

Implementing the Mathematical Practices Standards (IMPS) at Education Development Center (EDC) was a multi-year effort to design, develop, and test resources that increase teachers' awareness and understanding of the Standards for Mathematical Practice (SMP) described in the *Common Core State Standards (CCSS) for Mathematics*. The project responded to the urgent need for high quality models to support teacher understanding and implementation of the CCSS SMP. Our goals were:

- Increase teachers' awareness of the SMP
- Support teachers' understanding of the SMP
- Cultivate teachers' capacity to identify SMP in student thinking and
- Develop teachers' ability to identify how instructional tasks can support these SMP.

To meet these goals, the project developed and tested (1) a set of carefully designed *Illustrations* of the SMP and a website to disseminate these materials, and (2) a teacher professional development (PD) curriculum centered on these *Illustrations*. We believe such resources are critical to quality enactment of the CCSS, contributing to greater understanding of the SMP by providing illustrations of how they are exhibited in students' mathematical reasoning.

The *Illustrations*, designed for teachers in grades 5 through 10, each contain:

1. A **mathematical task** that supports student engagement with the SMP;
2. A **student dialogue** that exemplifies and clarifies one or more of the SMP;
3. **Teacher reflection questions** designed to prompt thinking about mathematical practices and content, student thinking, and teaching practices, along with related mathematics problems for teachers to investigate the mathematics and reasoning embodied in the dialogue; and
4. Additional materials that include a **mathematical overview** highlighting key mathematical ideas and describing how the students in the dialogue are using the mathematical practices? and **classroom supports** for using the task and dialogue for student investigation and reflection.

The student dialogues are the centerpiece of the *Illustrations*. They center on the thinking of three fictional students engaged in mathematical practice as described in one or more of the SMP while working to solve the associated mathematical task. The students are caricatures, but their dialogue is designed to exemplify and clarify the SMP and model mathematical discourse.

Thirty-one *Illustrations* were developed and all can be found at the project's website at <http://mathpractices.edc.org>. This website houses the *Illustrations* and other project resources such as videos that provide overviews and examples related to the SMP. Since the website's launch, the site has had over 257,000 visits by 219,000 different users.

The *IMPS PD curriculum* uses these *Illustrations* as a foundation. The PD curriculum is designed for use by local providers in a variety of school, district, or course-based settings to help educators understand and support student engagement with mathematical practice in their classrooms. The audience is grades 5-10 mathematics teachers and leaders, including special education or ELL/ESOL specialists with mathematics teaching responsibilities. The PD design incorporates repeated cycles of participants doing mathematics, analyzing their own mathematical thinking, engaging students with the same mathematical tasks, and analyzing student mathematical thinking with the SMP as a lens. The core PD activities are: (1) doing and discussing mathematics tasks, (2) analyzing dialogues and other student thinking artifacts, and (3) planning for classroom instruction focused on engaging students in aspects of mathematical practice. Connections to classroom practice include opportunities to plan lessons around *Illustration* tasks and tasks from teachers' own curricula, analyze work from teachers' own students, anticipate areas of student struggle, and plan teacher questions.

The PD curriculum includes ten two-hour sessions that can be organized in different ways based on school or district needs. The sessions are organized by mathematical content, with two introductory sessions followed by a

series of algebra/functions-focused sessions and a series of geometry-focused sessions. Each SMP is highlighted multiple times over the sessions. The PD includes options for middle and high school teachers.

Over the course of this project we worked directly with 88 teachers and teacher leaders to train them to facilitate the PD, and these teacher leaders led PD for more than 400 teachers in districts around the country in a field-test of the PD, with some then continuing to use the PD curriculum with additional teachers in their local contexts. Teachers completed assessments before and after participation in the PD, and a comparison group of teachers also completed these pre/post assessments. Data were analyzed on four subscales: Awareness of the SMP, Readiness to use SMP, Knowledge of SMP, and SMP Identification in Examples of Mathematical Thinking. There was no significant difference between treatment and comparison groups on any of the pretreatment subscale scores. Results from hierarchical regression analysis predicting post-treatment subscale scores show that teachers who participated in the PD scored statistically significantly higher than comparison group teachers on all four subscales, on average, even after controlling for pre-treatment scores. This analysis of the effects of the course has limitations in scope and methodology, but the positive results are nonetheless encouraging.

Last Modified: 10/26/2017

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