meeting content standards, such as complex Common Core literacy practices (e.g. listening, reading, composing, and research). It is not a non-academic component, but a key driver in learning rigorous academic content.
Implemented Using Evidence-Informed Practice

The multifaceted components of rigorous PBL are only possible when instruction is regularly informed by evidence of student learning. Deep understanding is facilitated when students generate and revise artifacts, guided by feedback and critique from their teachers, peers and community. Students need regular opportunities to self-assess and reflect on their own learning as well. In particular, when “the appropriate distinctions have been made by learners...learners are better able to grasp the significance of what the expert has to say” (Schwartz & Bransford, 1998, p. 511). Throughout rigorous PBL students learn through these multiple opportunities to connect and elaborate ideas and discover distinctive features of concepts (Schwartz & Bransford, 1998).

Implementation of evidence-informed practice requires strong teacher facilitation and project management skills. Learning opportunities and tasks must be universally-designed to present content in different ways, stimulate interest and motivation, and provide well-differentiated ways for students to express what they know (Meyer, Rose, & Gordon, 2014). Facilitating deep content understanding also requires mindful attention to students’ experiences and readiness to learn new information. As students express their emerging understandings, teachers provide feedback strategically and use formative assessments to improve instruction.

In PBL, intentionally integrated assessments can provide a rich understanding of the student learning that takes place over time. For example, the Learning Through Performance Project led by the Stanford Center for Assessment, Learning and Equity (SCALE) includes two 6th grade courses -- Math and Science -- that contain performance-based tasks to support high quality teaching in PBL. Throughout the project, student data are collected from both collaborative and individual tasks related to the essential or driving question. Common rubrics are used to help teachers identify strengths and weaknesses and track growth over time, as well as streamline language around quality student work. By using student evidence to inform teaching, PBL assessment and instruction are deeply interconnected, ensuring that purposeful, authentic, and meaningful project experiences do in fact result in learning rigorous content.

Summary

The rigorous PBL framework is intended to inform the design of high-quality materials for practitioners who are eager for well-designed projects aligned to course content. Taken as a whole, the framework contributes to a developing consensus about what rigorous PBL entails and helps create a shared community around PBL research as linked to practice. A rigorous approach to PBL content, instruction, and assessment also necessitates an evidence-based approach to improve PBL practice.
Evidence-Based Improvement in Rigorous PBL

Building the evidence base for rigorous PBL requires demonstrating how and under what conditions rigorous PBL can be effective at scale, and researching whether this comprehensive approach to PBL improves teacher practice and student outcomes. The process of implementation research relies on cycles of evidence-based improvement (Bryk, Gomez, Grunow, & LeMahieu, 2015). These cycles inform how to make projects more purposeful and authentic, strengthen connections to rigorous content, and best support teachers and students in developing meaningful and supportive interactions, and implement evidence-informed practices to promote student learning. A result of these improvement cycles is a robust model of PBL and evidence about the potential of PBL to meet the intended level of rigor.

The three phases of development, replication and validation, shown in Figure 2, reflect the LER evidence-based improvement approach to rigorous PBL.

Figure 2. Three-Phased Approach to Evidence-Based Improvement in Rigorous PBL

What is the minimal viable program? The Development Phase focuses on applying design principles for rigorous PBL to create a comprehensive and coherent minimal viable program that fully addresses the design elements of the rigorous PBL framework. During this phase, researchers and practitioners collaboratively engage to design materials. A comprehensive program includes curricular, instructional, and assessment components for students and teachers, as well as teacher resources that provide guidance about how to fully address the components of rigorous PBL. The materials are tested and refined in iterative cycles in small-scale studies. These studies explore the feasibility for implementation and identify the core features and resources needed for successful implementation. Coherence is established through evidence of how materials support productive teacher and student interactions that result in application of rigorous content and skills.

Which components are fixed, flexible...and why?

During the Replication Phase, researchers document the implementation of the program in new settings including how and why teachers adapt the program to enhance relevance in their local communities. This evidence is used to refine the essential fixed components of the program (e.g., maintaining connections to the driving question throughout the project, addressing core content standards). Evidence is also used to develop resources that guide teachers from diverse settings to make productive adaptations when implementing flexible components of the
program (e.g., building on the particular resources and interests of their students). This phase of research will demonstrate the viability of the PBL program in new settings.

**How do we expand and sustain rigorous PBL?**

In the Validation Phase, research efforts examine causal effects of the program on student learning processes and outcomes along with the necessary conditions for successful large scale implementation. For example, the Efficacy Study of the Knowledge in Action (KIA) Advanced Placement U.S. Government and Environmental Science Projects led by RAND uses a randomized controlled trial (RCT) approach with approximately 130 schools (65 KIA, 65 comparison) to estimate the causal impact of the KIA programs on students' academic knowledge, inter- and intrapersonal skills, and civic engagement. The study also examines factors associated with fidelity of implementation of the PBL AP models and the mechanisms which the effects of the program occur. The University of Michigan and Michigan State University recently completed a RCT with Project PLACE, a project-based approach to social studies and content literacy for second grade, and found that Project PLACE students performed better on a measure of social studies knowledge and skills (Duke & Halvorsen, 2015).

Studies in the Validation Phase are not exclusive to RCTs and may also dive deeper into the mechanisms (e.g., system supports, student and teacher interactions) that are critical to the sustainability of an effective PBL program. Communities who share an interest in tackling a pervasive problem of practice that is critical to the success of PBL (e.g., instructional coaching, using assessment data to improve instruction) can develop a network to address the concerns. These “networked improvement communities” apply improvement science methodologies to systematically study improve current practice and sustain best practices (Bryk, Gomez, Grunow, & LeMahieu, 2015).

**Strategies to Support Evidence-Based Improvement Cycles**

Several key strategies support evidence-based improvement cycles from development through validation phases. These include: developing research-practice partnerships, assessing multiple competencies of students and teachers, and documenting and sharing best practices.

**Developing Research-Practice Partnerships**

Researcher-practitioner partnerships are essential to developing capacity for continuous improvement of programs (Fishman, Penuel, Allen, & Cheng, 2013), and rigorous PBL requires that the voices of practitioners and researchers equitably shape the projects. Teachers know their local school communities and bring grounded experience in instructional approaches to engage their students in core content. District and school leaders can influence the systemic structures (e.g., pacing guidelines, time for co-planning and coaching) that make the successful implementation of rigorous PBL possible. Educational researchers bring theories of learning and methodologies to guide systematic design of lessons and approaches for examining implementation and evidence of impact of PBL practices. Together, practitioners and researchers collaborate to co-design curriculum lessons, assessments, teacher professional development institutes and resources to support implementation.

When productive relationships are established, projects may have a greater likelihood of taking hold and expanding within districts. The AP Knowledge in Action Project, for example, has
continued to spread throughout a school district in the Midwest, even after the research has officially completed. In addition to strong district support from curriculum coordinators, teachers attribute the enthusiasm to the very nature of PBL, which encourages students to make real-world connections and allows teachers to teach how they have always wanted to teach.

Assessing Multiple Competencies of Students and Teachers

Research in rigorous PBL examines student competencies related to standards-based academic content as well as social and emotional learning. For example, student measures for the SCALE Learning Through Performance middle school mathematics and science projects include performance data based on the Common Core State Standards and Next Generation Science Standards, perceptions of their teachers’ practices and learning opportunities, and attitudes toward learning science and mathematics. Likewise, the Efficacy Study of KIA Project led by RAND will report on student outcomes such as attitudes toward and engagement with learning; knowledge mastery based on the AP exam; critical thinking, problem solving, and written communication based on the CWRA+, intrapersonal and interpersonal skills; and civic engagement.

In addition to student outcomes, research should inform the extent to which the PBL program helps teachers to become more skilled at promoting meaningful and supportive interactions and implementing evidence-informed instructional practices. Learning Through Performance classroom observation data, for instance, will shed insight into teacher practice with regard to five areas: (1) facilitating authentic, active student engagement and agency; (2) giving students opportunities to learn rich and challenging academic content; (3) setting a clear, connected and coherent context for learning; (4) formatively assessing and monitoring student learning; and (5) using technology/tools authentically.

Documenting and Sharing Best Practices

Encouraging evidence-based adaptations and improvements to the minimal viable program makes PBL curriculum a living product. Because rigorous PBL is dynamic, a more cohesive community approach is needed to share: (1) data/findings that can improve how teachers can implement PBL and (2) productive curricular adaptations that promote student learning. PBL teachers and researchers have a responsibility to share productive adaptations, strategies for implementing these practices, as well as research tools for demonstrating the effectiveness of these approaches.

Researcher-practitioner partnerships can further develop as a result of researchers sharing of findings to support teachers in using evidence-informed practices. To facilitate rapid improvement cycles, LER incorporates, when possible, “practical” measures (Bryk et al., 2015) that provide actionable evidence to improve teacher practice. The LER Teacher Portal, for example, unobtrusively gathers data about the types of adaptations teachers make and how often they use particular lessons. The Portal facilitates rapid analyses of these adaptations for instructional coaches who work directly with teachers. The Portal also supports a dynamic model of PBL curriculum design, as teachers can upload changes to lesson plans and share reflections on why they made changes (see Exhibit 1). These data offer insights into how to improve the curriculum, for example which lessons require modifications or additional supports for implementation.
The sharing of adaptations can also help other teachers make productive choices about the flexible features of the PBL program.

**Summary**

These strategies of developing research-practice partnerships, assessing multiple competencies of students and teachers, and documenting and sharing best practices, when integrated within three phases of Development, Replication and Validation, describe a robust method for improving the effectiveness of PBL over time and at scale. Peculiarities of specific PBL courses and contexts will of course necessitate some unique methods and research strategies. Much like the framework for rigorous PBL, the articulation of this approach is intended to serve as a starting point for building consensus among the PBL community about how to study and improve PBL.

**Moving Forward**

A framework for rigorous PBL will help establish consensus around design principles that shape authentic and content-driven project experiences while also articulating how and under what conditions rigorous PBL can be effective at scale. Establishing consensus and clarifying potential synergies will also contribute to complementary research and practice communities. By gathering evidence that continuously improves implementation, it moves beyond traditional outcomes and builds a PBL community to support a substantial shift in practice. Doing so requires a comprehensive program that expands upon how research-practice partnerships can make PBL curriculum, instruction and assessment more rigorous and also explicitly integrates technology and social and emotional learning supports to enhance the student experience. While each of these areas stem from a wealth of research literature, they remain under-researched in the context of PBL. Going forward, LER will build the PBL research base in relation to five areas: (1) establishing and sustaining research-practice partnerships, (2) assessment integration in projects, (3) teacher learning and development in community, (4) drivers for technology integration, and (5) social and emotional learning through projects. By developing a community that documents and shares best practices informed by research evidence, LER aims for a more robust and multifaceted approach to taking rigorous PBL to scale.

**About Lucas Education Research**

Founded in 2013, Lucas Education Research operates as a sister division to Edutopia at the George Lucas Educational Foundation. Our mission is to build the evidence base to support best practices at classroom, school, and district levels that profoundly and positively impact the course of learning and lifelong achievement. We collaborate with research partners to design and evaluate innovative educational practices that can be replicated and taken to scale. Our work is currently focused on the study of a model for rigorous Project-Based Learning (PBL).
Exhibit 1. Lucas Education Research Teacher Portal

This exhibit shows the Community Curriculum View that organize all of the lesson adaptations that teachers are able to make and share. Each adaptation log has a description of how and why the teacher adapted a lesson. Teachers in the community can search by the adaptation rationale to borrow adaptations that meet their specific needs and build on the adaptations of others.
References


