

Strengthening Science/Empirical Reasoning

Prospectus

Context

As made evident by the recent attention to developing and expanding science, technology, engineering, and mathematics (STEM) initiatives, there is much left to be accomplished in improving STEM education within our country's secondary schools. Most of these recent initiatives focus on filling a pipeline for the STEM industries with a larger number of highly qualified young adults who are prepared to take jobs in those industries. In Big Picture Learning (BPL) schools, we believe, however, that there is a much larger and more important need: to create a generation of youth who are scientifically literate and eager and prepared to use well-developed processes for asking and answering questions about the world.

It is difficult to introduce students in classrooms, labs, or lectures to the real world of the scientific creative process. Science instruction is traditionally approached as lectures with occasional "cookbook" laboratory activities. This approach drives away a majority of young adults whose better understanding of real scientific inquiry through first-hand experience would benefit society's understandings of all things empirical.

The Work We Propose To Do

Empirical reasoning is one of the five Big Picture Learning Goals.

How do I prove it? The goal is to think, learn, and perform like a scientist: to use empirical evidence and a logical process to evaluate hypotheses and make decisions.

We propose to develop a set of projects and portals to address authentic and interesting challenges in the world of science. Our intent is to develop projects that have high motivational value for students and advisors, incorporate deep and sustained engagement of community resources, employ rigorous internship opportunities, integrate these projects into already existing programmatic structures of the BPL design, can be implemented in our BP schools throughout the country and internationally, and can be disseminated to all schools through professional development.

We will train and support our advisors (teachers) to substantially increase the academic rigor of student experiences and better address science within the context of actual students' interests—to activate the "empirical reasoning groove," to create learning plans appropriate to this approach, and to harness the expertise available to us in the communities where our schools are located. We are interested in creating settings in which we can offer multiple projects from which students can choose, based on their interests. These settings also provide the freedom, support, resources, and encouragement for those young adults who are naturally drawn to science to initiate and pursue their own unique science projects.

Goals and Objectives

We wish to demonstrate that all students can experience science as a deeply engaging way of thinking about the world and their place in it. Through such experiences, students will develop and use a diverse array of empirical reasoning skills and understandings.

In order to accomplish this outcome for students, we will need to prepare Big Picture School advisors to implement a project-based design for teaching science that is aligned with the essential elements of the Big Picture Learning design, including one-student-at-a-time learning plans, connections to real-world learning, and authentic performance assessments.

In order to accomplish these goals, we will:

1. Develop a small number of prototypes for field-testing within selected Big Picture Schools. We have already begun such design work.
2. Develop appropriate support materials for advisors and students. We envision a rich array of print and Web resources.
3. Develop an orientation, training, and support system for advisors. We will be particularly challenged to create a training and support system for advisors that is consistent with the Big Picture School design in which advisors are responsible for all of the discipline-based work of each of their students. This work will require attention to new staffing designs.
4. Develop appropriate student performance assessments. We are particularly concerned that prevailing assessments in science are inappropriate for the kinds of projects we envision that align to nationally recognized high school science standards.

Major Tasks

To accomplish these objectives, BPL will:

Develop prototypes. We have a number of ideas here that are in varying stages of development. For example, we have done considerable design work on a project dealing with designing and building a prosthetic hand. We have also developed preliminary designs for projects dealing with DNA sequencing to determine human migration history and with urban agriculture.

Develop support materials. We choose to use as science content highly engaging and motivating topics drawn from, and appealing to, students' interests as they engage the world. Moreover, we wish to blend attention to STEM skills with more general 21st Century skills and traditional academics through a rigorous and engaging curriculum.

Develop a professional development system. This will largely consist of familiarizing Big Picture advisors who come to assist their students at portal work of the similarities and differences from other approaches in student-centered, project-based learning. Ideally, the collaborative ideas, technology, "portal" methodology, travel and virtual workshops, and teaming will combine in such a way to induce an initial spark of excitement along the lines of each student's own interests.

Explore communication technology and opportunities. Determine a cost-effective, scalable means for dispersed teams to communicate and work collaboratively. We envision using high-bandwidth telecommunications and video conferencing between multiple learning sites and institutions as well as long-term periodic convenings (quarterly and annually) of groups, further supplemented by

individual travel among participant sites. Taken together, the Big Picture Learning network can leverage both the emerging lower costs of high-bandwidth communications as well as the highly flexible nature of its students' individual learning plans to create critical masses of students interested in various "portal" projects, both virtually and convened in resource-rich educational centers.

Develop performance assessment measures. In keeping with the Big Picture Learning design, assessments would be delivered in an authentic mode, documented in peer- and mentor-reviewed exhibitions of skills, discoveries, demonstrations, papers, talks, inventions, and integrations with other Big Picture student work.

Resources Required

BPL has already committed its own resources to this work in developing a detailed program design for one prototype—the prosthetics project. BPL needs additional resources in order to conduct and evaluate the prototype, develop additional projects, and then refine, document, evaluate, and disseminate the entire empirical reasoning initiative within its own network as well as to the schools in the Alternative High School Initiative (AHSI), a nationwide network of 11 organizations supporting over 300 alternative schools.

We estimate that this project will require about \$.925 million over three years. We need resources for personnel to develop and implement the prototypes in selected schools, develop a comprehensive education, training, and support system for advisors, and develop rigorous and authentic performance assessments. By the end of the three-year project, BPL will incorporate this entire initiative into its overall school design and maintain it through its local schools.

Benefits

By developing and promulgating innovative approaches to science education, BPL will contribute to the revitalization of science education in our schools and in other alternative school settings where hands-on learning in out-of-school settings and contexts is practiced. Through our dissemination of this work, we will help to create a generation of youth who are scientifically literate and eager and prepared to use well-developed processes for asking and answering questions about the world. Such an accomplishment would benefit our entire economy and society.