Innovation Center: Preparing High School Students for the 21st Century Economy by Providing Resources and Opportunities to Create Genuine Projects with Industry Partners (work in progress)

Mr. John Steckel, St. Vrain Valley School District
Ms. Patty Ann Quinones, St. Vrain Valley School District

Patty Quinones new Executive Director of Innovation for the St. Vrain School District will direct the Race to the Top grant (16.6 mil). Her leadership will be critical to execute the STEM Initiatives in this grant. Her lead in the areas of K-12 programming, integrating STEM curriculum in cores, developing teacher professional development, and opening the Innovation Center which will provide a pipeline for all students in the Skyline feeder for a vision of future opportunity and career success. Patty served as Principal at Skyline high school for 5 years , she transformed and formed the STEM & VPA Academies which have currently 500 students as part of these certification programs. She was instrumental in securing grants, business and educational partnerships for Skyline and continues to do this work in her new position. Ms. Quinones also organized efforts to implement: 1 on 1 Laptop Initiative, Mini-STEM Academy in the summer, HS Department of Computer Science, internships & jobs for STEM students. Ms. Quinones has presented at many national and regional educational conferences (ASEE, NSTA, CASE, CoCo STEM Forums). Co-authored: Best Practices in High school and Higher education.

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Dr. Daniel Knight is the Program Assessment and Research Associate with the Design Center Colorado in the Department of Mechanical Engineering, College of Engineering and Applied Science at University of Colorado Boulder. Dr. Knight's duties include assessment, program evaluation, education research, and teambuilding for the Center's hands-on, industry-sponsored design projects. Dr. Knight's research interests are in assessment, teamwork, K-12, and engineering for developing communities.

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If we want to change education and learning to make it more relevant, more effective and more enjoyable for all involved, teachers need to be the entrepreneurial designers and re-designers of the systems of schools and of the schools themselves. - IDEO

Introduction

We live in a technologically-driven society. Advancements in systems and tools that impact everyday life are increasing as STEM (science, technology, engineering and math) disciplines combine efforts to solve problems. The influx of students into many STEM disciplines in U.S. colleges is not following the pace of this growth. The National Academies' *Rising Above the Gathering Storm, Revisited* (2010), says that despite an increasing population of minority students, we are not attaining a diverse population in STEM undergraduate programs. While the number of U.S. engineering degrees in the U.S. has risen recently, it has not approached the historic highs of the 1980's (National Academy of Engineering, 2011). Yet, for U.S. STEM students to remain sensitive to the needs of society, the demographics of students must become representative of the nation's population. This call is especially pronounced in the field of engineering.

These representative numbers can only be realized through increased preparation of college-age students. Undergraduate engineering has become a test bed for pedagogy to increase student interest and abilities, reflecting the progress of cognitive development research in STEM learning. Analysis of best practices can improve instruction at all levels, including K-12. Above all, an environment to nurture problem solving and innovation skills is imperative. Unfortunately, there are few K-12 settings for students to obtain real-world experience that might attract them to STEM careers. To address this problem, the St Vrain Valley School District Innovation Center (IC) was created as part of a Federal Race to the Top grant. The IC is purposed as a design incubator to bridge the academic and career-readiness pathways for STEM students in a high school setting. The IC matches skilled students with STEM professionals to create intellectual property and to encourage entrepreneurial ambitions.

Background

An increase in K-12 STEM – and specifically engineering – programs has been on the rise in the United States. This is partly due to increased research on learning, as well as the realization that U.S. students are falling behind internationally on test scores. Now perceived as a national imperative, governments have allowed additional resources for STEM-focused K-12 programs.

In quality K-12 STEM initiatives, a few strategies are in the forefront, including situated and project based learning (PBL). Both strategies have roots in experiential education, inviting students to follow through a project from a problem to final product (Vincini, 2003). Research suggests that PBL engineering design courses are key elements for retention of undergraduate engineering students (Knight, Carlson, & Sullivan, 2007). At the K-12 level, research suggests that higher exposure to engineering during K-12 leads to higher self-efficacy in undergraduate first-year engineering (Fantz et al., 2011). It is expected that approaches designed for retention of undergraduate engineering students might help in attracting K-12 students to engineering (Ohland et al., 2008).

In 2006, the National Academy of Engineering formed the Committee on K-12 Engineering Education to identify best practices for K-12 engineering instruction (Katehi, Pearson, & Feder, 2009). The Committee found evidence of improved learning through K-12 engineering programs, and recommends that engineering learning can be enhanced by utilizing a real-world context in the K-12 classroom through partnerships with the local community (Katehi et al., 2009). K-12 STEM programs are capitalizing on these recommendations by designing specialized learning spaces fashioned after undergraduate engineering spaces (Seale & Abo-Shaeer, 2013).

The K-12 STEM Initiative

The Skyline feeder system within the St Vrain Valley school district is a high URM/low-SES feeder where 46% of the students are Hispanic and 59% are from low-income families. The STEM initiatives that are part of the district approach to school reform have provided a pathway for students to succeed in advanced education and a competitive global economy. In 2012, the district received a federal Race To The Top grant to improve feeder functioning through integration of STEM.

Historically, this effort began in 2006 when the search for a new focus for a traditional high school led to the creation of a new STEM Academy. A course pathway was developed with every grade level required to take specific engineering and computer science courses. Students gain experience in a variety of STEM fields including robotics, biotechnology, and renewable energy. Qualified graduates of the Academy are guaranteed admission into the engineering college at the University of Colorado Boulder. Currently, there are 400 students enrolled. The STEM Academy is connected to the IC through the Academy's Capstone Design Projects. These involve projects in engineering and computer programming which are accomplished with IC support. This allows for strong alignment of the Academy's curriculum with IC resources.

The Innovation Center

The St Vrain Valley School District's Innovation Center (IC) seeks to invent a pipeline for K-12 students into our top university STEM programs, preparing young people for careers in industry. An additional goal is focused on allowing students within the IC to experience real work for compensation.

The IC is currently operating in a newly remodeled 6,000 square foot design environment tailored to student inventors, designers, and entrepreneurs, with learning objectives that include analytical problem-solving skills, collaboration, entrepreneurship and innovation. The Center has a main office, a conference (pitch) room and student design spaces. The student design spaces include a collaboration area, fabrication shop, and an electronics lab. The electronics lab is designed and sponsored by SparkFun Electronics. The partnership with SparkFun Electronics goes beyond equipment, supplies and tools to include professional development, curriculum and industry expertise for IC students and staff.

Along these lines, a variety of industry partnerships have been developed to support schools with STEM expertise, mentoring and resources. Our students will support these clients with designs including prototypes, mobile apps and websites. A web-based, two-way portal allows business clients to propose projects to students and bid on projects proposed by students. IC students find other outlets to showcase their design projects to the public via the in-district STEMCOM and University of Colorado's Design Expo where students create posters and demonstrate hardware. The Design Expo also implements judging in a design competition.

Initial Accomplishments

This past summer, the IC was hired by three clients to produce two mobile apps including a point of interest app and a data collection app; the third project was to redesign a website. Students were selected based on their skill set and worked on a team to complete the project. They were compensated for the work by making $10 per hour.

For a preliminary understanding of program impact, STEM Academy students were surveyed with an attitude survey to determine STEM interest, efficacy, and identity scores. This survey has been previously developed and validated (Zarske et al. 2012) Table 1 presents the results broken out by our largest ethnic sub-groups. Overall, STEM Academy students demonstrated favorable STEM attitudes for interest, efficacy, and identity with attitudes towards efficacy the highest. STEM identity scores were lower for Hispanic students possibly indicating a greater need for a STEM community. It is hoped that this community will be supported by the development of the Innovation Center.

Conclusion

The high-tech needs of our modern society require a technically educated workforce. These needs provide opportunities for larger sections of society to participate in STEM fields, particularly underrepresented minorities and individuals from low SES backgrounds. A K-12 setting provides an ideal opportunity for reaching these individuals as they are embarking on their careers.

STEM interest, efficacy, and identity are all expected to be increased via exposure to hands-on, team-based technical design projects supported by the Innovation Center (IC). Although the initial center is up-and-running, plans have been made for a larger 40,000 square foot stand-alone facility to further develop the next generation of innovators. The IC will support K-12 students as innovative risk-takers who are internally motivated to strike out on their own as their careers unfold. This effort will be disseminated as a a starting road-map for school districts that have a desire to expand K-12 engineering out of the classroom and into the community.

Table 1: STEM Academy Attitude Survey Results, Fall 2013

Skyline STEM Pre-survey (n = 203, Grades 9-12)			
Answer Options (5-point scale, 5 = Definitely)	**Average**	**Hispanic Average**	**Caucasian Average**
STEM Interest	**4.32**	**4.37**	**4.29**
STEM Efficacy	**4.56**	**4.49**	**4.58**
STEM Identity	**4.03**	**4.20**	**3.94**

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