STUDENTfacturED:Providing a Way to "STEM" Out from Behind Old School Walls and Into the Real-World Workplace

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ABSTRACT

While the number of US businesses based on science, technology, engineering, and mathematics (STEM) fields has increased steadily over the past decade, the number of students completing STEM degrees is barely 10% of all conferred degrees. Additionally, US teens interested in pursuing a STEM career perceive major obstacles in their ability to achieve this goal. These obstacles include college readiness, learning effort required, and the high cost and lengthy time commitments. This negative perception may relate to how STEM education is delivered and the lack of opportunities to apply knowledge learned. To counter the negative perception, Salt Lake Community College has developed and implemented STUDENTfacturED, a student-run biotechnology manufacturing company that provides a mechanism to shift learning away from the old school experience toward real-world contextual application.
Keywords: STEM, Conference Proceedings, Teaching Quality, Hands-on learning

INTRODUCTION

Despite considerable efforts expended toward increasing interest in STEM majors/careers, US colleges are still reporting low STEM enrollment numbers, and even lower completion numbers. According to the National Center for Education Statistics (2011), the number of STEM-related degrees or awards conferred by US Title IV institutions in 2001 and 2009 are 385,842 and 433,742, respectively, which represent 12.9% and 10.7% of all conferred degrees and awards at those times.

Why is interest in and completion of STEM programs and careers so low? One part of the answer might lie in the finding that high school students are not ready for college level STEM coursework. For example, a Battelle report (2009) commissioned by the Biotechnology Industry Organization reported that only 28% of 8th grade students in the US who have taken the American College Testing (ACT) exam are ready for college-level biology. Examination of 2011 ACT College Readiness Benchmarks (ACT, 2011) results show that while more than half of the ACT-tested high school graduates met the English and Reading benchmarks (66% and 52% of graduates, respectively), just 45% met the Mathematics benchmark and only 30% met the Science benchmark. Overall, an appalling 25% tested met all four of these benchmarks. Sadly, the benchmark results have fluctuated little over the past five years.

Another part of the answer may be students' perception of STEM career paths. A recent American Society for Quality survey of US teens (2012) revealed that while 6th to 12th graders surveyed recognize the job prospects potential in STEM fields, 67% of respondents interested in pursuing a STEM career were also quite concerned about obstacles in their path to success – specifically, (1) preparation to handle college-level STEM subjects, particularly math and science, (2) the amount of effort (work and studying) required for STEM degree careers, and (3) the high cost and longer time commitment necessary to get a STEM degree. Interestingly, the ACT college readiness benchmark results align with students' perception of their preparation for college-level STEM subjects. This would suggest that improving college readiness, particularly for science and mathematics, could improve STEM perception.

Perhaps yet another part of the answer relates to how STEM education is delivered. Many, if not most, STEM fields focus on giving students vast amounts of complex scientific and technical concepts to master without also teaching them how such knowledge is applied or other related practical skills. The missing connection between knowledge acquisition and application is likely contributing to the perception that STEM degrees and careers are difficult and require hard work. Moreover, if students lack the capability to apply their own knowledge, they will experience considerable adjustment once they land a STEM job.

METHODOLOGY & FINDINGS

Salt Lake Community College has taken a groundbreaking step toward STEM education transformation by developing and implementing **STUDENTfacturED**, a student-run biotechnology manufacturing company that provides a mechanism to shift learning away from the old school experience toward real-world contextual application. The company launched in January 2012 and placed its first cohort of biomanufacturing students to "work" alongside business students to collectively operate this business/training enterprise. The company's business focus is on the production and sale of laboratory supplies to support biotechnology laboratory courses taught at the college, and at local high schools for college credit. The training side of STUDENTfacturED gives students an opportunity to apply their knowledge and skills in a real job setting, and thus gain valuable practical work experience. The authenticity of this experience makes it on-the-job training, *before the job*.

The students, under the guidance of a faculty mentor from the Accounting, Biomanufacturing, Business Management, or Marketing programs, were assigned one or more functions critical to STUDENTfacturED operations. Without hesitation, they excitedly and energetically immersed themselves in assorted activities on both the business and science/technology sides of the company. To provide the most realistic work environment, the mentors planned to guide using a hands-off approach, and so expected the students to apply and integrate previous and newly learned knowledge, communicate with each other, engage in teamwork, and even experience those frustrations typical of start-up companies. The goal was to allow the students to perform as much of the work as they could handle.

The outcomes observed for this first cohort were mixed. The students were very capable of handling work within their discipline, generating some impressive and important contributions. However, their limited understanding of biotechnology, and other science and technology fundamentals, hindered them from handling work outside their sphere of knowledge. Before drafting the production documents necessary to control manufacturing, the biomanufacturing students needed to understand the circumstances leading to the agreement to make custom products for a single customer and how these products would be used. In the process of costing out the manufacture of these custom products, the accounting students had to learn about the product as well, but their science background was too limited to allow them to translate raw materials and supply specifications into potential purchase selections for manufacturing. Most impacted of all were the marketing students who failed to develop and execute a product survey, a critical market research tool that would allow STUDENTfacturED to identify what the company's first products should be. Without this information, the business management students were not able to complete the business plan.

These observations mirror the situation that new-to-the-industry workers typically find themselves in when they land that first job. These individuals often find they do not have a broad enough knowledge and skills base to be able to work at "full throttle" from day one. In

most STEM businesses, the technical knowledge base is crucial to effective performance for not just the technical workers (e.g. the scientists, engineers, and production workers) but for the business support workers as well. Marketing is a prime example of this – to be able to successfully represent and sell a company's products, the marketer must have a good understanding of the products' functions, features and limitations and be able to communicate this information to the targeted customers, who are often very knowledgeable and can keenly detect a naive representative.

Another significant finding is the students' inability to handle and overcome the knowledge limitation barrier. This observation is a clear indication that the students' trouble-shooting and problem-solving skills are weak. This is also a common complaint that employers, particularly those in high-tech industries, have of their employees. It appears that STUDENTfacturED has mimicked a real company, common workplace problems and all.

CONCLUSIONS & FUTURE WORK

STUDENTfacturED most certainly provides students with an environment to apply their knowledge for a real-world purpose and receive feedback the application. As the Plan-Do-Check-Act process is meticulously applied to STUDENTfacturED's first semester of operations, it is clear that modifications are required to improve the students' learning experience. One such modification is finding a feasible method to deliver relevant biotechnology and STEM-based knowledge to students who are not engaged in a STEM program of study so that they may have the necessary understandings to better perform their assigned tasks for the company. A second modification is providing students with the tools and thought processes essential to trouble-shooting and problem-solving. These improvements, as well as others to come, should allow STUDENTfacturED to cultivate students for a career in a STEM industry, and to support President Obama's "Educate to Innovate" campaign to improve STEM education in the US.

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Vivian Ngan-Winward earned a Ph.D. in Molecular Biology & Biochemistry from Wesleyan University in 1991. After nine years in academic research, she entered the biotechnology industry, working as a scientist in R&D as well as regulatory affairs. In 2008, she returned to academia, as the Biomanufacturing Program Director at Salt Lake Community College, to develop and implement a biotechnology manufacturing training program with a quality and regulatory focus. She currently holds ASQ CQIA and CQE certifications. She can be reached at vivian.ngan-winward@slcc.edu