Chapter 5
Systematic Support for STEM Pre-Service Teachers:
An Authentic and Sustainable Four-Pillar Professional Development Model

Reenay R.H. Rogers
University of West Alabama, USA

Jodie Winship
University of West Alabama, USA

Yan Sun
University of West Alabama, USA

ABSTRACT

Developing a strong STEM teacher workforce is essential to improve K-12 (kindergarten to 12th grade) STEM education and to strengthen 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-pillar 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 provide K-12 students with authentic STEM learning experience 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 (Strobel, Wang, Weber, & Dyehouse, 2013).

INTRODUCTION

While no one would deny that the U.S. economic growth and innovative capacity are ever increasingly relying on discoveries and advances made possible by STEM (science, technology, engineering, and mathematics) disciplines, there is no secret that U.S. students are scared of STEM and have been lagging behind their international peers in STEM. The attrition rates for U.S. undergraduate students who major

DOI: 10.4018/978-1-4666-9471-2.ch005

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-pillar 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-pillar 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 insights into STEM careers and real-world STEM applications, and to broaden their horizons of the STEM disciplines..

BACKGROUND

Status Quo of K-12 STEM Education

The importance of strengthening and improving K-12 STEM education to the U.S. economy and competitiveness on global markets has long been acknowledged (NAE, 2004; NAS/NAE, 2007; NSB, 2007; NSB, 2008). Despite the importance and the estimation that STEM related jobs will grow 70 percent faster than other jobs in the next six years (Vann, 2013), low numbers of students pursing STEM disciplines and degree programs have been a big national concern (National Science Board, 2010). Troubling statistics persist: while 25% of high school kids drop out of high school and 57% out of those who do