

## Chapter 3

# Using Virtual Environments to Motivate Students to Pursue STEM Careers: An Expectancy–Value Model

**Jason A. Chen**

*The College of William and Mary, USA*

**Nick Zap**

*Simon Fraser University, Canada*

**Chris Dede**

*Harvard University, USA*

### **ABSTRACT**

*The purpose of this chapter is to bring a rigorous and well-studied theoretical framework of motivation to the study and design of virtual learning environments. The authors outline the key motivation constructs that compose Eccles and Wigfield's Expectancy-Value Theory (e.g., Eccles, et al., 1989; Wigfield & Eccles, 1992, 2000), and how it can be used in the creation of a virtual learning environment designed to promote students' interest in and motivation to pursue Science, Technology, Engineering, and Mathematics (STEM) careers. In addition, using Brophy's (1999) model of the motivated learner, the authors outline how this type of motivational virtual environment can be incorporated in classroom instruction to further bolster adolescents' motivation and competence in mathematics. Finally, they describe a NSF-funded project underway at Harvard's Graduate School of Education that seeks to develop a 4-day mathematics intervention, merging innovative technologies with regular classroom instruction to spark students' interest in STEM careers.*

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## INTRODUCTION

There is no learning without engagement, a situation that happens all too often in our typically lecture-based classrooms. At the same time, engagement without learning, which frequently happens in today's digital worlds, is not a healthy alternative. Some claim that online gaming is the answer to engaging and motivating students in their academic work. Yet, students can frequently be engaged in these virtual worlds without actually learning anything or being more academically motivated. In this chapter, we argue that Eccles and Wigfield's Expectancy-Value theory (e.g., Eccles, 1983, 1987, 1993; Eccles, et al., 1989; Wigfield, 1994; Wigfield & Eccles, 1992, 2000) offers researchers, educators, and designers useful and theoretically grounded motivation constructs that can be empirically studied in educational contexts. These constructs potentially provide a powerful way of linking engagement and learning.

In the first part of the chapter, we provide an overview of the theoretical frameworks in which prominent *expectancy* and *value* motivation constructs are based. In the second part of the chapter, we situate motivation within a larger picture—Brophy's (1999) model of the motivated learner, which extends Vygotsky's (1978) cognitive Zone of Proximal Development (ZPD) by incorporating a motivational ZPD. As a case study for the application of Brophy's model of the motivated learner, we describe a NSF-funded project underway at Harvard's Graduate School of Education called *Transforming the Engagement of Students in Learning Algebra* (TESLA). The chapter ends with a description of the design decisions in creating a motivating virtual environment for mathematics students in Grades 5-8, along with implications for educational practice.

## EXPECTANCY-VALUE MODELS OF MOTIVATION

Although there has been a wealth of research exploring motivation within technological environments, very few of these studies employ frameworks that are grounded in well-studied theories of motivation (Moos & Marroquin, 2010). Eccles and Wigfield's Expectancy-Value theory of motivation (e.g., Eccles, 1983, 1987, 1993; Eccles, et al., 1989; Wigfield, 1994; Wigfield & Eccles, 1992, 2000) provides a useful framework for understanding students' beliefs about how competent they are and what they value within the context of their academic studies. The motivation constructs we describe below are theoretically grounded and have been extensively studied in educational contexts.

### Expectancy Beliefs

Students are motivated toward or away from particular activities by answering the question, "can I do this?" This question lies at the heart of the expectancy component of Eccles and Wigfield's model. In this section of the chapter, we describe the following three expectancy constructs: causal attributions, implicit theories of ability, and self-efficacy. We first situate each construct within its theoretical home, and then describe its correlates and antecedents.

*Causal attributions:* Imagine you have just failed an important math test. What do you do when you discover this troubling news? According to contemporary attribution theorists, you are likely to search for a cause to your failure. Perhaps you failed because you were in a bad mood that day. It is also possible that you believed the test to be too difficult, or because you did not apply the appropriate study strategies when preparing for the test. You might also believe that you simply do not have the math "smarts" necessary

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