The Issue: Moving From STEM Engagement to Motivation to Persist

Jamie M. Bracey, PhD 18 June 2014

STEM (science, technology, engineering and math) education is widely understood to be critical to the United States' ongoing global competitiveness. In fact, the federal government spends nearly $3 billion per year on over 200 programs designed to increase K-12 interest and postsecondary degree attainment. The millions invested by foundations, corporations, benefactors and parents are not included in that figure. Unfortunately there has been little measurable change in STEM engagement, college attendance or workforce readiness, particularly among American minorities and females. Philadelphia mirrors the national disconnect between STEM talent demand, and the projected supply.

Unfortunately, as in all big cities, the Philadelphia public education finance debate is now a toxic political football, punted around with increasingly sad and frustrating results. One of the deepest losses has been the inability to treat STEM as more than a boutique, neo-vocational training activity and more like the innovation ecosystem it really is. But it doesn't have to be this way, and the social innovation that will be described in this article is inspired

by Dr. Martin Luther King's important missive "Why We Can't Wait." In our region, we can't wait to develop cohesive, integrated K-12 strategies to move us from STEM 1.0 (engagement activities) to STEM 2.0 (motivation to persist). Given the nation and region's projected STEM workforce imbalance, social innovation must yield approaches that accelerate cognition, domain competency and the motivation of urban students to lead in these wealth-generating domains.

The Context:

The Creative Tech Works Design Studio (CTW) is a STEM 2.0 model of social innovation. But understanding CTW requires a brief reflection on the STEM 1.0 models that led to its formation. The model emerged from three years of applied research at Temple University. The original goal was to study the impact of expert culture on cognition for urban middle and high school students. Those early STEM programs were often episodic presentations, parent orientations and frenetic summer camps with a million STEM activities. When funding allowed for deeper exposure, the program was heavily geared toward a specific domain.

In spite of the limitations, elements of STEM 2.0 were incorporated, including focusing on approach versus activities and tapping into sociocultural learning theory, which cognitively benefited minority students whose natural culture included high social group connectivity,

dynamic ebb and flow of communication, strong reliance on adults and a desire to compete. Infusing these advantages resulted in award-winning engineering and computer science programs that successfully raised minority student awareness, skills and competencies. Post-program data outcomes included very high increases in the desire to persist in STEM domains. This was critical because most of the students were African American and Latino public school students with limited social inheritance of STEM content knowledge.

Those early STEM 1.0 programs also reflected two core beliefs. First, that the focus on creating STEM curricula and resource materials was premature, and, frankly, a waste of resources when awarded to educators who couldn't figure out how to engage urban students in relevant ecosystems. Second, that engaging urban students would require structural models that allowed adult experts to make the content relevant sooner rather than later. These experts would also need to convey the authentic culture of the domain, giving students the chance to develop an "identity affinity" and a deeper interest they couldn't develop in episodic STEM workshops.

To increase the likelihood of identity affinity and persistence, a culturally relevant, cognitive apprenticeship, teaching and learning framework was used and yielded dramatic improvement in attitudes and procedural knowledge among minority adolescents. The

finding was compelling because it suggested student agency in being a STEMist, a deeper psychological state than just doing STEM stuff, and possibly a correlation with accelerating cognition.

The phenomenon occurred across biomedical research, naval engines design, bioengineering, robotics and computer science, providing significant qualitative evidence that an immersion approach integrating the culture of the domain, socially relevant contexts and rigor would accelerate both cognition and motivation to persist. When the university focus shifted from pipeline to retention, the dramatic achievements of the students in those programs influenced the decision to continue to evolve the approach into a community-based STEM initiative.

The Innovation:

The Creative Tech Works Design Studio is STEM 2.0 at its best. Founded by Worcreation, LLC, the model is a public-private partnership with Beech Community Services, Inc.,

one of the nonprofit entities of Beech Interplex, Inc. The Beech Companies emerged from the William Penn Foundation as a successful and independent community-economic development complex that has leveraged over $1 billion in the transformation of North Philadelphia.

Housed in the Beech Studios, CTW is a cognitive accelerator, a place to rapidly immerse urban high school students in a leadership, design, coding and wearable technology-maker space with one primary goal: to cognitively apprentice their skills in art, advertising, design-based thinking, problem-based learning, technical skill proficiency and historical research to rebrand and "rep" their own neighborhoods.

Without controlling for initial STEM proficiency, the CTW process for achieving STEM 2.0 has been able to avoid the silo approach of STEM 1.0. Instead, experts like Anthony Tyrone Howard (advertising and design), Dr. Ryan Baxter (engineering and wearable tech), Nana Essuman and Tariq Hook (computer scientists) and Christine Brown (community leadership) helped create an opportunity for students to become an extended family of learners in an authentic creative tech-maker space. The total immersion in a safe place for self-professed "geeks" allowed CTW experts to introduce and/or deepen skills in the four elements of the design studio: leadership outreach, the art of design, coding and the wearable technology required to produce a community event, City Streets: North Philadelphia – A Race to Ignite Our History.

Loosely inspired by the television show “The Amazing Race,” City Streets is STEM relevance on steroids. From using WordPress to designing the www.citystreetsphilly.com site, using Java to code the Android app, incorporating the LilyPad Arduino to light up the racers’ t-shirts, structuring the logistics for the routes, working with community leaders at the historic sites, producing the music for the commercial (https://www.youtube.com/watch?v=1DyDU-VBKmU), capturing video for documentaries and games and, ultimately, engaging families and community in their efforts, CTW is a phenomenal demonstration of how culture can be used to accelerate urban student motivation to pursue these domains.

This program is easily scalable across the region, and we are honored to share these exciting developments in STEM cognition. We anticipate that with a Kickstarter campaign, the CTW can replicate in key growth areas in Philadelphia or any major city. In fact, discussions are underway to host CTWs in Chicago, Washington, DC, Accra, Ghana, Salvador de Bahia, Brazil, and Duolo, Cameroon. But North Philadelphia is our home, and we know this model successfully engages urban adolescents in leading their own revolution into the innovation economy.

We hope you will join our movement, because none of us can wait.

Resources:

Bracey, J. M. (2013). Development of a STEM-based cognitive apprenticeship for cultural and linguistic minorities. Presentation at the national conference of the National Action Council for Minorities in Engineering (NACME), October, 2013.

Bracey, J. M. (2013). The culture of learning environments: Black student engagement and cognition in math. In J. Leonard & D.B. Martin (Eds.), The brilliance of Black children in mathematics: Beyond the numbers and toward new discourse, (pp. 171–194). Charlotte, NC: Information Age Publishing.

GAO, Science, Technology, Engineering, and Mathematics Education: Strategic Planning Needed to Better Manage Overlapping Programs across Multiple Agencies.

GAO-12-108. (Washington, D.C.: January 20, 2012). Congressional testimony downloadable at http://www.gao.gov/assets/660/653661.pdf

US Department of Education. Notes on STEM Education. Downloadable at http://www2.ed.gov/about/overview/budget/budget14/crosscuttingissues/stem.pdf

Bio:

Jamie M. Bracey, PhD is an educational psychologist and expert in STEM education, capacity building and community-based economic development. As Director of STEM Education at Temple University's College of Engineering, her areas of responsibility include K-12 STEM pathway development, policy analysis and institutional expertise in accelerating cognition for historically underrepresented groups in STEM disciplines. Dr. Bracey is also the principal of Worcreation, LLC and founder of the Creative Tech Works Design Studio. She is a passionate advocate of providing opportunities to teach students who are motivated to persist how to transform and create wealth.