

# Mathematical Professional Development for Elementary Teachers

**Sherri Prast**  
**School City of Hammond**

## Introduction

Because of my early experience and leadership with piloting a standards-based curriculum, I was asked to become a Select Cadre member of the Indiana Mathematics Initiative. As a teacher leader of elementary mathematics in the School City of Hammond, I welcomed the opportunity to improve my mathematical content, learn new strategies for teaching math, and collaborate with other teachers across the state of Indiana.

As members of the Select Cadre, it was also our responsibility to transfer the mathematical professional development we received to fellow colleagues within our district. This paper will focus on the professional development that our cadre team planned spanning three years. I will discuss each content session, how it was organized, what our goal was, and feedback from our participants. But first it is important to understand our history leading up to our partnership with the Indiana Mathematics Initiative.

## History

In 1999 I attended an *Exemplars*<sup>1</sup> workshop on mathematical problem solving provided by our district. During our session I asked our *Exemplars* consultant if there were any exemplary standards-based mathematics programs. She said there were two, and she recommended *Everyday Mathematics* from the University of Chicago. She was familiar with the program because her state had been using it for years. Since I felt that our newly adopted, traditional math program was lacking in problem solving and higher order thinking, I wanted to pilot this recommended program. During our lunch break, I called the company. I found out that there would be a cost for the student materials, but the teacher materials were free. My second grade team agreed to pilot it with me, so we could support each other as we learned this new program. I had to contact my district Title I office to see if they could help pay for the materials. They agreed.

The following year I was on the Math Curriculum Alignment Team for our district. We were aligning our curriculum with the Indiana Academic Standards. As we were working on this project, I was sharing all the good things that we had learned through teaching with a standards-based program. So, with support from our district, I recruited my math team and other interested teachers to pilot the program for the next year. Our original three-person team now became thirty. That second year I arranged support sessions for those 30 teachers at my school. During

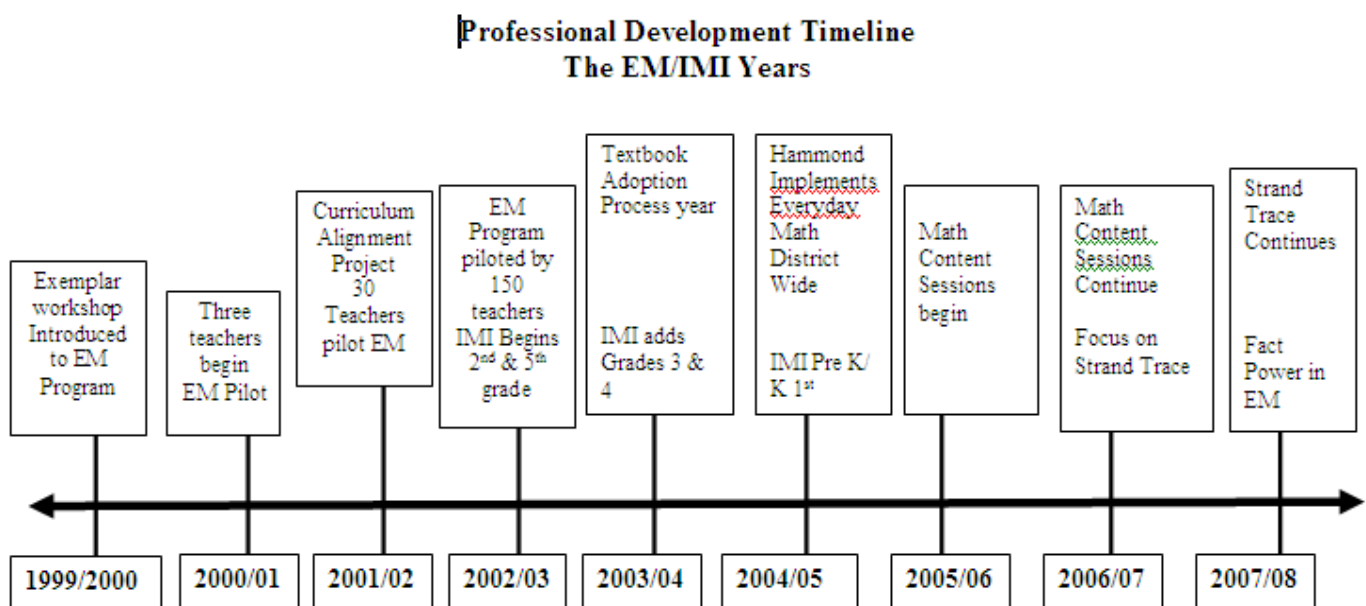
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<sup>1</sup> *Exemplars* is an organization offering professional development for teachers on mathematical problems and assessment.

those sessions, we realized how this standards-based math program was helping us to become better math teachers.

The next year we had an *Everyday Mathematics* consultant come to our district to explain the program to any interested teachers who wanted to pilot it. Many teachers had heard about how good this program was. We had over 150 people attend.

In the fall of 2002, our district was asked to participate in the Indiana Mathematics Initiative (IMI). This initiative is a statewide collaborative of nine school districts in Indiana and Indiana University Bloomington. This collaborative has been dedicated to the proper implementation of standards-based math programs and the building of the mathematical content knowledge of educators. The standards-based *Everyday Mathematics* curriculum was chosen as the common program to be used by elementary teachers in the project. By this time Hammond had close to 200 teachers who were using the program. (See Figure 1 for timeline.)



**Figure 1**

**Early Support 2004–2005: Games**

IMI provided sessions where consultants shared their expertise on using a standards-based curriculum. From our early training sessions I realized that our piloting teachers were going to need support with implementing the game component. The program uses games to help develop the ability to think critically and solve problems, while providing an enjoyable way for students to practice and master basic skills. Since I had been using the program for a few years, I felt our district could support the piloting teachers by providing game nights for them. We had IMI Select Cadre and Math Teacher Leaders in each grade level set up games for the teachers to play, so that they could become familiar with the math content and directions. We also gave them game packets with all the directions and materials printed on card stock, so teachers could assemble their games and organize them for easy implementation in their classrooms. We provided this type of support each grading period that year to the piloting teachers.

## Support in 2005–2006: Content Training

As a Select Cadre member it was my responsibility to help organize “transfer sessions” between IMI and our district. We transferred any content knowledge that we learned from our IMI workshops to our district teachers. Our first few years with IMI focused on implementing the standards-based program successfully. We also had several discussions on how to showcase our success stories with others, so the whole district would adopt this program. During the fall of 2004, we adopted *Everyday Mathematics* in Hammond. We began our content sessions in 2005 after learning from our IMI sessions that teachers teach better if they have a better understanding of the math concepts. Many elementary teachers only had one or two courses on the teaching of mathematics to prepare them for the classroom.

During the 2005–2006 school year, our sessions were planned and facilitated by the IMI cadre leaders. Any teacher who was interested in improving his or her mathematics teaching was invited to attend. Administrators were also invited. These sessions were planned because elementary teachers are not content specialists, and their teaching of math can parallel their understanding of the math itself. This came to light at an IMI workshop where we were administered a pre-test of our current math content. Many of our veteran teachers scored lower than they expected. Following our content sessions with IMI, our scores increased. We also wanted to give teachers the opportunity to explore how the mathematics content fits into the bigger picture of our curriculum’s scope and sequence.

Our IMI cadre team planned our content sessions for the year. We started with geometry because we felt many teachers might not have studied it since they took geometry in the 9th or 10th grade. From our experience with the pre-test we took for the IMI project, we realized that there are many skills one can forget, if not continually practiced.

We modeled our activities from those in *Bridges to Classroom Mathematics* (COMAP, 1998). The *Bridges to Classroom Mathematics* program, developed jointly by COMAP, TERC, and the University of Chicago and funded by the National Science Foundation, provides professional development materials for teachers using curricula based on the standards of the National Council of Teachers of Mathematics. (We highly recommend this resource for districts that want to bridge the gap between math content of teachers and teaching with a standards-based curriculum. The program allowed us to guide participants into a deeper understanding of geometry and other content strands. For more information, go to <http://www.comap.com/elementary/projects/bridges/index.html>.) We used activities from *The Staff Developer’s Guide: Mathematics for Elementary Teachers* and *The Staff Developer’s Guide: Everyday Mathematics* (COMAP, 1998). What follows is a description of some of the sessions, along with the feedback we received from participants.

We conducted a total of five sessions on content in 2005–2006, on the topics of geometry, patterns, functions, algebraic thinking, and fractions. Two examples of sessions are described in detail below, followed by brief descriptions of the other three sessions, as well as a discussion of the feedback that we received.

### Geometry Session

In October our first content session was on geometry. We had planned for our participants to complete an anticipation guide. The guide was made up of questions that tested their prior knowledge about geometry.

One of the questions was simply:

*Is a kite a parallelogram? Please Explain.*

Another was:

*A rectangle is a parallelogram that has all right angles.*

*Which of the following are rectangles?*

Write “always,” “sometimes,” or “never” to complete each sentence.

*Squares are \_\_\_\_\_ rectangles.*

*Rhombuses are \_\_\_\_\_ rectangles.*

*Trapezoids are \_\_\_\_\_ rectangles.*

Each teacher completed this activity individually.

Next we had our participants explore attributes of two-dimensional shapes and associated vocabulary. The activity culminated with a discussion about faces and bases of geometric solids. We then had participants applying what they had learned about two-dimensional shapes by doing two activities with quadrangles, followed by an activity led by the facilitators using Venn diagrams to discuss the similarities and differences among different quadrangles.

For our last activity, participants developed definitions for polygons. They were able to use geoboards to construct various figures, to aide in their development of a definition. The facilitators led discussions in small groups, coming to an agreement on the definitions of polygons, convex polygons, non-convex polygons, regular polygons, and non-regular polygons. Finally we closed the session with participants reviewing their anticipation guide and changing any answers based on their “discoveries.”

### Pattern & Functions Session

In November, our content session was on patterns and functions. Participants examined three routines involving patterns and functions. Our Select Cadre facilitators used the *Bridges to Mathematics Activity* “Patterns and Functions” to guide this portion of our agenda. This session was also designed to help participants understand the mathematical thinking behind certain activities and routines in the curriculum. The program routines that we focused on were “What’s My Rule?” “Frames and Arrows,” and “Function Machines.”

Next we had ten pattern and function stations set up around the room. Teachers rotated in groups of two to four people, spending seven minutes at each station. We wanted teachers to work with other teachers from different grade levels. Teachers appreciated doing the centers as a group, so they could help each other on the math content.

We had handouts on which teachers had to represent rates; read graphs; find patterns on a number grid; solve “frames and arrows” sheets, in which rules are applied to complete a series of numbers; complete four series of dot patterns; and to complete patterns of numbers in tables, along with stating the corresponding rule.

We ended our session with our groups discussing the stations. We asked, “Does anyone have any comments about the activities we just did?” We also discussed how these activities compared with what they had done in the past, and what differences they saw across grade levels.

### Three More Sessions

Feedback from teachers who attended our Patterns and Functions session asked for more on algebra. So, for our next two sessions, we focused on this topic. One session included activities using sequences with shapes, growing patterns, and other patterns and functions. The next session was organized with stations focusing on modeling, variables, and solving equations.

Our last session for the 2005-2006 school year focused on fractions. In this session participants used a variety of visual models to combine and compare fractions and then played an Everyday Mathematics fraction game.

### Feedback

Participants always filled out a feedback form, so we could better meet the needs of our audience. They were asked to write three things they learned, two ways they would use the information in their classrooms, and one thing they were still wondering about.

Examples of things participants learned included:

- “Geometric shapes can be confusing for students who are not visual learners.”
- “I learned what a kite is, and that it is not another name for a rhombus.”
- “Visual learners do better with patterns than auditory learners.”
- “How to compare fractions without determining a common denominator.”
- “Concrete examples are good for children to compare fractions.”
- “It was valuable to actually do and see activities from various grade levels.”

Examples of information they thought they would use in their classrooms included:

- “When I understand more about shapes, I am more able to explain the shapes accurately to my students.”
- “I will use proper terminology when teaching geometric shapes to my primary students.”
- “I will use my grid more regularly to work on tens. Many students have difficulty with understanding tens.”
- “Using multiple representations within one activity — change if too easy/difficult.”

This information helped us know that we were reaching teachers and helping them to deepen their content knowledge. We also used the information from each session about what they learned and what types of things they would use. Their requests for what they wanted to learn more about helped us plan for our next sessions and think about what to do in the upcoming years.

### **Support in 2006–2008: Strand Trace Quilts**

In 2006–07 and the winter of 2008 we hosted six after-school mathematics content sessions. Each session was held from 3:30–5:30 P.M. The teachers and administrators received a stipend for their attendance at these sessions, thanks to our IMI grant monies.

The math content sessions utilized a “strand trace” as the professional development model for each of the sessions. Each session focused on one Indiana Mathematics Academic Standard. Teachers traced the development of this standard in our curriculum as children progress from kindergarten through fifth grade.

While completing the traces, teachers deepened their understanding of the standards and the mathematics contained in each one. A strand trace quilt, made up of blocks from their “visual snapshots” (see below), was developed. It featured key concepts and vocabulary at each grade level for each standard. (See Figure 2 below.) Teachers explored the games aligned to the mathematics standards and shared how to make accommodations in the games for students with differing ability levels.

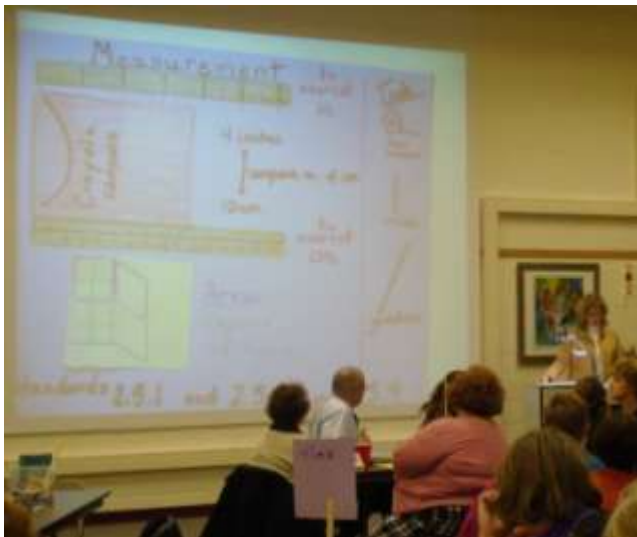
We traced the following six mathematical strands: algebra and functions, number sense, geometry, data and chance, computation, and measurement.

The facilitators, IMI Select Cadre members, followed the same format for each content session. We started with teachers examining Part 1 of math lesson from a grade level they were not currently teaching. The purpose for this was for teachers to learn how the content they were teaching is a small piece that fits into student learning over all grade levels. We wanted them to visualize that if “content pieces” are missing or not taught, then the student has gaps that will cause them difficulty in seeing the big picture.

Tables were set up with lessons chosen because of their rich mathematical content with the highlighted strand for that session. Each table had lessons from kindergarten through fifth grade. As they examined the lessons, participants were looking for performance indicators from the Indiana Standards and the content strands that were addressed. For example, they might ask, “Where is the algebra and functions in this lesson?” Teachers then individually drew a picture using words, icons, and symbols — a “snap shot visual”— to depict on paper how the standard and strand were addressed in that lesson.

Participants then formed groups based on the grade levels of the lessons they had reviewed earlier in the session. Participants shared within these new groups the snap shot visual they each created and decided which product best represented the content strand and Indiana Standard of that lesson. One person from each small group presented her/his visual to the group, explaining what it represented in terms of the standard and the lesson.

After the groups had shared, we placed the papers with their snap shots on the strand trace quilt. A discussion followed about what participants noticed about the trace of the strand through the grade levels. Members of the group commented on how important the early primary lessons are in building a foundation for higher learning of each concept; if teachers are skipping that lesson because of their lack of comfort in teaching that skill, it directly impacts that child’s ability to understand it in the next grade level. Another comment that was made was how the skills build developmentally, moving from the concrete to the more abstract.



**Figure 2.** On the left is a picture of one group presenting their snap shot visual, and on the right is a picture of the completed strand trace quilt.

Next participants did a “Game Trace” in which they played games that were aligned to the same strand but taught at different grade levels. As they played the games, participants talked about the content strands and Indiana Standards addressed in each game and how to adjust the game to make it easier or more difficult for individual learners.

We ended the session with a large group discussion asking participants to reflect on the activities. Participants completed a feedback form after each session and were encouraged to bring fellow teachers to our next strand trace. Some things participants learned included:

- “Algebra is based on patterning, every year the pattern increases in difficulty.”
- “Each grade builds on foundation.”
- “Algebra is addressed at every grade level.”
- “How important teaching every strand can be to the entire K–5 and beyond.” (I knew this but the visual (quilt) really make it pop out!)
- “Ways to adapt the games to meet developmental levels.”
- “How concepts connect across grade levels.”
- “Common mathematical language is important for teachers to use in all grade levels”
- “Second grade place value translates well into third grade place value lessons — good transition.”

## **2008: Fact Power and Vocabulary in a Standards-Based Curriculum**

In winter of 2008, we hosted two additional after-school mathematics content sessions. Each session was held from 3:30–5:30 P.M. The teachers and administrators received a stipend for their attendance at these sessions, thanks to our IMI grant monies.

One content session focused on teaching the basic facts in the standards-based curriculum, and the other focused on vocabulary development.

### Fact Power

We wanted to concentrate on this topic because we had heard that teachers were saying that teaching the basic facts was a weakness in our curriculum. We wanted to set the record straight and show teachers where and how the basic facts are taught in the program.

We began our agenda with a brief PowerPoint presentation titled the “The Facts about the Basic Facts.” In this presentation, we had a quote from Marilyn Burns, who discussed how the use of timed tests does not help students with conceptual understanding. We also shared a graph that shows when the different facts are emphasized across the different grade levels in the curriculum.

Next we had participants work with the grade-level materials and study units to find all areas where basic facts are introduced and practiced. Teachers recorded their findings onto chart tablets and shared these with the large group. We also talked about different strategies that are used for teaching basic fact fluency. Last we played games where students practice strategies for improving their automaticity of the basic facts.

### Vocabulary

The next session focused on activities that we received at an IMI session. These were activities presented by teachers from another IMI district, the Metropolitan School District of Pike Township. They were adapted from activities originally developed by Heather Lee Hart and presented with her permission. The activities were:

- “Who Am I? Vocabulary.” The facilitator placed vocabulary words on the backs of participants. Participants walked around the room asking yes or no questions about who they were.
- “Hot Potato.” Participants received a deck of cards with vocabulary terms. They had to get their team to guess the word by giving clues.
- Mathematical puzzles. Participants reorganized puzzles and answers so that every equation was matched with its own solution. Then they had time to design their own puzzles.

### Feedback

Some things participants learned from these two sessions included:

- “How many interesting strategies *EM* [*Everyday Mathematics*] uses to help kids learn ‘facts.’ etc. They are valuable!”
- “*EM* uses so many avenues to reach and teach all types of learners.”
- “I learned how all the different grade levels relate to each other in the program.”
- “I learned how important it is to incorporate all the activities because they are revisited later.”
- “I learned how I can differentiate a student’s fact practice by the use of the puzzles.”

### **Overall Reflection**

Over the years, we have learned that teachers are very busy and sessions that are after school are not well attended. Usually it is the same 30 or 40 participants. However, those 30 to 40 teachers share with their home school, and our numbers grow. It also helps when teachers are rewarded with a stipend for their time, which we were not always able to do. Our last session on Fact Power was such a “hot topic” that we had over twice as many participants. Had we known then what we know now, we would have started with that and hopefully hooked more participants into coming.

We know how precious their time is, so we make sure teachers leave the sessions with materials or information that they can share with others. The Select Cadre spent a lot of time and thought in planning the sessions. This is why it is so important for participants to fill out feedback forms. We want to know if what we are doing is making a difference in the way teachers are teaching and ultimately in the increase of student learning.

We have also learned that we must sustain our support for teachers, or the work we have done will be lost. Although we will no longer have the opportunity to participate in the IMI project, we will continue to keep our Select Cadre working together to move forward in developing our teachers’ math pedagogy. We are planning support sessions for teachers who are struggling with the implementation of a standards-based math program. Whether it is a new teacher or a veteran teacher, everyone learns at a different pace. We are also scheduling fall sessions, where we can go over some of the documents that were developed through the cadre’s leadership, such as the vocabulary alignment and the assessment opportunities. (See “Alignment Alley and Standard Street: The Process of Aligning Vocabulary and State Standards” by Donna Elliott (<http://www.indiana.edu/~iucme/perspectives/37elliott.pdf>) and “*Everyday Mathematics* Alternative Assessments” by Lois Huntington.

(<http://www.indiana.edu/~iucme/perspectives/36huntington.pdf>)) Lastly, we are working on a problem-solving piece utilizing the open response items from the new *Everyday Math* program.

We believe that effective teachers are lifelong learners, and we plan to continue supporting and nurturing that learning.

*Contact info:* Sherri Prast  
School City of Hammond  
Hess Elementary School  
3640 Orchard Drive  
SEPrast@hammond.k12.in.us