Chapter 2
Cloud Computing as a Catalyst for Change in STEM Education

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ABSTRACT

Cloud computing drives value to profit-centric businesses by establishing a utility computing model, allowing companies to focus on their core business function rather than concern themselves with the "plumbing" associated with technology infrastructure. How then, can this profit-centric model be applied to improve the delivery of Science, Technology, Engineering, and Math (STEM) education? Studies indicate that students perform far better in the workplace if their education in technical fields is relevant, current, and based on real-world scenarios (Pryor, 2014). If businesses are operating in the cloud, STEM education must follow suit. While cloud computing is traditionally associated with profit-centric organizations, this model has demonstrated benefits to non-profit and government organizations as well in terms of reduction of enterprise costs and time to delivery of new products and services. Even when a profit motive is non-existent (or at least not central to the mission of the organization), cloud computing can be a catalyst to transformative improvements in the academic community. As organizations adopt cloud computing, they must face changes in core business practices in order to take advantage of the on-demand service, rapid elasticity, and broad network access associated with cloud computing (Mell & Grance, 2011). Businesses must transform their business architecture in order to adopt this new technology architecture effectively. In the same vein, educators must consider how their business processes (i.e., pedagogy) must change in order to adopt this technology. This chapter considers cloud computing as a technology enabler for STEM education, and how it requires dramatic changes in pedagogy in order to ensure that STEM education is relevant, useful, and effective in the digital world.

INTRODUCTION

Trends in STEM education are directly related to the currents needs in society. To ensure the status of the United States, the populace must be trained to meet workforce requirements. "Current educational initiatives in science, technology, engineering, and mathematics (STEM) education

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are placing increased emphasis on the importance of engineering education for providing the skills necessary for the 21st century" (Strimel, 2014, p. 16). In response to societal needs, President Obama (2011) during a speech shared that "over the next 10 years, with so many baby boomers retiring from our classrooms, we want to prepare 100,000 new teachers in the fields of science and technology and engineering and math" (State of the Union, p. 1). In reaction to educational initiatives and societal needs, movements have begun to promote the education of future generations. In fact, "the Next Generation Science Standards and the National Assessment of Educational Progress's Technology and Engineering Literacy Assessment promote the idea that citizens need to be technology and engineering literate" (Strimel, 2014, p. 16).

For the United States to stay competitive in the world, STEM related careers must be promoted. The results of properly promoting STEM education will have positive effects in the U.S. for generations to come. The results of a study performed by Maokler and Kim's study (2014), they found that "through student interaction with role models, mentorship programs within higher education, career-linking program with industry, and outreach programs" (p. 8) students would cultivate optimistic expectations toward STEM related fields. In fact, they found that "students with parents who work in STEM-related occupations were 1.5 times more likely to develop an outcome expectation to pursue STEM majors" (Maokler & Kim, 2014, p. 8), hence, a multi-generational strategic educational plan geared toward positive STEM experiences and promotion of STEM careers at all levels of education would greatly benefit the United States status in the future.

Trends in Cloud Computing

According to the U.S. National Institutes of Standards and Technology (NIST), cloud computing is a model for providing scalable and extensible computing resources to end users based on demand (Mell & Grance, 2011). This model applies the concept of the public utility (e.g., water, power) to computing resources. Just as individuals do not generally know how much infrastructure is necessary to power a light bulb, end users of cloud computing platforms do not know or need to know about the infrastructure necessary to provide computing power for their needs. Cloud computing is the latest in a trend of utility computing models that essentially dates from the original models of distributed computing dating from the 1960s (Sahlin, 2013). Cloud computing allows the consumer to focus on the business need rather than the underlying technology: consumers are not concerned with the number of servers or switches, they only care that when they flip the switch, they get light.

Cloud computing in its current form started primarily as a model for reducing capital expenditures necessary to build traditional data centers and evolved from the Application Service Provider (ASP) industry from the late 1990s and early 2000s (Sahlin, 2013). The original argument was that small- and medium-sized companies would be able to provide enterprise-class capabilities and service levels without multi-million dollar expenditures. This concept eventually evolved to include multiple delivery models for cloud computing. NIST officially recognizes four delivery models as described in Table 1 below.

These current models have been recently adapted based on business needs. The public model of usage-based pricing, on-demand resources, and consumer self-service has become an attractive model for business units with the need to execute with speed and agility to stay ahead of their competition. As these offerings require little (if any) capital investment, the control of IT spending has begun to shift away from the CIO and toward the Business Unit General Managers who are willing and able to fund IT outsourcing via the cloud to execute to their business needs faster than the traditional IT organization. This decentraliza-