

Learning to Look for the Standards for Mathematical Practice

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This article describes how the Common Core Look-fors application for the iPad was used to help pre-service early childhood education and elementary/special education teachers learn to look for and recognize student enactment of the Common Core State Standards in Mathematics' Standards for Mathematical Practice. After using the iPad application for one semester in their college course and in their internships, the pre-service teachers reported that the application helped them to understand and identify the Standards for Mathematical Practice.

Introduction

The Common Core State Standards for Mathematics (CCSSM) are reforming mathematics education in the United States. To date, 45 states have adopted these standards. In addition to describing the mathematical content that all students should know at each grade level, these standards stress the importance of students' understanding of concepts and students' development of mathematical practices (National Governors Association Center for Best Practices, 2010). The CCSSM Standards for Mathematical Practice (SfMP) describe varieties of mathematical expertise that educators should seek to develop in their students. The SfMP are:

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

Unfortunately, many teachers of mathematics are unprepared to implement the CCSSM and most teacher education programs have not yet adapted to help prepare teachers to meet these challenges (Science and Mathematics Teaching Imperative, 2011).

Furthermore, because teaching is so complex, pre-service teachers are often overwhelmed by the number of aspects of classroom interactions that are of importance. Too often, pre-service teachers focus solely on classroom management issues. While these aspects of classroom interaction are important, a fundamental aspect of mathematical reform is the focus of teachers' attention on student thinking (Van Es & Sherin, 2002). This paper describes how one teacher education program used an iPad application to help pre-service early childhood education and elementary/special education teachers become familiar with the practice standards in the CCSSM and focus their attention on student thinking.

In order to help teachers identify instances in which the SfMP have been enacted, the Common Core Look-fors application for the iPad has been developed. This application provides an interface for entering observation data on

the SfMP. Each time children are observed engaging in one of the SfMP, a time marker can be recorded. Additionally, an observer can record the frequency in which teachers engage in actions which promote the mathematical practices. This cause/effect relationship is recorded and represented graphically. Notes and photos/videos can be included to provide evidence of the students engaging in the practices. The observation data can then be aggregated to show what SfMP were observed, how often they were observed, and when they were observed. Figure 1 provides a screenshot of the application.

instances of the enactment of the SfMP during class activities and in their field placement.

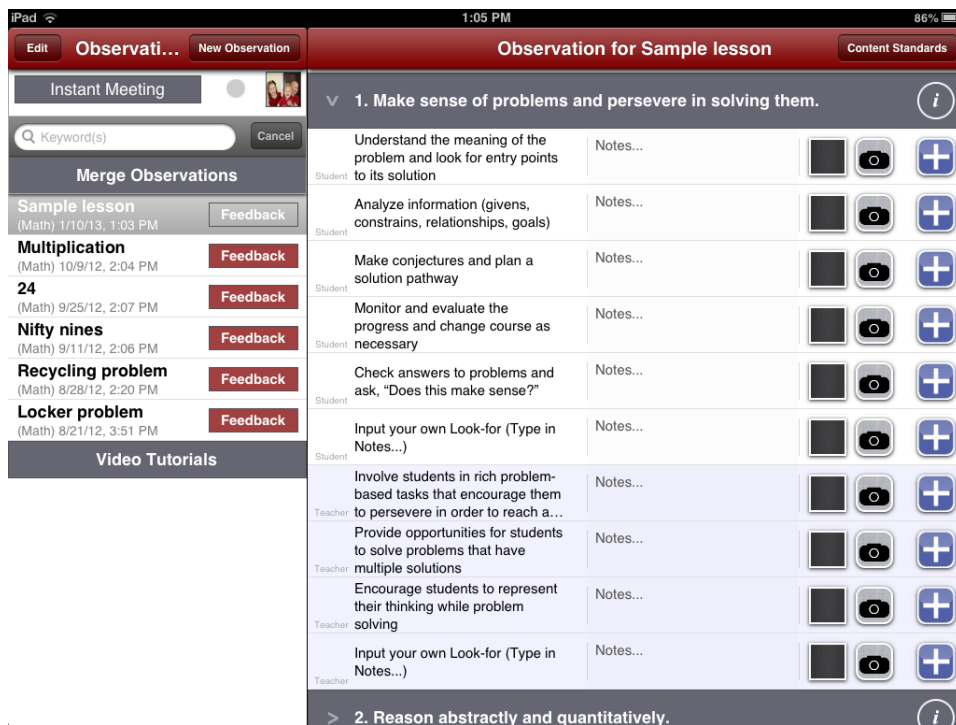
Research Questions

The primary research questions were:

How did the use of the Common Core Look-fors Application on the iPad increase pre-service teachers'?

1. Understanding of the CCSSM Standards for Mathematical Practice?

Figure 1



This application was used in an elementary mathematics methods course to help pre-service early childhood education and elementary/special education teachers become familiar with the SfMP and begin to think about how they can develop these practices in their students. The pre-service teachers used the application to record

2. Ability to identify instances of student enactment of the CCSSM Standards for Mathematical Practice?
3. Ability to collect evidence of student enactment of the CCSSM Standards for Mathematical Practice?

Context

Mathematics Curriculum, Methods, and Materials is a course taken by all Early Childhood Education and Dual Certification in Elementary/Special Education majors during the semester prior to their fulltime student teaching. The pre-service teachers take three additional pedagogy courses during the semester and spend 2.5 days per week in an internship at local elementary schools. The course focuses on how children in preschool through middle school learn mathematics, the difficulties they often encounter, and the ways in which teachers can help them overcome these difficulties. One of the most challenging aspects of the course is for the pre-service teachers to recognize that in addition to helping children learn mathematics content, teachers of mathematics also need to help students learn ways of thinking mathematically.

Participants

In Fall 2012, there were 26 pre-service early childhood education or elementary/special education teachers in the class; four pre-service teachers chose not to participate in the study. At the beginning of the semester, three of the 26 pre-service teachers indicated that they were unfamiliar with iPads, 12 indicated that they knew some about iPads, and 11 indicated that they were very proficient with iPads. None of the pre-service teachers were familiar with the CCSSM SfMP.

Procedures

On the first day of the semester, each of the pre-service teachers was provided with an iPad. The pre-service teachers were provided with basic instructions on iPad use and taught how to load the Common Core Look-fors application onto the iPad. The pre-service teachers were also introduced to the CCSSM and SfMP and were provided instructions on how to use the Common Core Look-fors application. Pre-service

teachers spent approximately an hour of the first class session engaged in mathematical problem solving. As they worked in small groups on the problem, they used their iPads and the Common Core Look-fors application to record instances of enactment of the first SfMP. In each subsequent class session a different SfMP was focused upon, the pre-service teachers engaged in mathematical problem solving, and the pre-service teachers used the application to record evidence of the SfMP exhibited by each other. The instructor also used the application to record evidence of the SfMP. Pre-service teachers' and the instructor's data were used to structure classroom conversations about the mathematics content and mathematical practices.

In addition to their college classroom activities, the pre-service teachers planned and implemented four open-ended problems in their internships. Hiebert et al.'s (1997) definition of problems was used, in which problems are defined as "tasks for which students have no memorized rules, nor for which they perceive there is one right solution method. Rather, the tasks are viewed as opportunities to explore mathematics and come up with reasonable methods for solution" (p. 8). Additionally, the problems were required to be open-ended, meaning that more than one correct answer was possible. A sample open-ended problem is "The school marching band has asked us to determine some possible marching arrangements for 36 marchers. Each marching arrangement must have an equal number of students marching in all rows. What are two possible arrangements?"

Prior to implementation, the pre-service teachers used Stein, Engle, Smith, and Hughes' (2008) framework for orchestrating productive mathematical discourse to anticipate student responses and plan the order in which students would be asked to present their ideas. During implementation, the pre-service teachers launched each problem by reading it to the students and making sure the students understood the problem;

they did not, however, model how to solve it. While students worked, pre-service teachers asked probing questions, selected students to present their thinking to the rest of the class, and used the Common Core Look-fors application to record enactment of the SfMP. At the end of each problem session, the pre-service teachers purposefully selected students to share their thinking and helped to make connections amongst the student-generated strategies.

At the end of the semester, the 22 participating pre-service teachers took an online survey about their use of the Common Core Look-fors application and also submitted written reflections on the usefulness of the application.

Results

Overall, the pre-service teachers felt that the use of the application helped them to become more knowledgeable about the Standards for Mathematical Practice. On the survey, 17 of the 22 respondents (77%) indicated that the use of the Common Core Look-fors application on the iPad increased their understanding of the CCSSM Standards for Mathematical Practice “some” or “a great deal.” Thirteen of the 22 respondents (59%) indicated that the use of the Common Core Look-fors application on the iPad increased their ability to identify instances of student enactment of the CCSSM Standards for Mathematical Practice “some” or “a great deal.” The pre-service teachers, however, were not as positive about the usefulness of the application for collecting evidence of student enactment of the SfMP. Only 10 of the 22 (45%) respondents indicated that the use of the Common Core Look-fors application on the iPad increased their ability to collect evidence of student enactment of the CCSSM Standards for Mathematical Practice. This may partially be explained by the fact that six of the pre-service teachers were not allowed by their schools’ principals to use the photo/video component of the application. The results of the survey are presented in Figure 2.

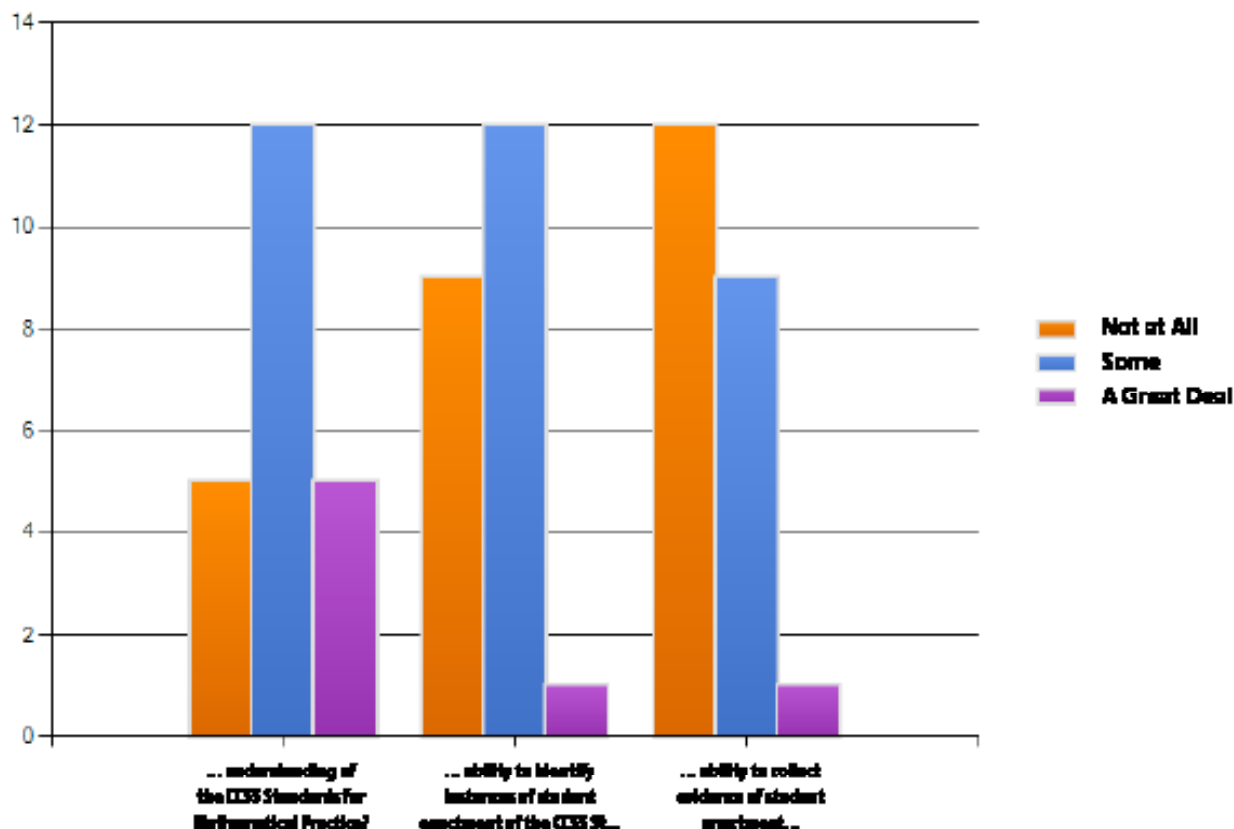
In written reflections, several pre-service teachers commented on the usefulness of the application in collecting and organizing evidence of student enactment of the different SfMP. One said, “The Common Core Look-fors application on the iPad provides an amazing organizational tool to categorize the video data and ensure that the students are mastering each of the mathematical standards.” Another pre-service teacher said, “I did not know how often my students engaged in these standards until I had to choose one for the explanation I was observing. I noticed that a student could fulfill several standards in one explanation. This illustrates how the standards truly do model the mathematical thinking process. They cannot truly be separated because each is needed in conjunction to solve the problem.”

Many pre-service teachers also commented on the usefulness of having videos of students. For example, one said, “These recordings provide exceptional observational data that support anecdotal records and written responses... the videos afford the instructor [the opportunity] to look back and observe in more detail the students’ individual and collaborative work... These videos, recordings, and pictures are more valuable than anecdotal records because they capture all of the small details that are so easy to miss in written observations.” They also help teachers remember which students solved problems using which methods. Another pre-service teacher stated, “It gave the instructor a clearer image of the knowledge that the students possess and areas in which they need guidance in their mathematical thinking and reasoning.”

An unexpected benefit was that the use of the iPad motivated the school age students to share their mathematical thinking. “Students would bicker about which students want to explain their thinking because exciting technology is involved in that process. The iPad gets children excited to share.” Another unanticipated benefit of the application was its listing of the SfMP and the

Figure 2

To what extent did the use of the Common Core Look-fors Application on the iPad increase your...



CCSS Mathematical Content Standards. The pre-service teachers appreciated having this easily accessible for reference when planning lessons.

Discussion

Teacher educators must find ways to support teacher learning about the CCSSM. The use of observation guides such as that provided by the Common Core Look-fors application seems to be a promising way to do this. Although observation guides can be paper-based, the iPad affords teachers the ability to easily video record and connect recordings to specific indicators. As described by the pre-service teachers, the use of the iPad may also provide motivation for students to share their thinking.

Admittedly, the pre-service teachers in this study used this application in a way that is different than for what it was designed. This application was originally intended to be used by classroom observers (not the instructing teacher). It was, perhaps, unrealistic to expect that pre-service teachers would be able to manage instruction and data collection at the same time. The pre-service teachers did surprisingly well at this, but in the future, we will have the pre-service teachers use the application to observe a peer's classroom, rather than their own. Nonetheless, it seems that the pre-service teachers benefited from the use of the Common Core Look-fors application; they became more familiar with the CCSSM SfMP and will be more likely to notice and support these standards in their teaching. Hopefully this will help these future teachers

create the types of mathematics classrooms envisioned by the writers of the Common Core State Standards.

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- The Common Core Look-fors application costs \$2.99 and can be found at: <http://itunes.apple.com/us/app/common-core-look-fors-mathematics/id467263974?mt=8>

About the Author

Christy D. Graybeal, Ph.D. is an assistant professor of education at Hood College. She is especially interested in issues related to middle school mathematics teaching.