

Chapter 7

Developing Science Pedagogical Content Knowledge (PCK) Among Preservice and Novice Elementary Teachers

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ABSTRACT

In this chapter, the author focuses on elementary-level practicing and pre-service teachers' development of pedagogical content knowledge (PCK), beginning with the state of U.S. students' science performance, and science instruction in elementary school settings. The historical development of studies related to teachers' knowledge forms (content, pedagogical, and pedagogical content) are explored individually, along with an investigation of models of PCK, PCK specific to teaching science, and studies on strategies for facilitating PCK development among elementary teacher candidates and in-service teachers.

INTRODUCTION

STEM (science, technology, engineering, mathematics) proficiency in the United States has long been in a state of decline, negatively impacting America's economy and security. Its citizens are not filling U.S. STEM jobs; to keep these positions filled, America relies on immigrants. International students are increasingly coming to

DOI: 10.4018/979-8-3693-0655-0.ch007

the US to be trained in STEM and then remain here to fill vacant STEM positions (Herman, 2019).

American students have been lagging behind other nations' science academic success for years (Santau et al., 2014). While other countries have greatly improved their students' science test scores, the United States' students' science scores have remained stagnant since 2006. The most recent PISA (2015) results indicated that the US ranked 24th out of 71 countries in science and the gap between high and low-performing students in science continues to increase (NCSES, 2019). Of the 35 OECD (Organization for Economic Co-operation and Development) countries, the US ranked 19th. In 2015 (most recent), scores from the National Assessment of Educational Progress revealed that only 35% of U.S. fourth graders were proficient or better in science. And, according to the TIMSS study (Trends in International Mathematics and Science Study) from 2105, of 48 countries, seven outperformed the U.S. in fourth-grade science. Finally, of U.S. high school students planning to attend college, only 20% were prepared to pursue STEM degrees (Committee on STEM Education, 2018). In contrast, U.S. colleges and universities offer some of the best STEM education programs globally, and America continues to be highly attractive to international students, especially those pursuing STEM degrees at both the graduate and undergraduate levels (Herman, 2019). In addition, STEM jobs in the U.S. have grown over four times that of other jobs, yet STEM positions continue to be unfilled by native U.S. citizens (Hossain & Robinson, 2012). This STEM crisis in the United States threatens our national security, economy, and world standings in STEM. We must address the problem where it begins, in the U.S. K-12 educational system, a system failing to motivate students in STEM.

The State of U.S. Science Education in Elementary Schools

U.S. children's first formal experiences with science should take place in the early grades of elementary school, and when they receive these expected experiences, firm foundations in science are established (National Research Council, 2012). Strong and early experiences with science are critical for the development of children's science content knowledge, science positivity, science-confidence, for promoting their science literacy and development as socially responsible citizens (King et al., 2001), and for promoting their interest in STEM fields. Yet, science in elementary schools continues to be either ignored, greatly diminished or taught mostly via direct instruction (Blank, 2012). In fact, instructional time devoted to science in elementary schools has declined since the *No Child Left Behind Act* of 2001, which placed priority on reading and mathematics, by 75 minutes per week (Center for Education Policy, 2008; National Research Council, 2012). By 2018, children were taught science on average, only 18 minutes per day, while they received

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