Chapter 19
Wearable Technology:
Improving Mathematical Classroom Discourse Using Pivothead Eyeglasses

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ABSTRACT

Teacher questioning is integral to teaching and learning in mathematics classrooms. Research indicates that purposeful questioning in mathematics classrooms engages, motivates, and deepens student understanding and critical thinking during mathematical discussions. This chapter used both qualitative and quantitative approaches to examine the levels of questions and questioning strategies used by elementary teachers while facilitating mathematical tasks. Findings indicate that teachers use more funneling questions than focusing questions while facilitating math tasks. Most teachers hardly arrive at that reflection and justification level of questioning. Teachers found the Pivothead glasses to be effective not only for teacher self-assessment of their questioning techniques but also for gathering data on student thinking. Regression analysis indicates that education, experience, and location are the most important variables influencing the level of questions asked and questioning strategies used by the teachers.

INTRODUCTION

Classroom discourse (verbal interaction including questioning) has been examined and evaluated by many researchers in order to reflect and improve upon the quality of teaching and training (Faruji, 2011; Flanders, 1970; Freiberg, 1981; Nasir & Abdul, 2006). The value in asking good questions is something that cannot be underestimated in mathematics education. The kind of reasoning and problem-solving abilities students construct and communicate during mathematical tasks depends on the teacher's types of questions and questioning techniques (Moyer & Milewicz, 2002). Research studies in recent years

have seen a surge of interest in the relationship between teacher questioning and student's knowledge levels; but student's level of understanding can be evaluated by teacher questioning strategies as an assessment tool (McCathy, Sithole, Mcarthy, Cho & Gyan, 2016).

Facilitating effective mathematical tasks requires that the teacher ask open-ended questions that may lead to many right answers, however, the learning environment becomes complex and less predictable. Novice teachers grapple with interpreting and understanding students' responses in an environment that utilizes open-ended questioning. Lampert (1986) noted that for teachers to handle such an environment, it requires principled knowledge of mathematical concepts and understanding of how students think and reason mathematically. McCathy et.al. (2016) argued that "Whereas experienced teachers have a repertoire of easily accessible strategies and pedagogical content knowledge, some teachers may have difficulty interpreting and responding to unexpected answers from children…Developing effective questioning strategies… could be an integral focus in mathematics… classroom discourse" (p.80).

There is not much known about how teachers implement questioning in the teaching of mathematics. Aizikovitsh-Udi and Star (2011) note that "We assume that good teachers ask good (and lots of) questions to their students. Yet this general recommendation fails to consider important questions about how teachers implement question asking" (p. 1354). Many agree that teachers should be trained on how to implement higher-order questioning techniques. Teachers who can question appropriately and effectively at various levels of the Bloom's Taxonomy are better able to discern the range of students' thinking (McCathy et.al., 2016). The National Council of Teachers of Mathematics (NCTM) (2014) developed categories of types of questions used in mathematics teaching. The categories align with the levels of Blooms Taxonomy in that, various types of questions categorized by the NCTM use similar words (or action verbs) found in the levels of Blooms Taxonomy. The Appendix summarizes the types of questions and the categories of questions that mathematics teachers should ask their students. These questions are adapted from NCTM (2014) and aligned to Blooms Taxonomy levels of cognitive thinking. The summary helps to show that the framework developed by the NCTM is grounded in what teachers already know about Blooms' Taxonomy.

McCarthy et al. (2016) note that "To increase teacher effectiveness and student success in mathematics, a self-assessment of teacher questioning techniques is essential" (p. 80). McCarthy et al. completed a study in which they examined the questioning strategies used by teachers during quadratic modeling. The questioning patterns examined in their study included; probing and follow-up, leading, check-listing, and student-specific questioning. Findings of this study indicated that guiding teachers (both pre-service and in-service teachers) through an analysis of questions they ask and responses they get from students during mathematical discourse may enable them to recognize both effective and ineffective questioning strategies. Our study was informed by these findings. In training and guiding in-service teachers about questioning, we provided professional development (PD) for four days. Teachers were trained on the levels of questioning, adapted from the National Council of Teachers of Mathematics (NCTM), 2014 (see Appendix). During the four-day training, teachers were given a chance to facilitate a mathematical task with students while video recording using Pivothead eyeglasses (wearable technology) before and after training. The following section describes the wearable technology used in this study and a brief summary of questioning patterns.

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