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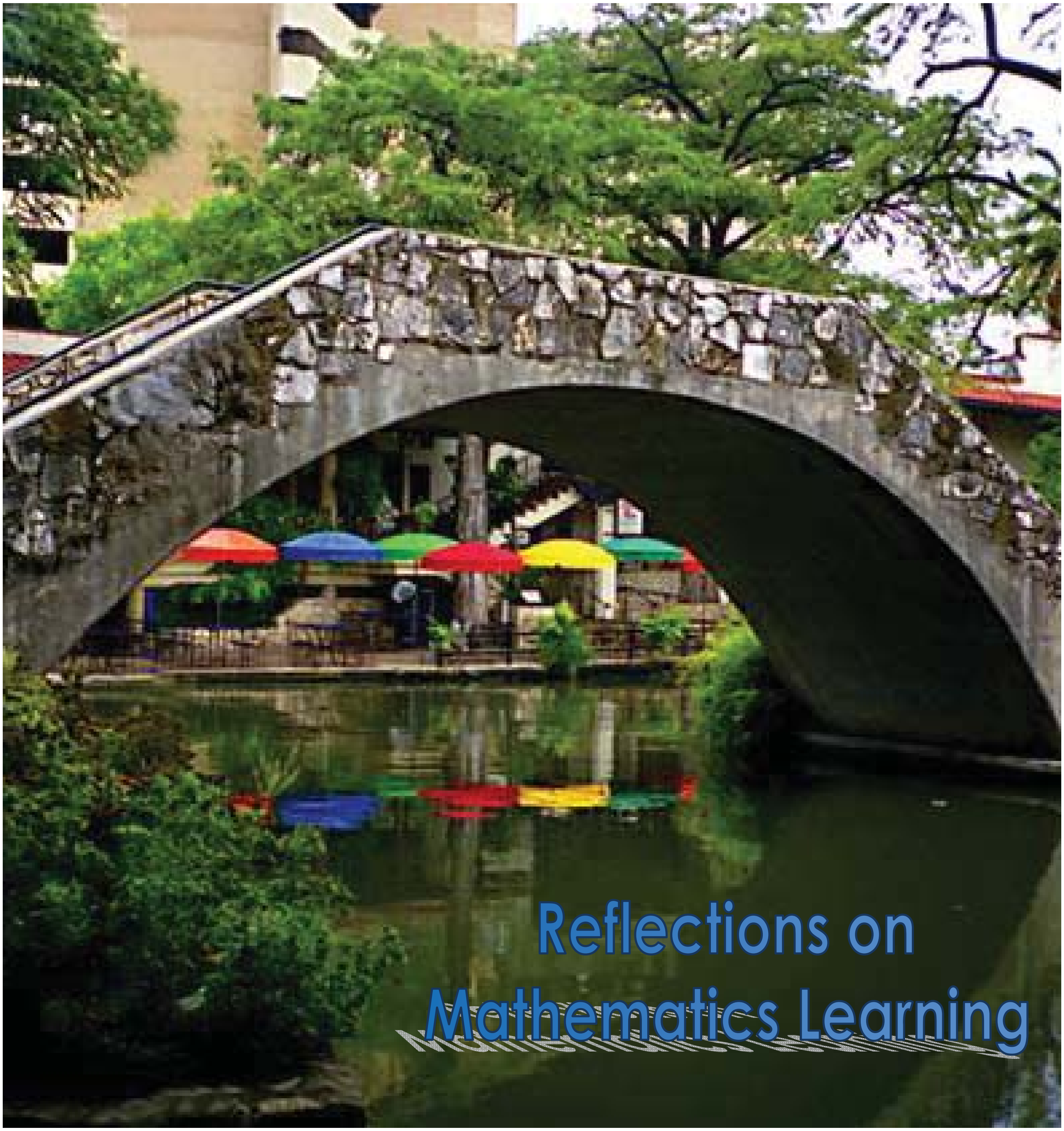

LOOKING FOR ELEMENTARY MATHEMATICS TEACHERS' COMMON CORE-FOCUSED INSTRUCTION

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This manuscript describes six elementary teachers' instructional changes through the lens of the Standards for Mathematical Practices (SMPs). Teachers were randomly selected from a larger sample of K-5 teachers who engaged in yearlong professional development targeting the SMPs. Videos of their pre- and post-professional development programs were examined using a SMPs-focused protocol. They overwhelmingly provided more opportunities for students to engage in the SMPs after the professional development experience. We connect this impression with ways to effectively foster elementary teachers' SMP-focused instructional practices through professional development.

Related Literature

Standards for Mathematical Practice

The Common Core State Standards for mathematics (CCSSM; Council of Chief State School Officers [CCSSO], 2010) will require teachers to reevaluate their current instruction (National Council of Teachers of Mathematics [NCTM], 2010). There are two halves to the standards: Standards for Mathematics Content and Standards for Mathematical Practice (SMPs). The SMPs offer characterizations of behaviors and habits that students should demonstrate while learning mathematics. The *Principles and Standards for School Mathematics* (NCTM, 2000) and *Adding it Up* (Kilpatrick, Swafford, & Findell, 2001) guided the descriptions of the SMPs. NCTM's (2000) process standards are problem solving, reasoning and proof, communication, connections, and representation. The notion of mathematical proficiency includes conceptual understanding, procedural fluency, adaptive reasoning, strategic competence, and productive disposition (Kilpatrick et al, 2001) in order to descriptively derive the notion of what is necessary for mathematical proficiency. Unfortunately, the promotion of these proficiencies is not evident in every classroom. Thus, professional development must be designed to enhance teachers' understanding of the SMPs and support them to enact mathematics instruction focused on them. These behaviors are not isolated and often occur in tandem with one another because they are interrelated behaviors (CCSSO, 2010). For example, modeling with mathematics and attending to precision are likely to occur during a modeling-focused activity. Students are expected to reflect on their mathematical models and revise them as needed, which likely occurred because they saw a way to more precisely (e.g., effectively or efficiently) describe the mathematical situation embedded within the task. In order for students to engage in the SMPs like this, teachers must design and enact instruction that allow students to wrestle with mathematics content and its applications in an environment that supports and sustains meaningful engagement with mathematics.

The literature is clear about teachers' instructional emphasis of the process standards or mathematical proficiency: it is not occurring often (Hiebert et al., 2005). Hence, mathematics teacher educators have tried to support instructional growth by providing long-term (i.e., one year or more) of professional development that assists K-12 mathematics teachers' understandings of mathematical proficiency and/or the process standards (e.g., Anderson & Hoffmeister, 2007; Boston, 2012; Boston & Smith, 2009). These recent studies and others describe ways to benefit teachers' instruction but there is a noticeable gap when the literature focuses on instruction in the CCSSM era. The purpose of this paper is to build upon the current literature base as a means to discuss K-5 mathematics teachers' instruction, specifically focusing on the ways they provide students' opportunities to engage in the SMPs.

Professional development: What works

A metaanalyis of PD suggests that there are some key features to designing effective inservice teacher education (Guskey & Yoon, 2009). Two of those five features include (a) professional development (PD) activities that encourage teachers to adapt a variety of practices to a content area rather than encouraging a set of best practices and (b) PD activities that encourage teachers to try ideas in their classroom. Boston (2012) details how focusing on implementing worthwhile tasks during a yearlong PD enhanced secondary teachers' knowledge, which in turn influenced their instructional practices. For example, after the yearlong PD they were able to identify elements of tasks with high cognitive demand and concurrently selected more tasks with high cognitive demand for their own instruction. Improving teachers' ability to select worthwhile tasks is not the only way to impact their instructional outcomes (Boston & Smith, 2009); supporting them to establish an effective learning environment and sustain mathematical discourse between students are also necessary to maximize students' opportunities to learn (NCTM, 2007). Building upon this foundation for effective PD, a yearlong project was conducted in a Midwestern state to prepare teachers to implement the CCSSM. We aim to explore how teachers' instruction changed to support students' engagement in the SMP and attempt to connect their growth to the PD project. Our research question was: How does teachers' mathematics instruction evolve during the PD? Further, we wondered how teachers' changes might be related to three central areas of this PD: learning environment, worthwhile task, and discourse. We examined K-5 teachers pre- and post-PD mathematics teaching specifically looking for specific instructional actions that are connected to the SMP.

Method

Context of the Professional Development

We focus on K-5 teachers' experiences as influenced by a yearlong grant-funded professional development program. Teachers met four times for four-and-a-half hour sessions between March – April 2012. We met for eight 8-hour days during the summer and then met twice face-to-face for four-and-a-half hour sessions between August – October 2012. Teachers were provided with numerous online assignments that were intended to facilitate further online interactions between March – October that might support teachers' understanding of the SMPs. Generally speaking, the aim of the PD projects included (1) making sense of the SMPs, (2) exploring inquiry through three broad areas consisting of worthwhile tasks, mathematical discourse, and appropriate learning environments, (3) implementing classroom-based tasks that aligned with the CCSSM, and (4) increasing mathematical knowledge and understanding. Teachers read and reflected on their instruction as well others implementing CCSSM-aligned mathematics instruction. Teachers read and discussed chapters from NCTM books (e.g., Mathematics Teaching Today [2007]) and completed various assignments including reflective journaling, writing, enacting, and reflecting on CCSSM-aligned mathematics lessons, and solving mathematics problems.

Participants

This project served 23 grades K-5 mathematics teachers and at least three teachers representing each grade level. Teachers came from urban, suburban, and rural school districts. We decided to randomly sample one teacher from each grade level for this initial study. We had no reason to believe that one teacher grew more than another during the yearlong professional development and random selection provided us with greater opportunities to characterize that growth compared to purposeful selection. Table 1 provides the years of teaching experience and school district context for each randomly selected teacher. We intend to explore all teachers' instruction after exploring this random sample of teachers as our pilot project.

Table 1. Participants' demographic information

Grade-level	Gender	Years Experience	District Context
Kindergarten	Female	13	Urban
First Grade	Female	12	Rural
Second Grade	Female	14	Rural
Third Grade	Female	12	Urban
Fourth Grade	Male	13	Rural
Fifth Grade	Female	6	Rural

Procedures

Data Collection and Analysis

Teachers were asked to design, enact, and videotape one lesson during the Spring 2012 and Fall 2012 semesters. The Human Subject Review Board indicated that only teachers' consent was required since the focus of our study was on teachers' instruction. Teachers consented to videotaping one lesson and sharing the video with us for analysis. Depending on the grade level and the local school context of the teacher, the videos were as short as 25 minutes and as long as 65 minutes. Since our study focused on ways that teachers supported students' engagement in the SMPs during instruction, we investigated the videotapes as a means to best report any instructional changes made during the PD program. Such analysis approaches have been used in similar studies such as Boston (2012) and Boston and Smith (2009).

Data analysis required two parts. The first part was composed of two stages. The first stage was watching the videotapes and reflecting on instruction using a protocol focused on the ways that teachers' instruction supported engagement in the SMPs. Two mathematics education faculty watched the videotapes and conducted the analysis. The protocol used for analysis was developed by Fennell, Kobett, and Wray (2013). It provides look-fors that link mathematics instruction with behaviors and actions that are associated with the SMPs. For example, three aspects were used for the first SMP: Make sense of problems and persevere in solving them. They included (a) Involve students in rich problem-based tasks that encourage them to persevere in order to reach a solution, (b) Provide opportunities for students to solve problems that must have multiple solutions, and (c) Encourage students to represent their thinking while problem solving (Fennell et al., 2013). While there may be other aspects indicative of SMPs, the protocol provides an evidence-based framework for examining mathematics instruction using the SMP lens. The second stage occurred after watching a video. We compared our coding observations with one another, pausing as needed to discuss areas where we differed. If needed, we watched the video a second time. Discussions ended when both coders agreed that there was sufficient evidence related to a look-for. The second part of data analysis focused on making sense of the data to answer our research question. We intended to quantify changes in the number and type of instructional opportunities related to the SMPs. This was accomplished by examining our evidence in two ways. The type and frequency of instructional opportunities related to each SMP were categorized. Then we explored the changes in instructional opportunities related to the SMPs across teachers with the goal of generating general impressions. After considering the data, we drew out general impressions that are shared in this manuscript.

Results

Overall, teachers provided more instructional opportunities intended to engage students in the SMPs. Figure 1 shows the frequency of instructional opportunities for each SMP during the pre- and post-PD instructional lesson.

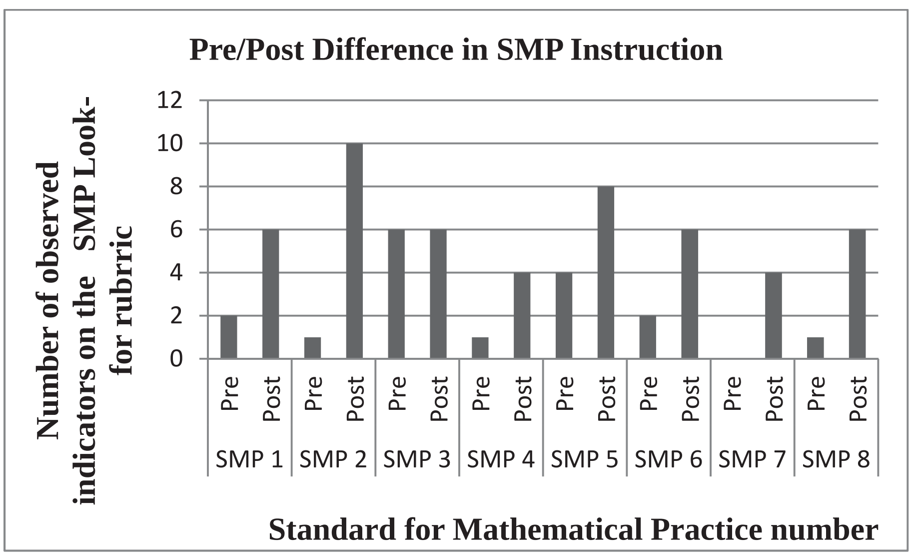

Figure 1. Frequency of observed indicators in Pre- and post-PD instruction

The participants showed an increased promotion of every SMP with the exception of SMP 3, which remained constant. The median and range for the frequency of codes was 1.5 opportunities and [0,6] for the pre-PD instruction and was 6 opportunities and [4,10] for the post-PD. These quantitative findings suggest that on average, teachers provided more opportunities for students to engage in the SMPs after the PD. Looking specifically at each teacher revealed that every teacher provided more opportunities to engage in the SMPs. We sought to qualitatively understand these changes with respect to the SMPs and three PD factors: learning environment, mathematical task, and discourse. Due to the brevity of this proceedings manuscript, we are only able to provide qualitative description of one teacher's instructional changes.

We noticed that instructional opportunities were clearly influenced by the implementation of their choice of task, changes in learning environment, and ways discourse was promoted. For example, the second-grade teacher's pre-PD instruction focused on guiding students through the definitions of a fraction in the context of exercise-laden teaching. Students were seated in rows and asked to follow her model of using pattern blocks to represent benchmark fractions. Then, students watched a video stemming from her textbook showing exactly the same activity as her students completed just minutes ago. Finally, students worked on a series of exercises without using pattern blocks. Students spoke only when the teacher asked a question. This directed instruction approach stands in stark contrast to her post-PD instruction.

The post-PD warm-up task was to determine how many letters there were in sum of the first names of the class. Students were seated in small groups and had access to a variety of manipulatives on their desks. The teacher encouraged several students to share how they counted the letters. After the warm-up task, she asked them to determine the number of legs in the classroom. The teacher utilized a think-pair-share approach with this task. Students used an initial representation (e.g., symbolic, graphical, verbal, and/or concrete) to solve this task and the teacher monitored students' work. She reminded students to explain what they were doing on their papers and to be prepared to justify why their approach is effective and efficient. As students finished working with an initial representation, she asked them to employ another viable representation to solve the problem. Finally, students shared how they solved the problem using multiple representations and then justified their strategy to a partner and then the class. Students also responded to questions from the teacher but the flow of discourse included multiple student-to-student interactions as well. It was apparent how the teacher provided an opportunity for her students to decontextualize the mathematical elements from the task and later contextualize the mathematical symbols with the referents in the problem. Through these instructional changes and ones like it, our sample of teachers provided greater instructional opportunities for students to engage in the mathematical practices.

Implications

From this study, we learned that teachers overwhelmingly engaged in greater opportunities related to the SMP after the PD then before it. These changes are associated with modifications to the learning environment, mathematical task, and/or ways that the teacher initiated and sustained mathematical discourse. For example, the second-grade teacher's post-PD changes are tied to all three instructional aspects. These changes led to greater opportunities to foster students' engagement in the SMPs. We cannot link one aspect of the PD with the changes but are able to suggest that yearlong PD focusing on the Common Core and our three central instructional aspects did lead to changes in the way these K-5 teachers designed and implemented mathematics instruction. The SMPs do not dictate curriculum or teaching but they do provide ideas for mathematically engaging students in classroom instruction. PD may help mathematics teachers at all grade levels make sense of mathematics instruction that supports students' appropriate mathematical behaviors.

This study has a second implication. Results from it support the prior literature suggesting that yearlong PD, which adheres to what works for designing and implementing effective PD, tends to lead to instructional changes that promote improved opportunities to learn.

Limitations

Qualitative approaches allow researchers to draw on their lenses and frames of reference to make sense of experiences in the world. The results offered here are not generalizable to all teachers and are particular to this set of teachers. Our sample also limits some of the findings. That is, teachers volunteered to participate in the PD and those who are less motivated to complete yearlong PD may have different outcomes making instructional changes. Furthermore, teachers differing in some way from our greater K-5 sample in terms of years of experience, school district location, or other aspects might lead to other findings. A third limitation was that the pre-PD video was done after nine hours of Common Core PD. Thus, any growth in teachers' promotion of the SMPs is limited because they experienced some PD prior to their pre-PD instructional video.

Conclusion

The third limitation provides an important finding about the importance of our yearlong Common Core PD program. Teachers had another 78 hours of PD following their pre-PD videos, which is a strong indication of the impact sustained PD has on teachers' instructional outcomes. That is, teachers provided limited opportunities for students to engage in the SMPs after nine hours of PD, yet improved greatly after more time to consider their PD experiences and translate them into pedagogical instantiations to promote the SMPs. The evidence found in this study suggests that K-5 teachers benefitted from reflecting and working to implement the CCSSM through three instructional areas: learning environment, mathematical task, and mathematical discourse.

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