Chapter 8
Principles of Effective Pedagogy within the Context of Connected Classroom Technology:
Implications for Teacher Knowledge

Stephen J. Pape
University of Florida, USA

Karen E. Irving
The Ohio State University, USA

Clare V. Bell
University of Missouri-Kansas City, USA

Melissa L. Shirley
University of Louisville, USA

Douglas T. Owens
The Ohio State University, USA

Sharilyn Owens
Appalachian State University, USA

Jonathan D. Bostic
University of Florida, USA

Soon Chun Lee
The Ohio State University, USA

ABSTRACT

Classroom Connectivity Technology (CCT) can serve as a tool for creating contexts in which students engage in mathematical thinking leading to understanding. We theorize four principles of effective mathematics instruction incorporating CCT based on examination of teachers' use of CCT within their Algebra I classrooms across four years. Effective implementation of CCT is dependent upon (1) the creation and implementation of mathematical tasks that support examination of patterns leading to generalizations and conceptual development; (2) classroom interactions that focus mathematical thinking within students and the collective class; (3) formative assessment leading to teachers' and students' increased knowledge of students' present understandings; and (4) sustained engagement in mathematical thinking. Each of these principles is discussed in term of its implications for teacher knowledge.

BACKGROUND

Mathematics classrooms are complex systems co-constructed by teachers and students as they negotiate norms for participation (Bowers, Cobb, & McClain, 1999; Cobb, Boufi, McClain, & Whitenack, 1997). The norms and resulting interactions are the basis for students' construction of what it means to learn mathematics, to act competently, and to engage in mathematical thinking in general and, more specifically, within the mathematics classroom in which they are presently learning (Gresalfi, Martin, Hand, & Greeno, 2009; Hiebert et al., 2005; Turner et al., 1998). Further, the quality and locus of thinking established within the mathematics classroom ultimately determines students' understandings. From a situated/sociocultural perspective, learning is the "relationship between an individual with a body and mind and an environment in which the individual thinks, feels, acts, and interacts" (Gee, 2008, p. 81). Gee theorized about opportunity to learn in terms of the learner's capacity (or, in Gee's terms, effectivities) to interact with the affordances of a classroom environment.

While the classroom context is co-constructed jointly by the teacher and students, the teacher's role is particularly important and influential. Teachers shape students' mathematical thinking through the tasks they provide, norms they set, classroom discourse they lead, feedback they provide, and levels of engagement they establish. Broad considerations in terms of such contexts include the nature of and sequencing of tasks (Hiebert & Wearne, 1993), establishment of an inquiry microculture (i.e., enculturation into ways of knowing in mathematics; Cobb et al., 1997), the nature of classroom interactions (Cobb et al., 1997; Patrick, Anderman, Ryan, Edelin, & Midgley, 2001), formative assessment and provision of feedback (Bell & Cowie, 2001; Shute, 2008), and creation of "contexts for involvement" (Turner et al., 1998).

Learning with understanding is an important goal of school mathematics and is predicated on deep examination of mathematical concepts and processes. While memorization of mathematical facts is critical for the development of expertise (Chi, Feltovich, & Glaser, 1981), understanding depends upon raising prior conceptions to a level of consciousness and deeply analyzing new knowledge in terms of these prior understandings (Bransford, Brown, & Cocking, 1999). Whether an individual learner can engage with the environment to gain new knowledge is contingent upon the relationship between the learner and the environment. Opportunities for deep examination of mathematics concepts and active learning may be possible through a metacognitive approach to learning, which includes students examining their present understandings, explaining their reasoning for mathematical operations, and investigating alternative processes for solving problems (Bransford et al., 1999).

In this chapter, we argue that classroom connectivity technology (CCT) can be used as an important tool for creating contexts in which students engage in deep mathematical thinking. Our analysis across four years of a randomized field trial, *Classroom Connectivity in Promoting Mathematics and Science Achievement* (CCMS), documented teachers' use of CCT within their Algebra I classrooms. Based on analyses of varied data (e.g., teacher interviews, classroom observations, student achievement data, and student focus group interviews), we propose four interrelated and complementary principles of effective mathematics instruction incorporating CCT.

- **Principle 1:** Effective CCT implementation is dependent upon mathematical tasks that support examination of patterns leading to generalizations and conceptual development.
- **Principle 2:** Effective CCT implementation is dependent upon classroom inter-

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