Chapter 3
An Investigation of the Effects of Integrating Computing and Project- or Problem-Based Learning in the Context of Environmental Sciences:
A Case of Pakistani STEM Teachers

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ABSTRACT

The chapter reports the results of integrating computing, project or problem-based learning and engineering process to address the needs of preparing the STEM workforce in Punjab, Pakistan through transforming STEM teaching and learning processes. It also aimed to build the capacity of the University of Education, Lahore to improve the quality and relevancy of its STEM teacher education programs and its partnership schools. A collaborative team of STEM and STEM education faculty from two U.S. universities and University of Education (UE), Lahore designed,

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developed, implemented, and evaluated STEM learning units with a specific focus on water and management of natural resources to under-served 6-8 grade students in Pakistan through the integration of project-based and problem-based learning (PBL) and Squeak Etoys, modeling, and simulation tool.

INTRODUCTION

The critical role that science, technology, engineering, and mathematics (STEM) workforce play in the sustained growth and stability of a country's economy is universally recognized. Increasingly STEM education is becoming known as a key driver of opportunity and a critical determinant of the level of innovation (Buckner & Boyd, 2015; Dutta, 2011; U.S. Department of Education, 2016). Data show that the need for STEM knowledge and skills will grow and continue to grow into the future. Thus, a well-prepared, skilled STEM workforce is a significant driver of innovation and contributes to significant economic productivity, both in developed and developing countries. However, preparing a STEM workforce that is creative and uses critical thinking and problem-solving skills to find innovative solutions requires creating a learning environment in which students engage in solving complex authentic and community-based problems, working with others (peers and local businesses), and developing real solutions (Fortus, Krajcikb, Dershimerb, Marx, & Mamlok-Naamand, 2005). STEM education that prepares the future workforce, therefore, should engage students of all ages in facing these grand challenges. According to the U.S. Department of Education (2016), grand challenges are those that are not yet solved at the local community, national, or global levels. These challenges among others may include, for example, problems related to water conservation or improving water quality, a better understanding of the human activities to manage water resources and; development of new technology-enabled systems for improving access to natural resources (Office of Science and Technology Policy, n.d.). Thus, creating a rich, experiential, and flexible learning environment that provides opportunities for the STEM workforce to explore the above-mentioned grand challenges requires innovative STEM education. Studies show that (e.g., NAE & NRA, 2014) an integrated approach to STEM education could provide such a learning environment. The integrated STEM approach emphasizes teaching all four subject areas (often taught separately) and underscores the application of knowledge to real-life situations. Flexibility in the learning environment, access to learning technology and learning materials in the classrooms as well as in the natural world further enhances students' STEM learning experiences and promotes opportunities for exploring STEM concepts and developing STEM skills. Global studies, however, indicate that deficiency of resources, as well as lack of professional development for teachers to engage students in deep-learning, has resulted in a lack of scientific