Chapter 18
An Authentic and Sustainable STEM Pre-Service Teacher Professional Development Model:
Authentic Learning Experience and Preparing for Tomorrow's STEM Professionals

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ABSTRACT

Developing a strong STEM teacher workforce is essential to improve K-12 (kindergarten to 12th grade) STEM education and strengthening the STEM talent pipeline in the United States. Based on the successful experience in Project Engage, a grant funded by the U.S. Department of Education, this chapter proposes an authentic and sustainable four-dimensional STEM professional development model. Grounded on social constructivist and interactive approaches, this professional development model is intended to cultivate STEM pre-service teachers' ability to 1) provide K-12 students with authentic STEM learning experiences as defined in the four types of authenticity (i.e., context authenticity, task authenticity, impact authenticity, and personal/value authenticity) identified by Strobel and his colleagues; and 2) help K-12 students develop knowledge of STEM careers and professional, abilities to work in the STEM fields, and ways of working as STEM professionals as summarized by Rogers and Sun.

DOI: 10.4018/978-1-5225-8583-1.ch018

INTRODUCTION

Continued U.S. competitiveness in an increasingly global economic environment relies heavily on an adequate supply of qualified STEM (science, technology, engineering, and mathematics) workforce (National Research Council, 2011; National Science Board, 2015; President's Council of Advisors on Science and Technology, 2010; U.S. Department of Labor, 2007). According to the U.S. Bureau of Labor Statistics, the future of the economy and the jobs of tomorrow are in STEM (U.S. Bureau of Labor Statistics, 2014). STEM related jobs have been projected to grow more than 9 million between 2012 and 2020 (U.S. Bureau of Labor Statistics, 2014) with already 8.6 million STEM jobs in May 2015 (U.S. Bureau of Labor Statistics, 2017). Unfortunately, going alongside with the high and increasing demand for STEM workers is the shrinking STEM workforce pipeline. The attrition rates for U.S. undergraduate students who major in STEM disciplines are high (Hayes, Whalen, & Cannon 2009; Moakler & Kim, 2014; Tinto, 1993). Data from the 2004/2009 Beginning Postsecondary Education Longitudinal Study indicates that many students who begin college in STEM majors will either change to a non-STEM major or leave college completely. In the U.S. about 28% of students seeking a bachelor's degree or associate degree between 2003 and 2009 entered a program of study in a STEM field. An attrition rate of 48% for bachelor's degree candidates and an attrition rate of 69% for associate degree candidates were obtained for the assessed period (Chen, 2013). As a result, the number of science and engineering graduates produced in the U.S. is among the lowest in the world (National Science Board, 2004).

To boost economy and to maintain its innovative capacity, the United States must deal with the urgent need of improving K-12 STEM education and cultivate its domestic STEM talent pool. The question is, how? Teachers do make a difference in student learning experience and learning outcomes, and this is particularly true in STEM disciplines (CADRE, 2011). Cultivating among K-12 students an interest in STEM and encouraging them to study STEM in college and later pursue STEM as a career requires developing a strong STEM teacher workforce who not only has solid STEM content knowledge but possesses in-depth understanding of STEM careers and how STEM disciplines are used in the workplace. The development of such a STEM teacher workforce should start with STEM pre-service teachers.

While most U.S. students do not get a series of good teachers, STEM teachers are particularly poorly prepared (CADRE, 2011). Teacher related issues, such as a dearth of well-prepared teachers, teachers' lack of STEM content knowledge, and lack of effective STEM teacher professional development (Abel & Lederman, 2007; Fulp, 2002; National Academy of Engineering, 2009; Sun & Strobel, 2013, 2014; van Driel, Beijaard, Verloop, 2001; van Driel, Verloop, de Vos, 1998), render it a daunting task to develop a strong STEM teacher workforce. The present chapter seeks to contribute to the effort of developing a strong STEM teacher workforce in the U. S. by proposing an authentic and sustainable four-dimensional professional development model for preparing pre-service STEM teachers. This pre-service STEM teacher professional development model was developed based on *Project Engage*—a three-year grant (2011-2014) funded by the U.S. Department of Education at the University of West Alabama.

Grounded in authentic learning theories and applying social constructivist and interactive approaches, the authentic and sustainable four-dimensional professional development model is intended to provide systematic support to STEM pre-service teachers allowing them to enrich their STEM content knowledge and STEM pedagogical content knowledge (PCK), gain insight into STEM careers and real-world STEM applications, to broaden their horizons of the STEM disciplines, and to enhance their abilities to prepare future STEM professionals.