

# Papert's Prison Fab Lab: Implications for the maker movement and education design

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## ABSTRACT

For three years, the author collaborated with Seymour Papert in the planning, design, operation, teaching and documentation of the Constructionist Learning Laboratory at the Maine Youth Center. This work is significant as it represents Dr. Papert's last institutional research project and marks his first attempt to design an educational environment based on the theory of constructionism from scratch. The implications for education reform and school reform are numerous. However, in the context of the 2013 Interaction Design and Children focus on DIY/maker culture, the overlooked work of the Constructionist Learning Laboratory the work of Papert, Stager and their colleagues is particularly pertinent. More than a decade before maker culture and "fab labs" emerged as a popular addition to formal education, Papert succeeded in creating a school built entirely upon the ideals of that movement.

## Categories and Subject Descriptors

K.3 Computers and Education

## Keywords

Seymour Papert, constructionism, school reform, design, fab lab, maker movement, Reggio Emilia approach, at-risk learners, physical computing, Arduino

## 1. INTRODUCTION

From 1999-2002, the author worked closely with Dr. Seymour Papert on the design, planning operation, teaching and documentation of a unique learning environment, the Constructionist Learning Laboratory (CLL). The author was the project's principal investigator, culminating in the doctoral thesis, "An Investigation of Constructionism in the Maine Youth Center." (MYC) [1]

The Maine Youth Center was a troubled prison facility for adjudicated teenagers from across Maine. During the project, students from twelve to nearly twenty-one years of age were CLL projects. For students under the age of consent, the CLL was an alternative to attending the traditional school within the confines of the Youth Center. The CLL team, led by Seymour Papert, David Cavallo and Gary Stager had no hand in selecting students who volunteered to participate. The school and prison

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IDC '13, June 24 - 27 2013, New York, NY, USA  
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 ACM 978-1-4503-1918-8/13/06&#0133; \$15.00.

leadership selected the young people we would teach.

Since the 1960s, Papert led several school-based interventions during which he and his colleagues introduced computer programming and robotics experiences for children and teachers. In settings like the Lexington and Brookline, Massachusetts Public Schools, The Lamplighter School in Dallas and the inner city Hennigan School in Boston, Papert led research projects studying the effects of his constructionist learning theory on populations of students in existing schools. [2-5] The CLL project was built upon a desire to build an alternative learning environment unencumbered to the greatest extent possible by the policies, practices and heuristics of traditional schooling. This goal was not entirely realized due to issues involving personnel, regulations, lack of trust and hostility imposed by the prison bureaucracy where the CLL was located. However, CLL students were successful in many ways and the lessons learned from working with a severely at-risk population of children in a hostile setting may be used to guide the design of future learning environments. The experience of building a school based on constructionism, tinkering, making and personal computing offers lessons for educators interested in learning-by-making, DIY culture, fabrication, programming and physical computing.

## 2. Constructionism

As indicated by its name, the Constructionist Learning Laboratory was designed to create an environment in which knowledge was constructed inside the head of the learner through the act of making something shareable outside of their head. [6-10]

The maker/DIY movement with its emphasis on learning through direct experience, hands-on projects, tinkering and invention, is based on constructionist learning even if its members and advocates are unaware of the theory. Advocates of learning-by-making are disposed to constructionism.

## 3. Fab and Fab Labs

In 2005, Gershenfeld predicted that the next major technological revolution would be personal manufacturing or desktop fabrication [11]. He promoted the idea of creating Fab Labs, places where everyday people could use technological tools to invent technological solutions to their problems. Fab Labs could be established in rural or underserved communities to be used by farmers, laborers or even children to make things. Gershenfeld, a colleague of Papert's at MIT, also recognized the powerful learning experiences that accompany the act of making things.

*"The distinction between toys and tools for invention, culminating in the integration of play and work in the technology for personal fabrication. The original inspiration and instigator for bringing these worlds together was Seymour Papert."* [11]

Gershenfeld would likely be surprised by the rate at which new fabrication materials and tools, like 3D printers and Arduino microcontrollers, would become available to lay people outside of research or high-tech manufacturing facilities. [12-15]

Others have worked to bring the tools, processes and values of the Fab Lab to school settings in the shape of maker spaces, FabLab@School or similar workspaces. [16] To date, many of the people engaged in such effort have a direct relationship with Papert or Gershenfeld.

The family is about to get much larger. The MakerEd initiative recently received a large DARPA grant to create one thousands school-based makerspaces over the next three years. “We are re-thinking the shop class and re-inventing the computer lab, and combining both of them. The makerspace should be like a library, available for use by anyone in the school to make things for a variety of purposes.” [17]

#### 4. Design goals of the CLL

The CLL was designed to support the following goals:

1. *Trying to pursue grade-linked curriculum goals was obviously futile and irrelevant to the needs of the majority of these students. Instead the primary goal was to develop the habits, attitudes and sense of self, needed to be a disciplined and successful learner. A secondary goal was to develop very basic skills in the areas of language, numeracy, and technological fluency.*
2. *These two goals would be served by an interdisciplinary, project-based method, where learners’ interests guide the areas of investigation, giving sufficient time for exploring projects, content, and ideas at length and depth.*
3. *There would be no segregation by age, grade level or knowledge level, nor division of the day into “periods” devoted to different “subjects.” The diversity of experience, ages, and levels of expertise would become strength, rather than a fatal flaw.*
4. *A major emphasis would be on building a collaborative culture of “learning and doing” where students assumed the roles of teacher as well as learner (and teachers became learners as well), The culture was to value both independence and discipline. A basic rule would be not to tell a student what to do at each moment but everyone had to work on something.*
5. *The working of the learning environment should be sufficiently flexible not only to change to take account of experience but also to give students a genuine sense of participating in its creation. [18]*

These goals may have been shared by previous implementations of constructionism and perhaps other school reform efforts. What made the CLL different was the central role of computing, the emphasis on construction and an ability to build the entire “school” to reflect those goals. The range of projects, tools and materials found in the CLL made it unique more than a decade before the maker movement embraced similar activities.

##### 4.1 A major influence

Resnick has advocated for learning environments to be like lifelong kindergartens. [19] The CLL was much more heavily influenced in its design and activity by the early childhood centers of Reggio Emilia, Italy. The Reggio approach envisions the classroom as the 3<sup>rd</sup> teacher (parent/teacher/classroom) filled with interesting artifacts, materials, works in progress, inquiry,

creativity, collaboration and evidence of learning. [20] Given the incarceration of our students, the CLL needed to replace the parent and create a wondrous space where learners could soar above their otherwise impoverished and punitive conditions for five hours each school day. In many ways, CLL students needed to be nurtured and protected in ways not dissimilar to those in the infant and toddler centers in Reggio Emilia.

#### 5. The learning environment

The CLL was comprised of two temporary mobile classrooms. The larger space was the primary learning environment. Each student had a workspace around the perimeter of the room. The center of the room was used for collaboration, testing of inventions and meetings. Walls were decorated with images of works-in-progress and photos of each student. Such photos were useful for visitors and even teachers due to the often-transient nature of the student population. This also made students feel as if they were part of something bigger than themselves.

There was a well-stocked library filled with high-interest fiction, non-fiction and reference books. The wide assortment of reading levels catered to, from early readers to complex technical manuals, were required by the enormous span of student literacy levels represented by our students. Given the constraints of a prison, books, like any other construction material or toy needed to be within reach of students. Although some of our students were diagnosed as illiterate and most labeled with a variety of learning disabilities, the classroom library was a favorite aspect of the CLL. If a student requested a book of poetry by William Blake, a biography of Shakespeare or a copy of Shogun, we got it for them as quickly as possible. This necessitated frequent afterschool shopping trips for the teaching staff.

Mountains of LEGO, tools, batteries, art supplies, recycled materials; clay and beanbag chairs were often strewn across the space. Each student workspace contained a personal computer.

The second smaller classroom was used more as an atelier or studio. [21] This space was used for specialized purposes like woodworking, photo developing or filmmaking. Students would need to be accompanied to this space by an adult.

#### 6. Change everything

A sense of urgency propelled those of us leading the CLL. Our students had been reminded repeatedly of their incompetence, wickedness, worthlessness, dishonesty, duplicity or disorders. The punitive nature of their surroundings made nurturing impossible and they faced low expectations. Collaboration, creativity and communication, the most frequently cited 21<sup>st</sup> Century skills, are viewed as dangerous in a penal facility, yet our previous efforts prepared us to be amazed by what children know and can do.

The Governor of Maine at the time, Angus King, asked Dr. Papert to help him create a model of what learning might look like in the future. King was likely guided by two competing needs. 1) The economic development of a relatively poor state that needed to augment lumber and tourism with a high-tech workforce; and 2) Amnesty International and former inmates were accusing the state of torturing teenagers in the MYC. [22] Regardless of his motivation, King recognized that doing the same thing louder would not achieve a different result. Most of the children in the MYC had been habitual school failures. New approaches were necessary if a different outcome were possible. As a result, the CLL was freed of all curriculum and assessment requirements by the State of Maine.

Such “freedom” was critical to our work even though we were forced to remind others in the MYC of our special mandate to change everything; curriculum, pedagogy, activity, assessment, classroom environment, schedule, staffing, materials, tools and expectations.

“School reform” efforts are doomed by their desire to tinker around the edges or change one variable and expect years of neglect, poverty or low self-efficacy to be eradicated en-route to perfect test scores.

The CLL differed from other constructionist research projects and school reform efforts in many ways beyond the unique setting of the MYC.

## 6.1 Students are individuals

Every attempt was made to get to know students in order to shape experiences that would help them grow as learners and people. Accepting student where they are and doing everything possible to support their progress is critical, especially with a transient student population.

### 6.1.1 Labels are destructive and arbitrary

Being placed in an Algebra II class because you are fifteen and then given a grade for that course when you are released after three weeks is a farce that does a great disservice to a student.

### 6.1.2 All children are competent

We had little patience for or faith in the ways in which students were diagnosed and classified. Therefore, we “exempted ourselves” from individualized education plans and initial student proclamations of what they couldn’t do. It was neither difficult nor time consuming to get a student engaged in making something. Those constructive activities provide an astute educator with a window into the thinking of a learner.

### 6.1.3 Eschew the deficit approach to teaching

We did not wallow in the shallow boxes our students had been placed. As a result, we found kids said to be illiterate who could write a 13,000 word autobiography the few days he was being released; “learning disabled” kids who could engage in sophisticated engineering projects; demonstrations of remarkable ingenuity and problem solving ability; boundless empathy and kindness; child-like wonder among the “most dangerous” children in society and an intense passion to learn new things and share that knowledge with others. Prior to the end of the CLL project, we had made great strides in convincing state officials to allow us to grant certificates of

Prior to the end of the CLL project, we had made great strides in convincing state officials to allow us to grant certificates of competency on which we would indicate what a student can *do*, instead of celebrating deficiencies in students leaving the CLL.

## 6.2 Quality work takes time

To assist our many visitors in understanding the underlying theories guiding the CLL, Papert created a one-page document called, “The Eight Big Ideas Behind the CLL.” One of those ideas was “Taking the proper time to do the job.” Too often, we deprive students of the time necessary to develop understanding or fluency, yet we have the audacity to criticize their work ethic or attention skills. A critical aspect of the CLL was keeping the same group of students together uninterrupted, except for lunch, for five hours each day. That allowed community building, camaraderie and sufficient time to get lost in the flow necessary to become good at something. We fought hard to preserve the

communal unity that such time afforded. Even physical education was offered to the entire class at the same time.

## 6.3 It’s their curriculum

In order to engage curious, passionate and intense teenagers for project work five hours per day, on projects that often spanned many weeks, students needed ownership of the pursuit and agency over the project. As in Reggio Emilia, most student projects emanated from what a student wished to create or a subject they wished to learn more about. Some projects were suggested by a teacher when it was appropriate to introduce a concept or skill to everyone at the same time, but even in such cases, the challenges were open-ended and allowed students to return to other work once a solid effort was made to address the challenge. Papert argued that what we did with students should have a reasonable likelihood of leading to the construction of a larger question or more complex hypothesis.

## 6.4 Less Us, More Them

Since our severely at-risk students were not typically fond of schooling, they didn’t suffer fools gladly. As a result, we found that there was rarely an instance where more than a minute or two of instruction was required before asking students to *do* something. This was a gift they gave us. Teachers could circulate, join project teams, seize teachable moments and sit alongside a student solving problems, rather than lecturing.

## 6.5 Coercion is counter-productive

Papert was fond of the saying, “Love is a better master of duty,” and CLL students who read his book, **THE CHILDREN’S MACHINE**, [23] cherished his statement, “nothing beautiful is forced.” The only rule in the CLL was, “You must be doing something.” Activity, whether inventing, programming or reading a book is critical in the classroom or maker space. Students with poor previous school experiences or low-literacy levels may reject report writing in any form, be it portfolios or lab notebooks. We compromised by asking students to take photos of their work, label them and hang them above their work area at the end of each day and begin each day by writing a to-do list. These artifacts made private thinking public and engaged the entire community in their learning. This form of documentation was beneficial to students when assessment is too often a form of judgment.

## 6.6 No piece of knowledge is more valuable than another

Papert once told me that at best school teaches a billionth of a percent of the knowledge in the universe, yet adults quibble endlessly about which billionth of one percent is important. Any inquiry generated by a student or inspired by a teacher in the CLL was worthy of pursuit.

## 6.7 Expertise comes in all shapes and sizes

The lack of age segregation in the CLL led to younger students sharing expertise with older peers and teachers learning from students. Any volunteer who wished to spend time in our classroom teaching anything, from building ultra-light airplanes to radio production to African drumming was welcome to share their expertise. A visitor asking a student, “Hey, whatcha doing?” was an opportunity for students to share express their knowledge and refine their thinking in the process.

## 6.8 Casual collaboration

Collaboration needs to be mutually beneficial and based on interdependence. We found, especially in a setting where collaboration was viewed as felonious, that young people

collaborate naturally and constantly in ways that adults need to be prompted to do. Student collaborations are often “through the air” or occur casually and fluidly. There is no need to force kids into groups. They gain benefit from a community of practice rich in intense activity.

## 7. Many artifacts, one constructionism

Previous research projects based on Papertian constructionism were focused on computer programming in Logo and robotics. Students in the CLL engaged in an enormous number and breadth of such projects, including video game design, mathematical problem solving, simulation construction and physical computing challenges involving LEGO robotics. However, they also produced gophercams designed to explore beneath the earth, gliders, television shows, animations, raised caterpillars, assembled medieval machines of war, built spectacular classical guitars requiring hundreds of hours of meticulous effort and wrote newsletters. CLL students won national awards for radio documentary production, engaged in investigative journalism, corresponded with authors and ran a photo studio on visitation days.

### 7.1 The technology ecology

A funny thing happens when you invent a machine to graph fluctuations in temperature data over a long period of time as one thirteen year-old did in the CLL; you use that machine to conduct more sophisticated experiments. When you build a guitar you want to learn to read music, play the guitar and score your film.

Like the Maker movement, the CLL project embraces a wide range of low and high-tech materials for the construction of artifacts and the learning that results.

## 8. The transformation into active learners

CLL students engaged in extraordinary learning-by-making during the life of the project. Students thought to be incapable of learning proved quite capable and even enrolled in college courses while in the CLL. A number of students went straight from the MYC to high education, an impossibility prior to their participation in the CLL. Not a single CLL student was removed from the classroom for discipline reasons over three years and the recidivism rate of the facility was 70%. The rate of those engaged in our program over the first 2 years was 14%, where even that number was inflated by two youth who returned for 1 day and one weekend respectively. [30]

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