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Fanning the Flames of Greatness

In This Issue, We Offer Ideas for Extending Your Passion to Other Mathematics Professionals

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CORRECTION FROM WINTER 2008 JOURNAL
The Winter 2008 *NCSM Journal* omitted co-author Daniel Clark Orey from the byline of the article, "It Takes A Village: Culturally Responsive Professional Development and Creating Professional Learning Communities in Guatemala." Dr. Orey is a professor of mathematics and multicultural education at California State University, Sacramento. We regret the omission.

Purpose Statement

The purpose of the National Journal of Mathematics Education Leadership is to advance the mission and vision of the National Council of Supervisors of Mathematics by:

- Strengthening mathematics education leadership through the dissemination of knowledge related to research, issues, trends, programs, policy, and practice in mathematics education
- Fostering inquiry into key challenges of mathematics education leadership
- Raising awareness about key challenges of mathematics education leadership, in order to influence research, programs, policy, and practice
- Engaging the attention and support of other education stakeholders, and business and government, in order to broaden as well as strengthen mathematics education leadership

High Quality Coaching Using the LieCal Observation Instrument

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In the LieCal[1] Project, virtually every teacher and every principal we interviewed emphasized the importance of posing classroom tasks that require conceptual understanding, making connections among mathematical ideas, and problem solving. Yet, despite this avowal of the importance of teaching higher order thinking, our observations showed that only slightly more than one-third of the 496 instructional tasks we observed in sixth grade mathematics classrooms involved thinking at higher levels. Similar results were reported in other projects (e.g., Stein et al., 1996). What can be done to remedy such a widespread disconnect between intent and practice?

Some educators believe that one answer may lie in the use of mathematics coaches. The recent coaching movement in the United States is an attempt to help teachers become more effective so that students learn at higher levels. However, too often, schools implement school-based coaching too simplistically, underestimating the complexity of implementing change initiatives. As a result, one concern is that coaching will not live up to its promise without more strategic and systematic development (West et al., 2007).

The purpose of this article is to discuss how the use of the LieCal observation instrument could lead to high quality coaching, and thus high quality teaching. We begin with a brief review of the recent literature about coaching competencies that are crucial to the success of mathematics coaches. Then, we present a framework used in the LieCal Project to design part of the LieCal observation instrument. Finally, using a classroom vignette from the LieCal Project, we discuss how the observation instrument from the LieCal Project can be used to help coaches attain these crucial competencies.

Coaching

The term "coaching" can be defined broadly to mean any job title that includes assisting teachers with improving mathematics instruction as part of their responsibilities (West et al., 2007). Across America today, hundreds of instructional coaches are being hired to improve professional practice in schools (Knight, 2007). Some coaches are in roles that are poorly articulated, are not trained in the complexities of adult learning, or face a school culture that hasn't been adequately prepared for this form of professional development (Sweeney, 2007). Therefore, professional development is needed to develop effective coaching skills. In designing professional development for coaches, three components are crucial: establishing trusting relationships, using content knowledge as the focus of coaching, and using influence skills to change behavior (Driscoll, 2005; Knight, 2007).

Establishing Trusting Relationships in Coaching

It is most important that coaches not be perceived as critics of teachers' practices. Effective coaches have to learn to discuss instructional issues with teachers in ways that enlighten without threatening or offending the teachers. For that reason, most advocates of the coaching movement agree that effective coaching begins with the establishment of

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a trusting relationship and open communication between the coach and the teacher (Brady, 2007; West & Staub, 2003).

An effective way for coaches to establish trusting, open relationships with teachers is to collaboratively analyze student work to determine the students' understandings and misconceptions. The key to being an effective coach is listening and asking questions to develop the teacher's own capacity during the analysis (Silicon Valley Mathematics Initiative, 2007). When coaching questions are grounded in student work and student learning, the dialogue between teacher and coach takes on a collaborative spirit, with the common goal of improving student learning. If the coach phrases genuine questions for reflection rather than questions with a single correct answer (Feger et al., 2004), the teacher will see the coach's questions as prompts for reflection, not critical judgments that put the teacher on the defensive.

Using Content Knowledge as the Focus of Coaching

Too few coaches pay attention to the specific mathematical content of a lesson. In response, the concept of "content-focused coaching" (West & Staub, 2003) was developed by researchers at the University of Pittsburgh. A content-focused coach helps teachers deepen their content knowledge of the mathematics being taught and broaden their repertoire of pedagogical strategies to help students access important mathematical concepts and skills (West, 2006).

The focus of content coaching is on students' thinking, understandings and work products. Of particular interest to content-focused coaches is the question: "How does this lesson engage students in thinking that moves them toward the teacher's stated goals?" (West & Staub, 2003). To answer this question, coaches must help teachers gather and interpret evidence of student understanding. The purpose is to link evidence of understanding to teaching so teachers can decide whether they need to modify instruction. Together, coaches and teachers analyze students' thinking by discussing questions like: "What is the mathematics?" "What does this piece of student work, or this student's response, tell us about what the child understands?" "What might you do next?"

Using Influence Skills to Change Behavior

In order to influence or persuade teachers, coaches must apply skills that are similar to those of effective leaders. When coaches lead teachers through difficult change, they challenge what teachers hold dear, and often teachers' first reaction is to resist. To help overcome such resistance, coaches need to understand and capitalize on one of the principles of effective leadership, which is to persuade, rather than dictate (West, 2006).

Coaches find that teachers' actions are frequently incongruent with their espoused intents. In leadership theory, a typical intervention is to call attention to a gap between espoused theory and theory-in use. The intervention first involves the coach presenting a challenge by pointing out gaps between intentions and actions. Then, the coach provides support by helping the teacher understand the source of the gap so that new ways of thinking and acting can be integrated into their teaching practice. By acting in this way, the coach holds out an implicit vision of congruence between aspirations and actions (McGonagill, 2000).

Task Framework and Observation Instrument

Mathematical Task Framework

In the Mathematical Tasks Framework, Stein and Smith (1998) define a task as a segment of classroom activity that is devoted to the development of a particular mathematical idea. The Mathematical Tasks Framework distinguishes four levels of cognitive demand found in tasks: memorization, procedures without connections, procedures with connections, and doing mathematics. Tasks categorized as "memorization" or "procedures without connections" are considered low-level cognitive tasks. Tasks categorized as "procedures with connections" or "doing mathematics" are considered high-level cognitive tasks.

Besides distinguishing the four levels of cognitive demand, the task framework also differentiates three phases through which tasks pass: first as they appear in the instructional materials; next as they are set up or announced by the teacher; and finally as they are actually implemented by students in the classroom (Stein and Smith, 1998).

Realizing that a focus on the cognitive demand of mathematical tasks and on the way they are implemented in classrooms can assist teachers in the reflection process, we used the Mathematical Tasks Framework as the basis for designing part of the classroom observation instrument in the LieCal Project. As a tool for reflection, the Mathematical Tasks Framework draws attention to what students are actually doing and thinking during mathematics lessons. The focus on student thinking, in turn, helps the teacher adjust instruction to be more responsive to, and supportive of, students' attempts to reason and make sense of mathematics.

LieCal Observation Instrument

The LieCal Project compares the relative effectiveness of a National Science Foundation funded middle school mathematics curriculum with curricula that was not funded by NSF. An important part of the LieCal Project is the examination of instructional practice using classroom observations. During 2005-2006, two trained research specialists observed 195 lessons. While in the classrooms, the observers made minute-by-minute records of the lessons as they unfolded. Afterwards, they filled in LieCal observation forms by reflecting upon and coding important aspects of the mathematical tasks that were used during the lessons.

Among other things, the observers coded how the LieCal teachers selected and used tasks to maximize student opportunities to learn important mathematics. The Appendix shows the form used to code one task. The first column of each table on the form distinguishes among three phases of each task: as intended by the author, as set up by the teacher, and as implemented by the teacher and/or students. If the cognitive demand of a task changes as it unfolds--from curriculum intent, through setup, to implementation--the completed form captures that change.

Creating Coaching Opportunities Using the Observation Instrument

In this section, we present a classroom vignette to show how the observation instrument can be used to create coaching opportunities. The classroom vignette is taken from a LieCal 6th grade mathematics class that uses a non-NSF funded curriculum. Mr. A spent the previous day's class teaching two different approaches (factor trees and lists) to finding the greatest common factor of two or three numbers. The students had been given a homework assignment of 20 exercises to practice finding the greatest common factor, and at this point, most students in the classroom were comfortable with the procedures.

As in all the LieCal schools, Mr. A's school values problem solving. The teachers are encouraged to have the students work problems that encourage higher-order thinking skills. In his pre-observation interview, Mr. A himself professed to value problem solving and higher-order thinking. Consequently, Mr. A spent a second day on the topic of greatest common factor, devoting most of the class period to having the students solve an application problem in groups.

Presenting the Task

The Plants Problem: The table lists the number of tree seedlings Emily has to sell at a school plant sale. She wants to display them in rows so that the same number of seedlings is in each row.

Seedlings for sale

Type	Amount
Pine	32
Oak	48
Maple	80

8. Find the greatest number of seedlings that can be placed in each row.
9. How many rows of each tree seedling will there be?

This first excerpt captures how Mr. A set up the task. After a student reads the problem aloud, Mr. A leads the following discussion:

Mr. A: *Now, what do you think we can use to find that answer? Hint, hint, it's something we've been working on for the last few days. Shamika.*
Shamika: *GCF.*
Mr. A: *GCF, OK, so that would help define number 8; let's also look at number 9. Anna, read 9.*
Anna: *How many rows of each tree seedling will there be?*
Mr. A: *OK, after you find your GCF in 8, you should be able to use that to help you find the answer for 9. All right, now we're going to work as a group on this. I'm going to give us, oh, about 5, 6, 7, 8 minutes or so. I'll watch to see how long it takes. And I'll be back with you in a little bit to see how the groups did on this. OK?*

Analyzing the Cognitive Demand of the Task

<u>Task as intended by the author</u>. In terms of the Mathematical Tasks Framework, this task, as intended by the author, was coded as *Procedures With Connections*

because it "… focuses students' attention on the use of procedures for the purpose of developing deeper levels of understanding of mathematical concepts and ideas," (Stein et al., 2000, p.16). It therefore fits into the school's priority of focusing on problem solving and higher order thinking skills. Mr. A correctly identified this task as one that could lead to a high level of cognitive demand, because it asks students to engage with the conceptual ideas that underlie the procedures for finding GCF in order to successfully complete the task and develop understanding. He hoped that it would stimulate students to make connections between the concept of GCF and the application of the idea to a real-life situation.

Task as set-up in the classroom. A decline in cognitive demand occurred in the set-up phase for the task. The observer coded the task set-up as *Procedures Without Connections* because the "Use of the procedure is … evident based on instruction…" (ibid, p. 16). During this phase, the teacher reduced the level of cognitive demand by the way he set up the task. Before the students had time to think about the solution to either of the problems, Mr. A. told them how they should proceed. Furthermore, Mr. A. described how to use the answer from problem 8 to solve problem 9. His directions took away the challenge introduced by the unstructured nature of the task, and hence reduced the cognitive demand.

Task as implemented by the teacher and students. The actual implementation of the problem was also at a reduced level of cognitive demand. In the following excerpt, the students have computed the GCF of 32, 48, and 80 to be 16. However, they have done so only because they were directed to do so by Mr. A. What is evident in this second excerpt is that the students did not know why they had found the GCF, nor did they realize that 16 was the answer to problem 8.

Shamika: *Because you can't divide 3 by 16.*
Duane: *It only goes to 15…trying to figure out.*
Shamika: *I know you can't divide it, 3 divided by 16, though. If there's 3 trees and we got 16 for the greatest common factor, and there's 3 trees, how can you divide 3 by 16?*
Carlos: *I don't know. But, um, wouldn't, wait, if there's how many rows of tree seedlings will there be, and there's 3 trees, wouldn't it just be 3 rows, one for each tree?*
Shamika: *3 trees.*
Duane: *3 rows.*
Shamika: *3 rows of seedlings.*
Duane: *But no, she wants to even 'em out on each row.*
Shamika: *It don't say even 'em out.*
Duane: *Yes, it does. Look it. She wants to display them in rows with the same number of each type of seedling in each row.*
Shamika: *Oh. Mr. A? But it won't be even though.*
Duane: *It can't be 3 rows.*
[At this point, Mr. A walks up to the group for the first time.]
Shamika: *We got 16 for our GCF.*
Mr. A: *That, that sounds great.*
Duane: *What's number 9?*
Shamika: *16 divided by 3.*
Mr. A: *No, 16 is your GCF. 16, 16 is the amount of the greatest number of seedlings that can be placed in each row.*
Duane: *Well, what about number 9?*
Mr. A: *Well, number 9, now we have to use the answer from here to find the answer to number 9 by using division.*

Rather than asking the students to explain what they knew about the task, Mr. A provided brief answers that did not lead to any conceptual understanding about the solutions. Specifically, when he walked up and heard the number 16, he said, " …16 is your GCF. 16, 16 is the amount of the greatest number of seedlings that can be placed in each row." Then he proceeded to give them a procedural hint to get the answer for problem 9. Mr. A's interactions with other groups were also procedurally oriented.

This third excerpt took place during the whole group discussion at the end of class. In it, Mr. A continues to focus the students' attention on procedures, rather than the underlying concepts.

Mr. A: *OK. Now, what did we agree that the GCF or the most seedlings in a row could be? This is problem 8. What did we agree? Karl? How much?*
Karl: *16.*
Mr. A: *16. And most groups ended up with 16. Look, you guys, I wrote it out earlier. I used the tree method. Look, please.*
[Here, Mr. A refers to a tree diagram on the overhead.]
2 x 2 x 2 x 2 = 16 seedlings in a row. It ended up being the prime factorization that they had in common was 2 times 2 times 2 times 2. And for some reason, some of you were going, that equaled 8. Well, look. 2 times 2 is 4. 4 times 2?
Karl: *8.*

Mr. A: *8 times 2?*
Karl: *16.*
Mr. A: *All right. So, it ended up being 16 seedlings in a row. Now, let's use that answer to divide to find the answer to 9. Someone read 9. Read 9. Tony.*
Tony: *How many rows of each tree seedlings will there be?*
Mr. A: *OK, how many rows of each tree seedlings will there be? Very good. Now, go back to the table. How many seedlings were there for pine? How many? Go to the table. How many, Bonita?*
Bonita: *2 rows.*
Mr. A: *Listen to my question. How many seedlings were there for pine?*
Bonita: *32.*
Mr. A: *32. What can we divide 32 by to find out how many rows? Bonita?*
Bonita: *Divide it by 16.*

From the observer's point of view, it appeared that most groups did not understand the reason to use the GCF even after the whole group discussion. In terms of the Mathematical Tasks Framework, Mr. A's implementation of the task would be classified as *Procedures Without Connections*.

This vignette illustrates how a teacher can miss an opportunity for students to solve a task with a high level of cognitive demand at several critical junctures during the class. First, during his set-up, Mr. A reduced the level of cognitive demand when he provided hints that essentially told the students how to solve the problems in the task. Next, in responding to student requests for help during group time, he eliminated the sense-making aspects of the task and deprived the students of the opportunity to develop meaningful mathematical understanding. Finally, during the summary discussion with the whole class, Mr. A continued to question students about procedures rather than about their understanding of why they should use the GCF to solve the problem.

Building Coaching Competencies

Although Mr. A was hoping to engage his students in a high-level task, the coach observed that he intervened very early to reduce the cognitive demand. Why did this happen, and what can the coach do about it?

In this section, we discuss how the coach can use the task analysis portion of the LieCal observation instrument to affect Mr. A's future set-up and implementation of high level tasks. This discussion draws on the three components of a successful coaching relationship. That is, we will show that the coach can change Mr. A's future behavior by focusing on content, and by using persuasion, while maintaining a trusting relationship.

From past experience, the coach knows that there are several reasons why teachers might lower the cognitive demand of problem situations.

- The teacher thinks the students do not have the necessary background (e.g. number sense, operation sense, basic facts, algorithm skill, the connections among them) to solve the problem.
- The teacher has an underlying belief that students learn best when shown.
- The teacher's students do not behave when they are put into open-ended structured problem solving situations.
- The teacher assumes that once a student gets an answer, the student understands what the answer means. As a result, the teacher does not probe to find out if a student really understands the conceptual basis for the answer.
- The teacher has a closely held vision of an effective teacher as a "sage on the stage."

An effective coach realizes that Mr. A may not even be aware that his beliefs led him to lower the cognitive demand of the task. A thoughtful conversation about student thinking during the task can help the coach influence the teacher's pedagogy, and at the same time cement a trusting relationship and focus on the mathematical content of the task.

During the post-lesson discussion, the coach must be careful to maintain the trusting relationship between the coach and the teacher. This can be done effectively by concentrating on the students' work and the students' learning. The coach can begin by having a discussion with Mr. A about how the students' work shows whether the students learned how to use the GCF to solve the Plants problem.

C: *While you were observing the groups working on the task, I was doing the same.*
A: *I was really pleased with the behavior of all the groups, weren't you?*
C: *Yes, I agree that they were very well behaved. It is obvious that they know what is expected of them when they are working in groups.*

A: Thank you. We have worked hard on that.
C: I was observing Shamika and Duane's group just before you walked up to them. I thought they were really struggling with the problem. They had found that the GCF was 16, but their conversation indicated that they were trying to figure out what the 16 meant. They kept asking whether they could divide 3 into 16. And I wondered if they even knew what the 3 meant, because Shamika kept talking about 3 trees and Duane talked about 3 rows. Did you observe other groups having the same type of difficulty?
A: Most of the groups I observed got 16.
C: I wonder if they knew what the 16 meant in relation to the problem, or how to use it to solve problem 9.
A: Well, I think so, because when I set up the problem I told them they needed to find the GCF to get the answer to problem number 8.
C: Why did you tell them that they needed to find the GCF?
A: I wanted them to understand that this problem was related to the work we were doing yesterday, and I think they did understand because they got the right answer to problem #8.

At this point in the conversation, many thoughts are going through the coach's mind. The coach wants to get Mr. A to realize there is a disconnect between Mr. A's goals for the lesson and the way the lesson was set up and implemented. On the one hand, teachers should be a main source of mathematical information and actively help students make sense of mathematics. On the other hand, teachers should not intervene too much and so deeply that they cut off students' initiative and creativity. It is essential for teachers to balance between allowing students to pursue their own ways of thinking and providing important information that supports the development of significant mathematics (Ball, 1993; Ball & Bass, 2000).

How will the coach get Mr. A to realize the balance has not been established? The coach steered the conversation as follows.

C: How do you interpret the difficulty that Shamika was having just before you walked up?
A: She had the answer, she just didn't know it.
C: I wonder why she didn't know she had the answer.
*A: Maybe because she doesn't understand what GCF means for this problem. … … **[Realizing what he just said--]** Oh, I hadn't thought about it like that.*
C: Like what?
A: I guess I just assumed that if she had the answer, she knew what it meant, but I never really asked her that. So maybe I didn't know for sure. Like they said in our last in-service about the importance of probing students' thinking. I guess I didn't do that.
C: Yes, I remember that in-service, too. Thinking back, what was your initial reaction to it?
A: At that time, I wasn't sure about the whole idea. Maybe there is something to it, after all. Thinking back on what happened today, I may have made some poor assumptions by not asking for my students to explain their answers. Maybe I did too much thinking for them.
C: Thinking back on the lesson, what would you change?
A: Well…, I'm not sure. I need to be sure that they really understand what they are doing. Like Shamika. Until you told me, I didn't realize that the students had problems knowing what to do with the GCF once they found it. Maybe I should spend more time explaining what the problem is asking for before they start.
C: I think it's a good idea to make sure they really understand the problem before they start. I saw them work well in groups. Do you think they could work in groups to make sense of the problem before they begin to solve it?
A: Well, … maybe. But what would I ask them to do, and wouldn't most of them be floundering?
C: Ahhhh, don't underestimate them. You could give them a short time, say five minutes, to read and understand the problem. After five minutes, have a class discussion centering on how the display could be laid out so that the same number of seedlings are in each row.
A: But when I gave them the hint to use the GCF, didn't that do the same thing?
C: Judging from what I saw in Shamika's group, they found the GCF but had no idea what to do with it. If the students came up with any way, say four trees in each row, at least you could direct the conversation to the fact that they are using common factors.
A: Yes, and from there they would have to realize that they need to use the greatest common factor, not just any old factor.

In the course of this conversation, the coach was able to help Mr. A realize that he holds some underlying beliefs about teaching that guide his actions. Specifically, Mr. A believed (1) that his students did not have the necessary background to use the GCF and (2) once a student gets an answer, the student understands what the answer means. So, he acted in total harmony with his underlying beliefs, and literally told the students to find and use the GCF. This diminished the challenge of the task from the beginning, but he was able to justify this move to himself because of the strength of his other underlying beliefs. The coach helped Mr. A realize that, at least in this situation, his beliefs interfered with his goal of having students use high level thinking to solve problems. As a result, the next time Mr. A has his students work on a high level task, he will be more aware of the need for students to spend time understanding the problem and its solution, and how his teacher moves can inhibit or enhance that understanding.

Conclusion

The LieCal observation form is a lens for reflecting on teacher instruction. By using the form, a coach is guided to reflect upon and decide whether the evolution of mathematical tasks during the lesson matches the teacher's goals. The form helps the coach know what to look for during the lesson and what to talk about with the teacher afterwards.

To give insight into the evolution of the task, the LieCal observation form requires that the coach record a minute-by-minute account of the events of the lesson, including questions asked, answers given, teacher moves, and student moves as they unfold during the lesson. Ideally, the coach has scheduled a meeting to discuss the lesson. Prior to that meeting, the coach refers back to the minute-by-minute log to analyze the goals of the tasks as intended by the textbook author, how the tasks were set up by the teacher, and how the tasks were implemented by the teacher. The minute-by-minute log also helps the coach think about the examples the teacher used and the questioning strategies that enhanced (or not) the development of students' conceptual understanding and problem solving.

The LieCal observation form, with its minute-by-minute log and its task analysis form, helps focus the coach's attention on important topics that he/she should discuss with the teacher. For example, "Did Mr. A realize that the cognitive demand of the task had declined?" "Did Mr. A realize that his students stayed at level of memorized procedures that are disconnected from underlying ideas?" Perhaps not. The post-lesson conversation may be the first time that Mr. A realizes that his actions do not match his goals.

In this article we have examined how the LieCal observation instrument can be used to help coaches foster the three components of good coaching: establishing trusting relationships, using content knowledge as the focus of coaching, and using influence skills to change behavior.

When the coach discusses student actions, reactions, or work with the teacher, as recorded on the LieCal observation form, the coach is strengthening their trusting relationship, not jeopardizing it, because the focus is on helping students, rather than on correcting teacher shortcomings.

By using the LieCal observation form, the coach helps the teacher (1) focus on setting up tasks so that they foster the goals of the lesson, (2) organize the implementation of tasks to foster the goals of the lesson, (3) formulate questions that challenge students to meet the goals of the lesson. By focusing on students' thinking, understandings and work products the coach helps the teacher link evidence of understanding to the teaching that occurred in the lesson. This content coaching, which uses mathematics as a focus for discussion, can be used to help teachers meet their goals.

At the same time, the coach is influencing the teacher to change behavior because the coach's questions help the teacher himself realize that there is a disconnect between the teacher's stated goal and the teacher's actual actions.

References

Ball, D. L. (1993). With an eye on the mathematical horizon: Dilemmas of teaching elementary school mathematics. *The Elementary School Journal,* 93 (4). pp. 373-397.

Ball, D. L. & Bass, H. (2000). Interweaving content and pedagogy in teaching and learning to teach: Knowing and using mathematics. In J. Boaler (Ed.), *Multiple perspectives on mathematics teaching and learning*. International perspectives on mathematics education. Westport, CT: Ablex.

Brady, C. H. (2007). Coaches' voices bring 6 lessons to light. *Journal of Staff Development*, 28(1), 46-50.

Driscoll, M. (2005). Influence skills in instructional coaching: Reflections for the September 2005 instructional coaching conference. Newton, Mass.: Education Development Center. Available as pdf file at *http://cllc.edc.org/instructionalcoach06/*.

Feger, S., Woleck, K., & Hickman, P. (2004). How to develop a coaching eye. *Journal of Staff Development*, 25(2), 14-18.

Knight, J. (2007). 5 Key points to building a coaching program. *Journal of Staff Development,* 28(1), 26-32.

McGonagill, G. (2000). The coach as reflective practitioner: Notes from a journey without end. In C. Fitzgerald & J. G. Berger (Eds.), *Executive Coaching: Practices and Perspectives*. Palo Alto, CA: Davies Black Publishing.

Silicon Valley Mathematics Initiative (SVMI) (2007). Pedagogical content coaching. Palo Alto: Noyce Foundation. Available as a pdf file at *http://www.noycefdn.org/math/documents/PedagogicalContentCoaching.pdf*.

Stein, M. K., Grover, B. W., & Henningsen. M. A. (1996). Building student capacity for mathematical thinking and reasoning: An analysis of mathematical tasks used in reform classrooms. *American Educational Research Journal*, 33, 455-488.

Stein, M. K. & Smith, M. S. (1998). Mathematical tasks as a framework for reflection: From research to practice. *Mathematics Teaching in the Middle School*, 3(4), 268–275.

Stein, M. K., Smith, M. S., Henningsen, M.A., & Silver, E. A. (2000). *Implementing Standards-Based Mathematics Instruction: A Casebook for Professional Development*. New York: Teachers College Press.

Sweeney, D. (2007). Mirror, mirror, in the lab. *Journal of Staff Development*, 28(1), 38–41.

West, L. (2006). Coaching as leadership. In S. Leinwand (Ed.), *Leadership for Student Achievement in Mathematics*, Monograph Series for Leaders in Mathematics Education, (Volume 4, 42-54). Lakewood, CO: NCSM-Houghton Mifflin Company School Division and McDougal Littell.

West, L., Hanlon, G., Tam, P., & Novelo, M. (2007). Building coaching capacity through lesson study. *NCSM Journal of Mathematics Education Leadership*. 9(2), 26-33.

West, L., & Staub, F. C. (2003). *Content-focused coaching*[SM]*: Transforming mathematics lessons*. Portsmouth, NH: Heinemann & Pittsburgh: University of Pittsburgh.

Appendix

Analysis of Mathematical Tasks

Each mathematical task should be analyzed from four categories: Task as Intended, Task Set-up, Task Implementation, and Factors Associated with Decline or Maintenance of High-Level Cognitive Demands.

Task as Intended by Author	Solution Strategy	Representation (Circle all that apply)	Explanation (Circle all that apply)	Cognitive Demand (Circle **one** level only)
	1 Single 2 Multiple	1 Symbolic 2 Written words 3 Pictorial 4 Table 5 Graph 6 Verbal 7 Manipulatives	1 Not required 2 Show work 3 Explain/justify	1 Memorization 2 Procedures w/o Connections 3 Procedure w/ Connections 4 Doing Mathematics

Task Set-up by Teacher	Solution Strategy	Representation (Circle all that apply)	Explanation (Circle all that apply)	Cognitive Demand (Circle all that apply)
	1 Single 2 Multiple	1 Symbolic 2 Written words 3 Pictorial 4 Table 5 Graph 6 Verbal 7 Manipulatives	1 Not required 2 Show work 3 Explain/justify	1 Memorization 2 Procedures w/o Connections 3 Procedure w/ Connections 4 Doing Mathematics

Task Implemen-tation by Teacher and/or Students	Solution Strategy	Representation (Circle all that apply)	Explanation (Circle all that apply)	Cognitive Demand (Circle all that apply)
	1 Single 2 Multiple	1 Symbolic 2 Written words 3 Pictorial 4 Table 5 Graph 6 Verbal 7 Manipulatives	1 Not required 2 Show work 3 Explain/justify	1 Memorization 2 Procedures w/o Connections 3 Procedure w/ Connections 4 Doing Mathematics

Factors Associated with the Decline of High-Level Cognitive Demands: (Circle all that apply)

1 Challenging aspects for students routinized   2 Emphasis shift   3 Too much/little time
4 Class management problems   5 Inappropriate task   6 Lacks accountability for high level

OR

Factors Associated with the Maintenance of High-Level Cognitive Demands: (Circle all that apply)

1 Scaffolding   2 Self-monitoring   3 Model performance
4 Sustained press for meaning   5 Build on Prior Knowledge   6 Draw Frequent Connections