Chapter 13

The Effects of Teacher Content Authoring on TPACK and on Student Achievement in Algebra:
Research on Instruction with the TI–Nspire™ Handheld

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ABSTRACT

A year-long PD program was provided to four NYC integrated algebra teachers. The PD comprised of teacher authoring of curriculum that incorporated TI-Nspire™ technology. Teacher TPACK levels were measured through a TPACK Levels Rubric, created and validated by the authors. The rubric was used to assess the teachers' written artifacts (lesson plans and authored curriculum materials) and observed behaviors (PD presentations and classroom teaching through observations). Results indicated that, first teachers' TPACK scores for written artifacts paralleled those of PD presentations. Second, the classroom teaching was either at the same level or lower than written artifacts. Third, teachers did not improve with every lesson they developed; instead, their scores vacillated within the two or three lower TPACK levels. Finally, the students taught by the teachers with higher TPACK level had higher average score on the NYS Regents exam and higher passing rates.

INTRODUCTION

Despite the sizable number of emerging technologies for teaching mathematics, few teachers have had the experience of utilizing them in the classroom. In fact, many mathematics teachers are themselves novices in the domain of pedagogical technologies, and could therefore greatly benefit from a program designed specifically to develop their Technological, Pedagogical, and Content Knowledge (TPACK). Such a program would help them to think strategically in planning, organizing, implementing, and critiquing a curriculum that integrated technology in guiding student learning with specific content. Furthermore such a program would aim to meet the needs of all the students in a given class, regardless of their initial proficiency in the subject (Mishra, & Koehler, 2006; Niess, 2008). Professional Development (PD) would be one way to ensure that teachers acquire TPACK.

In this chapter we describe a study of a year-long PD program provided to four teachers teaching integrated algebra in a New York City public school. The context of the PD was the authoring by the teachers of a curriculum incorporating TI-Nspire technology. TI-Nspire is a low-cost personal handheld computing device for mathematics and science supporting a broad range of instructional models as well as a number of advanced modes of assessment. Three important layers of analysis provide the basis for research in the use of the TI-Nspire: (1) *Effectiveness.* Graphing calculators enhance student learning (Ellington, 2003; Khoju, Jaciw, & Miller, 2005). (2) *Enhanced representation and communication of important mathematics.* TI-Nspire's linked representations help teachers to focus student attention on the relationships among multiple representations, such as algebraic equations, geometric constructions, graphs, and tables of data. (3) *Deeper opportunities to learn.* By using the new document features of TI-Nspire, teachers would find they can almost certainly increase the time in the classroom students spend doing

mathematics in an environment possessing the ingredients that promote success - namely, increased support for mastering difficult concepts and skills, high student participation, and tools for reflective practice. Finally, TI-Nspire capabilities extend beyond the familiar graphing calculator. Additional instructional models allow teachers to support project-based learning, engage in participatory simulations, and encourage students to build mathematical models. The need remains to build cumulatively on our existing understanding of teaching secondary mathematics with graphing calculators. By developing PD programs that concentrate not only on teachers integrating technology into their teaching but also on their actually authoring their own materials that need can be directly addressed.

Given the unique characteristics of the PD program we developed, we were able to test the following research questions:

1. To what extent is a designed model of PD in which teachers author original materials that integrate TI-Nspire technology associated with changes in teachers' TPACK levels as measured by external assessment of teaching artifacts (lesson plans and TI-Nspire documents) and observed behaviors (classroom teaching and PD presentations)?
2. Is there a relationship between a teacher's TPACK level and student achievement?

BACKGROUND

In this section we provide background information on the PD model used in the study. We discuss first the importance of the teacher content authoring. We then review the context of the study i.e., the role within it of the TI-Nspire technology. Lastly we provide background on our two dependent variables, namely, TPACK and student achievement.

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