This is Our Moment

Constructionism 2014 Plenary Talk

Gary S. Stager, Ph.D.
Executive Director: Constructing Modern Knowledge

gary@stager.org

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Abstract

In this plenary address, the speaker will share three societal trends that validate and vindicate decades of leadership by the constructionism community. The growing acceptance of learning-by-making represented by the maker movement, a newfound advocacy for children learning computer programming, and even the global education crisis, real or imagined, are evidence of predictions and efforts made by constructionists being realized. This conference offers a brief opportunity for celebration before returning to the "hard fun" required to harness the momentum of these trends and improve the learning ecology.

Paper

Three societal trends afford members of the constructionism community with cause for optimism. While two of these trends are positive and one negative, their trajectory is towards a greater acceptance of constructionist learning by formal and informal communities of practice.

The general population has begun to recognize that knowledge is a consequence of experience and that technology can play a role in the construction of knowledge. This revelation is an act of constructionism in and of itself. Despite our decades of paper writing, conference attendance and teacher training, people unfamiliar with the term are constructing constructionism without being taught. Such "popular constructionism," is manifest in explosive growth of the global maker movement and a revaluing of children learning to program. Such progress is accompanied by a backlash by the formal system of schooling, just as Seymour Papert predicted nearly a quarter century ago. (Papert, 1991)

THE MAKER MOVEMENT

At Constructionism 2012, there were concerns expressed about the maker movement that to be candid, smacked of elitism. While it may be true that the moms,

dads, and teachers advocating for making may lack a scholarly vocabulary for expressing principles of constructionist learning, they are not hostile to that information. The popularity of Maker Faire, Hour of Code, Scratch, and books like, "Invent To Learn – Making, Tinkering, and Engineering in the Classroom," are proof of a desire to learn more about learning. It is also the case that academics in the constructionism community would benefit from learning what members of the maker movement know and can do. The elements of community organization and creative spirit of the maker movement are to be admired.

As we assert in our book, (Martinez & Stager, 2013) Papert is not only the "father" of constructionism, but of the maker movement as well. In "Computer as Material: Messing About with Time" (Papert & Franz, 1987) and earlier, "Computer as Mudpie," (Papert, 1984) Papert described a new role for the computer as part of a continuum of construction materials, albeit one imbued with protean qualities. (Papert, 1980)

"If you can use technology to make things you can make a lot more interesting things. And you can learn a lot more by making them. This is especially true of digital technology." (G. S. Stager, 2006)

Papert not only provided the basis for constructionism as a learning theory, but also played a pivotal role in predicting, inventing, and advocating for the constructive technology now being popularized by the maker movement. Long before his involvement in the development of programmable LEGO robotics kits or being an advocate for one-to-one computing, made the case for such innovations and even expressed the importance of hardware extensibility.

In 1970, Papert and Solomon described the sophisticated technological needs of young children engaged in making things with computers.

"The school computer should have a large number of output ports to allow the computer to switch lights on and off, start tape recorders, actuate slide projectors and start and stop all manner of little machines. There should also be input ports to allow signals to be sent to the computer.

In our image of a school computation laboratory, an important role is played by numerous "controller ports" which allow any student to plug any device into the computer... The laboratory will have a supply of motors, solenoids, relays, sense devices of various kids, etc. Using them, the students will be able to invent and build an endless variety of cybernetic systems." (Papert & Solomon, 1971)

Neil Gershenfeld, one of the leaders of the personal fabrication movement who predicted much of the current maker movement, recounts how Papert viewed the inability of children to construct their own computers as a "thorn in our flesh." (Gershenfeld, 2005) The availability of the $35 Raspberry Pi and its offspring the Beaglebone, Yun, Gallileo, and other low-cost Linux computers, all with an ability to

interface with the world, removes that thorn. Each of these tiny computers are capable of running Scratch, Snap!, Python, and Turtle Art. They also feature a range of inputs and outputs for extensibility. Scavenging for peripherals to use with such a computer, customizing it, and programming it to solve personally important problems is consistent with both maker and constructionist ideals. The computer hardware industry and leaders in the educational computing world have spent decades deriding Papert's claims that children should build, program, maintain, and repair their own computers, not merely to reduce costs, but as an expression of agency over an increasingly complex, technologically sophisticated world. Emerging technology, like the Raspberry Pi, is resonant with the maker ethos of "If you can't open it, you don't own it," (Jalopy, Torrone, & Hill, 2005) and ideals expressed by Seymour Papert long ago.

Papert's colleagues or former students created many of the favorite technologies of the maker movement, including Scratch, Makey Makey, the Lilypad, and LEGO robotics. The FabLab and FabLab@School efforts to spread learning through digital fabrication also acknowledge Papert's inspiration.

Making Megachange?

Modern making is a brew of new technologies, computation, and timeless craft traditions. The artificial boundaries between disciplines blur and enrich each other.

"So, too, the mega-change in education that will undoubtedly come in the next few decades will not be a "reform" in the sense of a deliberate attempt to impose a new designed structure. My confidence in making this statement is based on two factors: (1) forces are at work that put the old structure in increasing dissonance with the society of which it is ultimately a part, and (2) ideas and technologies needed to build new structures are becoming increasingly available." (Papert, 2000b)

Attend a Maker Faire and you will marvel at the ingenuity, creativity, passion for learning, and desire to share knowledge on display. Maker Faire provides a venue for collaboration, showing-off, and sharing personal inventions. The creation of shareable artifacts is a basic tenet of constructionism. (Ackermann, 2001) Maker Faires, Make Magazine, and web sites like instructables.com provide unprecedented venues for sharing technological project ideas and products.

Look in any direction at a Maker Faire and you will discover children and adults learning and creating together "samba school style." (Papert, 1980) Kids like Super-Awesome Sylvia, Joey Hudy, Quin Etnyre, Caine Monroy, and Schuyler St. Leger embody Papert's belief in "kid power." (Generation_WHY, 1998; Papert, 1998) These, and other children, are beloved heroes, legends, and leaders of the maker movement, not because they are cute, but due to their demonstrable talent, knowledge, and expertise. Like in a samba school, these young experts value their interaction with elders because they share a common goal of continuous growth.

There were one hundred officially sanctioned Maker Faires and Mini Maker Faires around the world in 2013. These events attracted over 530,000 participants. Attendance increased 64% since 2012 and 335% since 2011. "Maker Faire organizers are influencing local education initiatives, encouraging hands-on learning in Science, Technology, Math, Science (STEM) and Art (STEAM) curricula." 27% of Maker Faire organizers in 2013 were museums and many Maker Faire organizers are creating or expanding community-based makerspace-type facilities where the community may learn together outside of a school setting. (Merlo, 2014)

Those explosive numbers only tell part of the story of the explosive growth in making and its influence on winning hearts and minds for constructionism. Maker Faires and Mini Maker Faires are official events sanctioned by Maker Media resulting from a formal application process. Countless other events led by local hackerspaces, clubs, scout troops, plus school-based maker days and Invent to Learn workshops are doing an impressive job of laying the groundwork for a rise in the appeal of constructionism.

Parents in highly competitive independent schools are becoming champions of constructionism based on the benefits of making they witnessed in their own children. Such parental enthusiasm gives lie to the notion that parents want joyless schools focusing on increasing test scores and provide much needed support for educators sympathetic to constructionism, but beaten down by the status quo. After parents at The American School of Bombay participated in a half-day "Invent To Learn" workshop with their children, they began demanding that classroom practice change to incorporate more making.

The maker movement and its accompanying "constructible" technology has resuscitated constructionism in a New York City public school started by Carol Sperry and Seymour Papert in the early 1980s. (Papert & Franz, 1987) Without Tracy Rudzitis' impromptu lunchtime "Maker Space," where the folding tables and freedom transform the learning experience for middle school students, computing would be dead at "The Computer School." (G. Stager, 2014) In countless settings, the "neat phenomena" associated with popular maker technologies, such as 3D printing, Arduino, Makey Makey, squishy circuits, wearable computing, and conductive paint have caused schools to revive school art and music programs, otherwise sacrificed on the altar of budget cuts, tougher standards, or global competitiveness.

The publication of the Next Generation Science Standards, authored by the National Academy of Sciences, (Quinn, Schweingruber, & Keller, 2012) includes specific demands for computer science, engineering, tinkering, and hands-on scientific inquiry to be part of the diet of every American. These standards, written by actual scientists, add gravitas to what some might deride as the playful act of making.

"I think the technology serves as a Trojan horse all right, but in the real story of the Trojan horse, it wasn't the horse that was effective, it was the soldiers inside the horse. And the technology is only gong to be effective in changing education if you put an

army inside it which is determined to make that change once it gets through the barrier." (Papert, 1999)

BILLIONAIRES DISCOVER CODING

Since Constructionism 2012, Silicon Valley executives, pop-stars, basketball players, politicians, government ministers, and the President of the United States have called for children to learn to code. (note: apparently computer programming is now called, "coding.")

If you view programming as an intellectually rewarding activity, then it is surely good news that countless millions of dollars are being spent on initiatives like Code.org, Code Academy, and the creation of computer science instruction via Khan Academy.

Mark Guzdial identifies three reasons for learning to program:

1. That's where the future jobs are, in the mix of computing with other disciplines.
2. The second reason is that a liberal education is about understanding one's world, and computing is a huge part of today's world. We ask students to take laboratory sciences (like biology, chemistry, and physics) in order to better understand their world and to learn the scientific method for learning more about their world. The virtual world is an enormous part of the daily lives of today's professionals. Understanding computing is at least as important to today's students as understanding photosynthesis.
3. If you understand something well, you should be able to define its process well enough for a machine to execute it. If you can't, or the execution doesn't match the observed behavior, we have a new kind of feedback on our theories.

Regrettably, the impetus behind the current desire for "kids to code" seems more rooted in economic insecurity and foreign job killers than recognition that programming is a good way to understand formal systems, make sense of the world or answer Papert's timeless question, "Does the child program the computer or the computer program the child?"

The pedagogical approach preferred by the coding proponents appears to be, "kids will go on the Web and figure it out." In that case, the same paltry percentage of kids is likely to develop programming fluency now than before great wealth and media attention was dedicated to the cause.

Although well intentioned and surely better than another generation of children doing little more with a computer than preparing an occasional PowerPoint presentation on a topic they don't care about for an audience they will never meet, the advocates of coding seem wholly ignorant that many teachers used to teach children to program during the 1980s. Many of these educators taught Logo and the

Logo community developed a great deal of wisdom regarding how, what, why, and when to teach children to program. Dozens of books were written and hundreds of thousands of copies were sold. We danced recursion and acted out procedureality. Now, that knowledge base is largely ignored in favor of catchy slogans and YouTube videos. The constructionism community has a wealth of knowledge to share with coding proponents and a great number of questions as well.

- Which programming languages are best for children to use and why?
- Is computational thinking a fancy term for what Alan Kay calls "computer appreciation?" (Kay, 1996) Is this just a way of providing the illusion of computing without sufficient access or actual experience?
- What are the goals of learning to program?
- How does computer programming support, enhance or build upon other intellectual processes?
- What can kids make with a computer?
- Are computing, coding, and computer science synonymous?
- What should a child at a particular age be capable of programming and which concepts should they be able to put into use?
- What sort of teacher preparation is required in order to realize the dream of computer science for all?

We have no idea what children would be capable of if they programmed computers for a sustained period of time. Although we taught tens of thousands of Australian fifth-seventh graders to program in LogoWriter or MicroWorlds between 1989 and 1995, (Johnstone, 2003) schools substituted computing for report writing, note taking, and office tasks by the time those children reached high school. In many cases, computers once an integral learning appendage, were barely used at all as soon as schooling got "serious" and focused on achievement or careers.

In the current coding for all craze, there is little attention given to the proposition that while programming, students may learn other things or explore powerful ideas concurrently. Programming appears to be a means to an end – becoming a programmer, even if that objective is barely defined or the process is trivial.

Coding advocates also send schizophrenic messages. Somehow, the same people can assert that programming is sufficiently difficult that anyone who manages to learn to code will find herself on economic Easy Street and yet, coding is so simple anyone can do it.

In 2014, code.org launched "Hour-of-Code" in a massive publicity blitz intended to attract the attention of schools. While this sounds like a work of satire, Hour-of-Code attracted President Obama, Bill Gates, Mark Zuckerberg and other cultural icons to record messages supporting the initiative. (Betters, 2014)

The idea of learning anything substantive in an hour seems preposterous. No amount of advertising or cheerleading is likely to result in more schools teaching computer science in a fashion that appeals to a wide variety of children or supports multiple learning styles. Hour-of-Code is an example of what Papert called verbal inflation and reminds us that "When ideas go to school, they lose their power." (Papert, 2000b) By definition, Hour-of-Code must be trivial. Perhaps the goal of "Hour-of-Code" was never really to teach or even inspire kids to program, but to create the illusion that the very same Silicon Valley moguls seeking to dismantle public education aren't so bad after all. (ASU+GSV Summit, 2014; Severns, 2013; G. Stager, 2011; Strauss, 2013, 2014) The cost of such an effort is trivial. "We've now reached 25 million kids, and the entire Hour of Code cost $1.2 million. That's 5 cents a child," said code.org co-founder Hadi Partovi. (Delevett, 2014)

If we stipulate that the motives of the coding advocates are pure, new questions arise when coding is proposed as the purview of schools. Although efforts like code.org would love to infiltrate schools, they are less concerned by where kids learn to code. When a role for coding in school is delineated through governmental policy or curricular statements, the concerns become more even more acute for constructionists.

Coding through school-colored glasses

Conservative UK Education Secretary Michael Gove announced in January 2012 that the national ICT curriculum should be scrapped at once because it is "a mess," "harmful," and "dull." (Burns, 2012) Since Gove's provocative BETT speech several American states, Singapore, and Estonia (Gardiner, 2014) have joined the chorus calling for all students to be taught computer science, even if they have no idea what that means or what is involved in achieving success. The exhaustive Royal Society study commissioned by the UK Government to guide the curricular shift towards every child learning computer science includes thoughts such as, "Computer Science education does not necessarily involve computers." (Furber, 2012) Progress indeed.

The UK National Curriculum is short on actual examples of what a student might *do* or *make* with a computer, but long on vocabulary leaving implementation of the curriculum prone to memorization, not actual computer science. (Berry, 2013; Department of Education, 2013a, 2013b) Regardless of your feelings about the substance of the new UK curriculum, efforts around the world are being met with opposition by the theoretically most "tech savvy" teachers in the system, the existing ICT or computer literacy teachers who are resistant to change. The road ahead seems bleak when you factor in a shortage of qualified teachers, an overstuffed school day, inadequate computer resources and an abysmal participation rate among girls and minorities. (Ericson & Guzdial, 2014; Guzdial, 2006; Guzdial & Reed, 2014) And that doesn't even include a discussion of why so few students are interested in learning computer science even where it is offered.

In the United States, there are proposals in several states to allow Computer Science to earn Foreign Language course credit. (Edutopia, 2013; Guzdial, 2014) Once again,

policy-makers with little understanding of CS hear "language" and think they can check off two boxes at once, foreign language and computer science. Aside from the obvious flaws in this logic, the substitution is as much a symptom of unquestioned curricular heuristics than it is support for high quality computer science offerings. Swapping a subject you have trouble defending for CS is another example of the idea aversion (Papert, 2000b) Papert spoke of.

"Computer science for all" is a laudable objective and a welcome change in direction. The constructionist and maker communities possess a great deal of expertise and wisdom that should play a major role in shaping both policy and pedagogical practice. Without such involvement, this rhetorical effort may do more harm than good.

EPISTEMOLOGICAL POLITICS

At the very moment when incredible new technologies emerge with the potential to supercharge learning, increase ways of knowing, amplify human expression, forge strange alliances, and empower each teacher and student, the School system has never been more draconian. This too is part of Papert's prophetic wisdom.

"I have used Perestroika in the Russian political sense as a metaphor to talk about change and resistance to change in education. I use it to situate educators in a continuum: are you open to megachange, or is your approach one of seeking Band-Aids to fix the minor ills of the education system? The dominant paradigm is the Band-Aid–most reform tries to jigger the curriculum, the management of schools, the psychological context of learning. Looking at the Soviet experience gives us a metaphor to talk about why this doesn't work. For stable change a deeper restructuring is needed–or else the large parts of the system you didn't change will just bring the little parts you did change back into line." (Papert, 1991)

Global trends point towards greater public school privatization, addiction to standardized testing, teacher shaming, union busting, savage urban school closures, the rise of charter schools, national curricula, PISA score competition, the suspension of local democracy via mayoral control of school districts, and sacrificing the art of teaching for the mechanics of curriculum delivery and crowd control. (Crotty, 2014; Ravitch, 2013, 2014) Bill Gates tells us that class size does (Vise, 2011) not matter and that teachers may be replaced by YouTube videos. (Tan, 2013) Propagandistic films intended to stoke parental hysteria like, "Waiting for Superman," play in theatres and on Oprah. (Ayers, 2010; Guggenheim et al., 2011; Karp, 2010; Miner, 2011)

The Rise of Instructionism

In his Perestroika analogy, Papert predicts that constructionism will be met with more instructionism, hopefully until constructionism prevails. One look at the state-of-the-art in educational computing points to a rise in instructionism.

Not only do schools still have computer labs three decades after their creation, but the computers in those labs are increasingly used for computer-assisted instruction, test-prep, standardized testing, and surveillance. Cory Booker, Mayor of Newark, New Jersey said, "Computer programming is quickly becoming an essential career skill. Learning to code is a fantastic opportunity equalizer - if you're good at it, it can help you achieve your dreams." He did this while presiding over a scorched-earth "school reform" regime that eliminated Logo programming, art and music in dozens of elementary schools.

When schools do invest in personal computers, they are likely to buy iPads incompatible with making; what Alan Kay calls "symmetric creation" (Greelish, 2013) or make even worse decisions. The Australian state of Victoria invested $180 million and eight years of distractions in a Gosplan-like fantasy called Ultranet. (Tomazin, 2014) The Los Angeles Unified School District just pledged to spend as much as $2 billion for iPads for the sole purpose of standardized testing in a procurement process only Putin could love. (Blume, 2014; Smith, 2014)

The sudden epidemic of bad teachers proclaimed by politicians and the public's growing dissatisfaction with schooling may be signs of the traditional system crumbling. Can we rise above this period of darkness by lighting a path towards megachange?

"Just 100 years ago, John Dewey was saying things about educational change, not very different from what I believe in. He couldn't get very far. And the reason why he couldn't get very far is that he had only philosophical arguments. He didn't have an army. You must have an army, and it's an army primarily of children and the adults also are a political force in this." (Papert, 1999)

Constructionism is a stance and therefore inseparable from politics. Papert might say that the current chaos plaguing education is "the last flick of a dying dragon's tail." (Papert, 2000a)

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Papert reminds us that we need to shift our self-concept in order to bring about the change children deserve.

"Now there is an opportunity to become the person whose job is to facilitate rethinking the whole learning environment of the school, the whole structure of education. We are entering a period in which the person who was "the computer teacher" has the chance to become the educational philosopher and the intellectual leader of the school, of the education world." (Papert, 1991)

It is inadequate to dismiss schools as relics of the past because that is where you will find millions of kids who need us. Fellow travelers in the maker movement and the unlikely allies behind the coding campaign might be just the army we need inside of

a cardboard horse, with LED eyes, and synthesized speech all controlled by a tiny microcontroller running Scratch.

Let us spend these few days in Vienna celebrating a growing acceptance of our ideas, but then return home to lead and engage in the hard work of improving the learning ecology.

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