Chapter 11
A Theoretical Framework for Implementing Technology for Mathematics Learning

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ABSTRACT
This chapter details a theoretical framework for effective implementation and study of technology when used in mathematics education. Based on phenomenography and the variation theory of learning, the framework considers the influence of the learning context, students’ perceptions of the learning opportunity, and their approaches to using it upon measured educational outcomes. Elements of the TPACK framework and the CTFK model of teacher knowledge are also addressed. The process of meeting learning objectives is viewed as leading students to awareness of possible variation on different aspects, or dimensions, of an object of mathematical learning.

INTRODUCTION
Implementation and study of technology within the mathematics curriculum must consider an appropriate theoretical framework. Leading theories of mathematical learning tend to focus upon one particular aspect of learning: cognition, social interaction, or context. Further, technology use and educational research based upon these theories limit focus to the primary considerations of the chosen theory, with limited scrutiny or examination of alternatives. The view of learning taken by the phenomenographic research approach and its associated variation theory (Bowden & Marton, 1998; Marton & Booth, 1997; Prosser & Trigwell, 1997; Runesson, 2005) avoids these limitations. Phenomenography and variation theory share a unique relationship; the fundamental assumptions
The initial search of the existing literature for this work was part of a comprehensive and broader doctoral dissertation literature review (Miller, 2007). Searches for recent publications on learning theories and technologies utilized the ERIC, Educause, and JSTOR databases to focus upon issues in education. Manuscripts were included based upon two criteria: (1) examination of either the constructivist or situative perspectives, and (2) application of technology to improve learning. Article selection considered a historical view of the theories via publications from their originators alongside more recent interpretations and applications. Identification of writings regarding phenomenography and the variation theory of learning took a similar, albeit more comprehensive, approach. A more thorough review of phenomenography and variation theory was facilitated by their more recent development and the smaller body of published work.

There are both benefits and limitations to this selection method. It could be argued that inclusion of additional and more delineated learning leading theories could lead to alternative conclusions regarding their influence upon the implementation and study of technology use in mathematics learning. However, these two perspectives are regarded as dominant in the realm of mathematics education in the United States (Cobb, 1994; Cobb & Bowers, 1999; Davis & Sumara, 2002; Oregon Technology in Education Council, n.d.). Constructivism forms the basis of the Principals and Standards of the National Council of Teachers of Mathematics (1989, 1991, 2000) and the benefits of situated learning is evident in their attempt to emphasize meaningful,
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