*The Mathematics Educator*
*2005, Vol. 8, No.2, 84-94*

# Evoking Pedagogical Curiosity: A Coaching Approach to Support Teacher's Professional Growth

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**Abstract:** Professional developers use a variety of coaching approaches to support elementary teachers' enactment of recommendations from the National Council of Teachers of Mathematics. Research indicates that teachers often adapt the recommendations and maintain traditional discourse practices. Previous research suggests a new coaching approach, "evoking teacher's pedagogical curiosity," to help teachers ask questions from curiosity instead of searching for answers that match their own. This coaching approach is described using a single case study.

## Introduction

In the early 1990s, the National Science Foundation funded large-scale initiatives to encourage the implementation of mathematics reform recommendations by teachers (Webb, Heck, & Tate, 1996). These initiatives provided opportunities for teachers to engage in sustained professional development throughout the year with in-class support and both summer and school-year workshops. Change in mathematics instruction was sporadic, indicating that research should examine what features of follow-up activities support teachers' professional growth.

Olson and Barrett (2004) investigated four coaching approaches to encourage professional growth, using cognitive coaching (Costa & Garmston, 1994) as a coaching framework. They sought to encourage three first-grade teachers to implement reform mathematics recommendations using a teacher development experiment methodology (Simon, 2000). Four approaches (using rich tasks [Stein & Smith, 1998], co-teaching [Showers & Joyce, 1996], modeling instruction [Becker, 2001], and reflecting [Schon, 1987]) were utilized with cognitive coaching to promote the use of (a) rich mathematical tasks, (b) questions that elicited students' mathematical ideas, and (c) attentive listening to students' responses and noticing nuances of meaning. Like Mrs. Oublier (Cohen, 1990), the first-grade teachers used the innovative materials in traditional ways by managing the discourse as though mathematics contained only right and wrong answers and in ways that discouraged the exploration of students' understanding. The three first-grade teachers were resistant to change, and it was only when they were asked to predict how their students might respond to a related question that the teachers began to listen more carefully to their students' responses. This coaching approach was characterized as *evoking teacher's pedagogical curiosity* and theorized as an approach that could support teachers' professional growth. The present study builds

on Olson and Barrett's research by investigating how a coach might evoke a teacher's pedagogical curiosity. Specifically, I describe how this coaching approach was used to support a first-grade teacher's implementation of mathematics reform recommendations.

## Coaching a First-Grade Teacher

Ms. Lavender (pseudonym) was an experienced teacher working with both fourth- and first-grade students for over eight years. She described her teaching practices in a medium-size urban school district as "traditional" before participating in a 3-year systemic-change initiative designed to develop students' conceptual understanding of mathematics. Ms. Lavender agreed to participate as a case study so that I could explore the use the evoking teacher's pedagogical curiosity approach to support her professional growth.

The coaching goals were designed to help Ms. Lavender use mathematical problems (rich tasks) and ask questions to prompt students' exploration of mathematical ideas. Theoretically, I believed that if Ms. Lavender explored the relationship between an activity and its outcomes (Tzur & Simon, 1999), then she might gain new insights about developing students' conceptual understanding. I created a model (see Figure 1) to illustrate the steps that I followed to evoke her curiosity.

Three coaching sessions serve as examples to illustrate how this coaching approach supported Ms. Lavender's development toward the desired conceptual advance. I characterized her teaching practices and created a conceptual advance from which learning trajectories emerged (see Figure 1). During the post-lesson conversation, Ms. Lavender reflected about the relationship between a task and student responses. Then, I posed a question to evoke her curiosity about students' thinking or a teaching practice. I analyzed Ms. Lavender's interactions with students for evidence of questions that stemmed from curiosity and prompted her to expand her arena of curiosity. Following are three examples to illustrate the process of evoking Ms. Lavender's curiosity and supporting her professional growth.

## Tic-Tac-Toe Hundreds Style

Ms. Lavender identified a mathematical goal to help students explore place-value concepts using a small portion of the hundreds chart. She described the tic-tac-toe task during our pre-lesson conversation: "I draw a tic-tac-toe grid on the board and put a number in the center. Then children go to the board and fill in cells. After placing a number in the grid, I ask each child to give a reason for his or her number placement. I am working on helping them think about moving on the hundreds chart by ones and tens, building their understanding of place value."

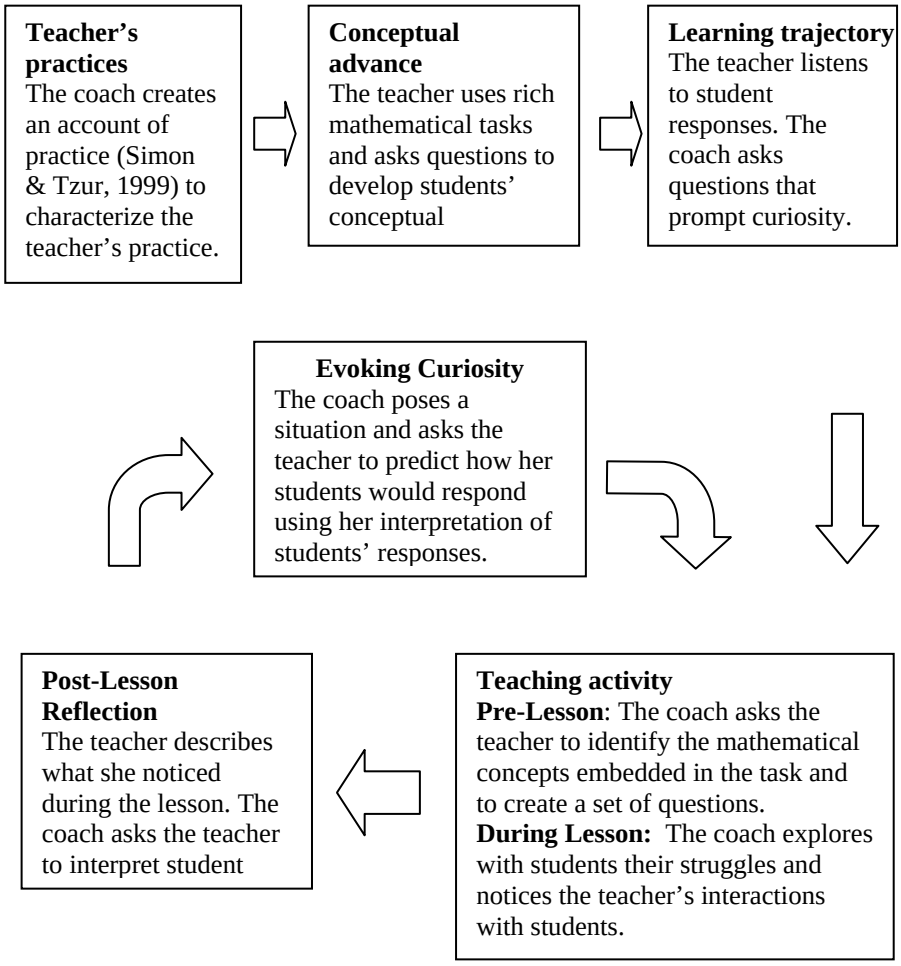


*Figure 1*. Description of a coaching approach that encourages a teacher to reflect on the relationship between an activity and student outcomes by evoking pedagogical curiosity.

Ms. Lavender began class by drawing a tic-tac-toe grid on the white board and wrote 58 in the center square. Paula was given the marker and wrote 59 in the square to the right of 58.

| | |
|---|---|
| 1: Ms. Lavender | How did you know to put 59 there? |
| 2: Paula | 59 comes after it [58]. |
| 3: Ms. Lavender | Because 59 comes after it. Would you please give the marker to Chastity. Would you fill another one in? Okay, what number is that? |
| 4: Chastity | 49. |
| 5: Ms. Lavender | How did you know that 49 went there? |
| 6: Chastity | Because over 49 is over 59. |
| 7: Ms. Lavender | What do you mean that 49 is over 59? What do you mean by that? |
| 8: Chastity | Because it looks like that. |
| 9: Ms. Lavender | How much more is 59 than 49? How much more? (Pause 7 sec) Okay honey, how much? |
| 10: Chastity | Nine. |
| 11: Ms. Lavender | Nine? You're real close. That's good. Let's try it. Let's look and see, okay? Come over here, let's look and see. Count up, how many more, please. |
| 12: Chastity | One, two, three. |
| 13: Ms. Lavender | Keep going please. |
| 14: Chastity | 4, 5, 6, 7, 8, 9 (pause) 10. |
| 15: Ms. Lavender | Ten! 59 is 10 more than 49. Okay. Remember our hundreds chart and we're counting up [from] 49, if we started at 49 we'd counted on 10 more it would be 59. |

Ms. Lavender asked questions to elicit the child's reasoning (lines 1, 5, 7, 9). The child stood at the board and answered Ms. Lavender's questions while the remaining class members sat quietly at their seats, sometimes watching and sometimes fiddling with their desk. When Chastity responded incorrectly (line 10), Ms. Lavender suggested a procedure to count the number of squares between 49 and 59 on the displayed hundreds chart (line 11). She focused Chastity's attention on a procedure with the intent of developing her understanding of place value. After Chastity counted ten squares, Ms. Lavender stated the relationship between the numbers on the hundreds chart (line 15). The questions that Ms. Lavender asked focused attention on using a procedure to solve the problem while developing students' understanding of a concept.

During our post-lesson conversation, I asked what Chastity learned about place value. Ms. Lavender responded, "Chastity saw that if she counted on ten then you moved down one row of the hundreds chart." I asked whether Chastity could fill in a square directly above a given number and if she could explain that it was ten less. Ms. Lavender replied, "Yes, she could fill it in, but I don't know if she could give a reason." I tried to prompt her curiosity, "Do you think she could fill in missing numbers that looked like this?" (see Figure 2).

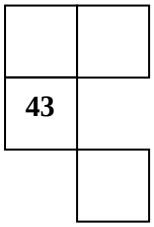


*Figure 2*. Drawing of a portion of a hundreds chart with missing numbers.

Ms. Lavender responded with wonder and decided to ask all her students to fill in the chart to see what they would do. She reflected, "I've never thought about asking them to try things just to find out if they could do it. I'll give them that problem tomorrow."

**Counting Money**

Students are expected to identify the value of different coins and count change by the end of the first grade. Ms. Lavender gave students one penny each day to correspond to the number of school days and gradually added the other coins at the $10^{th}$, $15^{th}$, $25^{th}$ day of school to help students reach the instructional goal. On the tenth day of school, each child had 9 pennies and she planned to ask each child individually how many more pennies he or she needed to make ten cents. Ms. Lavender expected each child to respond with *one more penny* and then planned to ask each child for a justification. During the lesson, most of her students responded as she expected. Jevon was an exception.

| | |
|---|---|
| 1: Jevon | Ten. |
| 2: Ms. Lavender | Okay, lets think about that (she placed 10 pennies on the table next to his line of nine pennies). How many would that be? |
| 3: Jevon | 5, 6, 7, … 18, 19. |

| | |
|---|---|
| 4: Ms. Lavender | You would have a lot more than 10 cents wouldn't you buddy (pause). Let's think about that again. You would have a lot more money than everybody else. |
| 5:Jevon | You would take some back. |
| 6: Ms. Lavender | You're right, I will take some of it back. How many more pennies do I need to give you? |
| 7: Jevon | One more. |
| 8: Ms. Lavender | One more. How do you know that? |
| 9: Jevon | I looked at it. |
| 10: Ms. Lavender | What did you look at? |
| 11: Jevon | The 8 and add 2 more (pushed 8 pennies together and pointed at the single penny that Ms. Lavender placed on the table). |
| 12: Ms. Lavender | Why did you look at the 8 and add 2 more? I only see one penny over there. |
| 13: Jevon | I knew I had 8 and if I added 2 more I'd have 10. I had 1 so I needed 1 more. |

Ms. Lavender asked a question that required a rote response. Jevon replied with an unexpected response (line 1). Ms. Lavender asked a series of questions, first to help him conceptualize how many more ten would be and then if it made sense (line 2). Jevon counted his nine coins and looked at the remaining ten coins (line 3) and concluded that that he needed one more penny to make ten cents (line 11). Ms. Lavender exhibited curiosity (by the tone of her voice) and encouraged Jevon to explain his thinking (line 8) and his use of a related number fact (line 12).

Ms. Lavender emphasized the importance of asking questions while teaching during our post-lesson conversation. She stated, "If I hadn't asked [Jevon how he knew to add one more penny], I would never have known that Jevon was able to use related math facts. I would have assumed that he counted on [began counting at nine and counted on one to reach the number ten) and that would have been wrong. Unless you ask, you will never know. When I teach and ask questions that I don't know how they will respond, I learn from my first graders. They often solve problems in unexpected ways." I asked if she changed her plans when her students gave an unexpected response to evoke her curiosity. She replied, "When I work with students individually, I try to ask questions to help me understand what they are thinking about and then help them to figure out the solution themselves. I never thought about doing that in a large group. I just want them to answer." I asked her to predict what would happen if she built instruction from a students' response during a large group discussion. Ms. Lavender considered this idea and concluded that she had no idea what would happen because the thought of using a student's response during a math lesson had never occurred to her.

**Calendar Math**

Ms. Lavender used calendar math to reinforce place-value concepts by keeping track of the number of school days with straws. A student bundled ten straws with a rubber band every ten days. Our coaching session occurred on the 53rd day and Ms. Lavender planned to ask children to discuss their own meaning of 53. I asked why she was posing this task. She replied, "I don't know how they think about a large number like 53. I was wondering about that now that all the children find counting easy. I'll never know unless I ask."

Ms. Lavender held five bundles of straws and three single straws in her hand and asked. "We have 53 days in our school year. What does 53 mean?"

| | |
|---|---|
| 1: Kevin | It's one more than 52. |
| 2: Ms. Lavender | Okay, it's one more than 52. Anthony what does 53 mean to you? |
| 3: Anthony | It's an odd number. |
| 4: Ms. Lavender | It's an odd number. What does that mean, that it's an odd number. |
| 5: Anthony | I forgot. |
| 6: Ms. Lavender | You forgot, can you think about it. What does it mean to be an odd number? (Pause) How did you know that it was an odd number then? |
| 7: Anthony | Uhmmm. (Pause) it uhm, it's, if I look up there. |
| 8: Ms. Lavender | You looked where? |
| 9: Anthony | At the straws. |
| 10:Ms. Lavender | At the straws (Anthony pointed at the three single straws). These 3 straws? (Pause) And what does, how did that, how did those 3 straws help you to decide that this was an odd number? |
| 11: Anthony | Because, there was more than 2. |
| 12:Ms. Lavender | There's more than 2 and what does that mean then? There's more than 2? (Pause 2 sec) Why, I still don't understand how you knew that that was an odd number. Is there any other reason why you thought it was an odd number besides you counted by ones? Okay, anybody else? Katherine. |
| 13: Katherine | Uhm, it is uhm, there's 5 tens and 3 ones. |

| | |
|---|---|
| 14: Mike | Uhm, three's an odd number too. |
| 15:Ms. Lavender | Three's an odd number to you? Okay. Why is this an odd number? |
| 16: Mike | And one person that lives at the house and a friend came over. And there were 3 cookies. That can make and then there would be one left over. |
| 17: Anthony | There's 3 cookies and one friend came over and there's two friends. They share, each gets one and there is one left. |
| 18. Sheri | So that's why it's not an even number because there's an extra one. We can't divide it evenly. |

Anthony provided an unexpected response to Ms. Lavender's question (line 3). She wondered how her students thought about odd numbers (line 4). As students shared ideas, Ms. Lavender asked probing question (line 10 and 12). She first elicited Anthony's mathematical thinking. He conjectured that since three was greater than two, it was an odd number (line 11). Ms. Lavender wondered aloud if four was an odd or even number to help her students to focus on the characteristics of odd and even numbers. She used her students' responses to explore the concept of odd numbers and their properties (lines 13-18). The discourse pattern also changed. Students independently discussed their ideas without Ms. Lavender acting as a mediator (lines 16-18).

Ms. Lavender was excited about the discussion and during our post-lesson discussion she commented, "I was surprised when Anthony said that 53 was odd. He was right but I wondered what odd meant to them. So, since I didn't know, I kept asking questions to satisfy my curiosity and it lead to a really good discussion. I don't think everyone understood, but they understood the part about 3 being odd." I asked Ms. Lavender to describe how her teaching practices were changing. She replied, "I think I'm a better teacher when I wonder about my students' thinking. When I wonder, I ask better questions that help me figure out how to help them. Our discussions are more interesting."

## Discussion and Summary

These three examples illustrate how I prompted Ms. Lavender to reflect about the relationship between the activity and her students' responses. Essentially, I asked her to describe what she noticed and to interpret a student's response. After a short discussion about the underlying mathematical concepts embedded in the students' responses, I posed a question from my own curiosity.

I listened to her reflections about Tic-Tac-Toe and began wondering if Chastity really understood that when you move vertically on the hundreds chart by units of ten. I wondered if she would be able to fill in missing numbers on a piece of the hundreds chart. I was curious about how she might fill in a number on a diagonal and crafted a problem (see Figure 2) that would allow me to investigate these ideas. While I focused on the mathematical thinking of one child, Ms. Lavender wondered about her students' solutions and asked her entire class to fill in a missing numbers problem the following day. She reported that most of her students correctly filled in the upper two cells but not the cell diagonal to the 43. This prompted her to realize that teaching procedures led to correct answers but not necessarily to concepts that could be applied to non-routine problems. By prompting Ms. Lavender to pose a task that she was curious about, she gained an insight about her students' ability to use mathematical reasoning to solve non-routine problems and she refined her conception about teaching and learning

Ms. Lavender listened carefully to Jevon's response indicating that he needed 10 more pennies. She posed a task creating cognitive dissonance and helped Jevon realize that 10 more pennies would be too much. As we discussed Jevon's responses, Ms. Lavender realized that she helped Jevon consider two mathematical interpretations of *more*: the cardinal aspect (which is more) and the ordinal aspect (how many more). Clearly, Ms. Lavender exhibited curiosity about Jevon's reasoning. I noticed that she was comfortable working with one child and wondered if she ever considered using this practice with the entire class. I asked her to reflect about the use of unexpected responses. Ms. Lavender began to wonder what might happen, and when an opportunity arose she asked questions out of her own curiosity. She discovered during calendar math that her curiosity led to a rich class discussion about the properties of numbers. As Ms. Lavender reflected about the discussion about odd numbers, she realized that asking questions out of curiosity helped her create questions that could lead to interesting discussions about mathematical concepts and select non-routine problems to further explore mathematical ideas with her first-grade students.

In summary, I found that I was able to evoke a teacher's pedagogical curiosity when I became curious myself. I asked Ms. Lavender to (a) predict students' responses, (b) lead a discussion based on an unexpected response, and (c) reflect about the intersection of using curiosity to guide her questioning and students' responses. Ms. Lavender learned to ask questions from her own curiosity that helped her explore mathematical concepts with her students, taking advantage of mathematical problems that sometimes emerged during instruction to develop students' conceptual understanding. The characterization Ms. Lavender's teaching practices using an account of practiced enabled me to create a conceptual advance that

focused my attention on specific practices. The approach of evoking curiosity allowed me to create learning trajectories and activities in which Ms. Lavender became an investigator. She reflected more deeply on the relationship between activities and student learning by exploring her students' thinking.

Further research is needed to determine whether this coaching approach facilitates professional growth of teachers and to establish the conditions in which it is effective. I also wonder whether the evoking teachers' pedagogical curiosity coaching approach can be adopted by coaches who work with large numbers of teachers across several schools.

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