Hiebert et al. (1997). *Making Sense: Teaching and learning mathematics with understanding*. Portsmouth, ME: Heinemann.

3 *The Role of the Teacher*

All teachers believe they have certain responsibilities in a mathematics class. For many teachers, these include explaining ideas clearly, demonstrating procedures so students can follow them, and encouraging plenty of practice so students can execute these procedures quickly and accurately. One of the major differences in the system of instruction we are describing is a change from these traditional responsibilities. The most important role for the teacher becomes creating a classroom in which all students can reflect on mathematics and communicate their thoughts and actions. Clear explanations and demonstrations from the teacher become less important than explanations and demonstrations by students. This is a different way to think about teaching. The roles and responsibilities change in very significant ways.

To describe the changes in the role of the teacher, we will focus on two responsibilities: providing direction for the mathematical activities of the class, and guiding the development of the classroom culture. We will spend most of the time with the first of these because the second is discussed more thoroughly in Chapter 4.

Providing Direction for Mathematical Activities

The Dilemma

We begin our discussion with the biggest problem for teachers: how to assist students in experiencing and acquiring mathematically powerful ideas but refrain from assisting so much that students abandon their own sense-making skills in favor of following the teacher's directions (Ball 1993b; Lampert 1991; Wheat 1941). To put it another way, how do teachers handle the tension between supporting the initiative and problem-solving abilities of students and, at the same time, promoting the construction of mathematically important concepts and skills? Or, using Ball's words, how do teachers develop "a practice that respects the integrity both of mathematics as a discipline *and* of children as mathematical thinkers" (376)?

In most school settings the tendency of students to rely on their own problem-solving abilities is very fragile. If they sense that the teacher expects them to solve problems in a certain way, they will abandon their own efforts to understand and will search for ways to satisfy the teacher. So teachers need to allow and promote students' autonomy (Kamii 1985; Kamii and Joseph 1989). They need to respect students as intellectual participants. On the other hand, if left on their own, students can spend a great deal of time floundering and making little progress. More than that, if teachers do not intervene at all, students are likely to miss a good deal of mathematics. The hands-off approach is overly conservative. It underestimates students' ability to make sense of powerful ideas and ways of thinking that teachers can share with them. In addition to respecting students as thinkers, teachers must respect mathematics as a discipline.

Can teachers resolve this dilemma? Not by following a rule or a recipe. In fact, Lampert (1985) argued that dilemmas like this one are a natural part of teaching. Rather than resolving the dilemma by choosing one of the options, and rather than resisting or ignoring the dilemma, teachers should embrace it. By remaining open to the tension, teachers can remain sensitive to both the subject and the students.

We agree with Lampert that this dilemma, and others, are not entirely resolvable. We also believe that there are productive ways in which teachers can deal with this dilemma. That is, we believe it is possible for teachers to intervene in ways that stimulate and push students' thinking forward and, at the same time, promote students' autonomy. The principle that guides decisions about how to achieve this balance is familiar by now: to create an environment in which students reflect on and communicate about mathematics. But we can be more specific.

Selecting and Designing Tasks

One of the most critical responsibilities for a teacher is setting appropriate tasks. As we noted earlier, appropriate tasks enable students to reflect on and communicate about mathematics. Although it is possible for students to share in selecting tasks, and teachers should always be aware of and open to students' participation, students are unlikely to select and invent tasks that, over time, will engage them in the full range of mathematical ideas. Teachers must assume responsibility for setting tasks.

Selecting Tasks with Goals in Mind

Our discussion of tasks has focused on the characteristics of individual tasks. These characteristics are useful for teachers as they decide whether

particular tasks are appropriate. But the teacher's role in selecting tasks goes well beyond choosing good individual tasks, one after another. Teachers need to select sequences of tasks so that, over time, students' experiences add up to something important. Teachers need to consider the residue left by working on *sets* of tasks, not just individual tasks.

Students' understanding is built up gradually, over time, and through a variety of experiences. Understanding usually does not appear full-blown, after one experience or after completing one task. This means that the selection of appropriate tasks includes thinking about how tasks are related, how they can be chained together to increase the opportunities for students to gradually construct their understandings.

Tasks are related if they allow students to see the same idea from different points of view, or if they allow students to build later solution methods on earlier ones. Tasks that are related in these ways increase the coherence of students' mathematical experiences. By coherence we mean that, through the student's eyes, the sequence of activities and experiences fit together and make sense. Students see that they are not just engaged in a series of individual, random problem-solving activities, but that the activities are connected and are leading somewhere. There is good reason to believe that students take away deeper mathematical understandings when the mathematical activities are coherent, both within lessons and between lessons (Hiebert and Wearne 1992; Stigler and Perry 1988). And the way in which tasks are connected helps to establish this coherence.

How do teachers select tasks that, over time, help students weave together their individual experiences into a coherent whole? We believe that the selection of sequences of tasks must be guided by the teacher's vision of what the students can take with them over the course of the year and how these residues might be formed. Task sequences are selected that are consistent with the teacher's goals for students and the teacher's vision for how the goals might be achieved.

A third-grade class was just beginning to study multiplication. The teacher, Ms. Higachi, believed there were two kinds of residue that were important. She wanted the students to take away the notion that multiplication, as an operation, can be used to solve several different kinds of problems, and she wanted them to acquire a method for multiplying that they understood. Her vision also included the hypothesis that many students would connect multiplication initially to repeated addition and, although this connection would give them an initial method for solving the problems, she wanted them to see multiplication as more than repeated addition. Ms. Higachi used her vision to select a sequence of tasks through which students might, over time, form these residues. She used some of the tasks from the commercial textbook series and designed some of the tasks herself.

The first tasks selected by Ms. Higachi were story situations that described multiple groups of items. In some cases, the groups had different numbers of items and in some cases all the groups had the same number of items, say 7 boxes of doughnuts with 6 doughnuts in each box. Class discussions centered around comparing the different situations: noticing the differences in methods that could be used to find the total number of items, the kinds of units that were suggested in each situation (e.g., boxes and doughnuts), and differences in the ways the situations could be represented with written words and symbols. All of these differences pointed to something special about the situations which had the same number of items in each group. Ms. Higachi then introduced the multiplication symbol, ×, as a way of representing these special situations (e.g., $7 \times 6 = 42$, for 7 boxes of 6 doughnuts each is 42 doughnuts).

To begin their study of multiplication, Ms. Higachi had selected tasks that, together, would focus attention on the special features of the simplest multiplicative situations. These simple grouping situations also allowed students to develop solution methods that connected with their counting and addition skills. Although these kinds of tasks can be dealt with meaningfully by second graders, and even first graders, Ms. Higachi found, through conversations with her students, that most of them had not yet encountered these kinds of tasks, and so she decided to begin here.

In order to provide opportunities for students to enrich their understandings of multiplication, Ms. Higachi then presented a series of tasks that required a different way of thinking about multiplication. These tasks asked questions like the following: If you have 3 different kinds of meat, and 2 different kinds of cheese, how many different sandwiches can you make, putting 1 kind of meat and 1 kind of cheese in each sandwich? Over time, as students worked through a number of similar tasks, with materials available to act out the situations, the class discussions focused on the kinds of units in each situation, the methods that were used to find the solutions, and the ways the situations could be represented with written words and symbols. Ms. Higachi asked about similarities and differences between the first kinds of tasks and these tasks. Several students suggested that both types of problems could be solved using the same method (counting up by 6s, or 2s, etc.) even though the problems looked different at first. Ms. Higachi underscored this suggestion. She had, in fact, selected the sequence of tasks with this kind of residue in mind.

Over the course of the year, Ms. Higachi selected tasks representing other models of multiplication. One set of tasks included measuring the heights of plant seedlings that the students were growing and calculating the final height if the plants would eventually grow eight times as tall. Another set of tasks involved finding the area, in square units, of various rectangles. Discussions always focused on the units in the situation, the methods used to find the solutions, and the ways in which the situations could be represented with written words, numbers, and symbols.

Ms. Higachi knew that students would only begin building a full understanding of multiplication through interacting with these tasks. In later years, students would encounter a greater variety of multiplicative situations and would develop more efficient methods. Her goal for this year was to allow students to construct at least one solution method that they understood, and to develop the sense that multiplication encompasses a variety of problem situations.

We need to point out that Ms. Higachi's selection of tasks is only one possible sequence. There are other appropriate selections that could be made. We recounted Ms. Higachi's choice only to provide an illustration of how one teacher's vision of the residues that might be left from working with multiplication guided her selection of tasks. She believed these residues would be formed over time by working through a series of related problems, not by solving one (even very clever) problem. She understood how the problems students worked on in third grade might connect with those encountered before third grade and after third grade. Her vision guided the selection of the individual problems and how they were sequenced. Stories of other teachers selecting tasks with goals in mind are found in chapters 7–10 and other useful sources, such as Parker (1993).

Before leaving this section, we want to point out that there is another way of talking about this issue, a way that returns us to the dilemma for teachers. In this context, the dilemma becomes one of how to set goals and plan for instruction, over time, without removing students from the equation. In traditional systems of instruction, teachers often describe their mathematical goals by listing the skills and concepts they plan to teach. These goals then push teachers toward activities like demonstrating, explaining, showing, and so on because these are thought to be the best and clearest ways of teaching the skills and concepts. The trouble is that these plans often are based on objectives of covering material and do not consider carefully the kinds of residues that might get left behind. The plans often are not sensitive to what we know about how students construct understanding, and do not allow for the kind of reflection and communication that is essential.

In contrast, there is growing interest in nontraditional curricula that are filled with interesting problems, often large-scale real-life tasks. Teachers are to present the problems to students and allow them to work. Sometimes the work on a task will extend over a period of days or even weeks. The goals include engaging students in doing mathematics and solving the problems. The goals are not lists of skills and concepts. Although such programs place a positive emphasis on respecting students' autonomy and respecting their intellectual capabilities, the content goals often are unspecified. It can be difficult for teachers to identify the mathematical goals that can and should be planned for and worked toward during the year.

The system of instruction we are recommending takes a different approach than either of these two. As in the nontraditional approach, mathematics begins with problems. But, the system encourages teachers to use their learning goals for students, and their vision of how these goals might be achieved over time to select sequences of problems. Simon (1995) describes this vision as a "hypothetical learning trajectory." The trajectory is the teacher's vision of the mathematical path that the class might take, and its hypothetical nature comes from the fact that it is based on the teacher's guess about how learning might proceed along the path. The trajectory guides the teacher's task selection, but feedback from students and the teacher's assessments of the residues that are being formed lead to revisions in the trajectory. Tasks are selected purposefully, but the sequence can be revised.

Selecting coherent sets of tasks provides a way for teachers to enact or materialize their vision for what students can learn over the course of the year. Setting goals in terms of students' experiences and residues that might be left is a different way of thinking than the more traditional conceptions of goals as lists of instructional objectives. We believe it has the advantage of bringing together two notions that sometimes compete. Mathematics for students can begin with problems and, at the same time, teachers can set quite specific goals to guide the selection of tasks and, in turn, the mathematical activities of students. This provides one way of dealing with the dilemma described earlier.

Knowledge Needed to Select Tasks

What do teachers need to know to select or make up appropriate individual tasks and coherent sequences of tasks? The simple answer is that they need to have a good grasp of the important mathematical ideas and they need to be familiar with their students' thinking.

Grasping the important ideas means knowing the lay of the land. It means being familiar with the main markers and how they are arranged and how they can be rearranged. For example, in many fourth-grade classrooms, students are finishing their work on addition and subtraction of whole numbers, working seriously on multiplication and division of whole numbers, beginning work with fractions, measuring with standard units, and examining two-dimensional and three-dimensional figures. Selecting appropriate tasks for fourth graders requires knowing these topics—how they relate to each other and how they relate to more elementary (prior grades) and more advanced (succeeding grades) treatments of them. Teachers need to feel as if they can walk around in this terrain, getting from one location to another via a variety of routes (Greeno 1991). Such knowledge will help them construct sequences of tasks that spotlight the important mathematics, allow it to be problematic, and follow a path that moves sensibly through the terrain. The residue that is left from working on the tasks is likely to be relationships that help students to begin to find *their* way around in this terrain.

Teachers also need to know how their own students think about mathematical problems and how most students of similar age and experience are likely to solve problems. This information is crucial for two reasons: One is that it allows teachers to select tasks that link up with tools that students are likely to bring with them. The second is that it provides a clue about the kind of residue that might get left behind. In other words, information on students' thinking indicates how students might enter the situation and how they might leave. Obviously, this is valuable for selecting tasks that connect with where students are and that pull them in appropriate directions.

We have not always understood the importance of knowing how students think. Many classroom teachers, of course, have discovered that they can make better instructional decisions when they have this information. But, in general, we have not fully appreciated how critical and how helpful such information is for planning instruction. Recently, a good deal of research has been conducted as part of the Cognitively Guided Instruction project (see Chapters 1 and 7) that has demonstrated the good use teachers can make of such information. Investigators found that teachers who had access to information about how children are likely to solve addition and subtraction word problems of various kinds were more likely than teachers who did not have this information to select and create a wider variety of word problems and to focus more on the methods children invented to solve the problems (Carpenter et al. 1989). In other words, teachers can use their knowledge of students' thinking to select and design appropriate tasks and to use them wisely.

Constructing conceptual maps of the subject and learning about students' thinking are not trivial tasks. Teachers face a real challenge in acquiring this knowledge. But we believe it is the kind of knowledge that should provide the target for teachers and the kind of knowledge that teachers can build over time. Teachers can build their knowledge of students' thinking by reading the available literature and by listening to their own students solving problems and sharing strategies. Over time, teachers can accumulate a wealth of information about how their students are likely to solve problems, and about what kind of residue different problems are likely to leave behind.

Providing Relevant Information

How much information should teachers provide? How much should teachers tell students? These questions have been discussed for years. Traditional practice has been to provide lots of information. In fact, teaching has, at times, become synonymous with presenting information; good teaching has often been synonymous with presenting information clearly. Periodically, educational reformers have advocated presenting less information, shifting more responsibility to the students to search for or invent the information they need.

Early in this century, John Dewey (1910) recognized the importance of this question. He said that no educational question was more important than how we can learn from what others tell us. If teachers tell too much, students will not need to develop their own problem-solving abilities; if teachers tell too little, students will not make much progress. Nearly twenty-five years later, Dewey saw that this question was still plaguing teachers. Some teachers said they were following Dewey's proposals by withholding information from students and allowing students to discover and invent things on their own. Dewey (1933) attempted to clarify his position by saying that teachers should provide information if it is needed for students to continue their problem-solving efforts and they cannot readily find it themselves, and if it is presented as something to consider and not as a prescription to follow. Dewey then said, "Provided the student is genuinely engaged upon a topic, and provided the teacher is willing to give the student a good deal of leeway as to what he assimilates and retains (not requiring rigidly that everything be grasped or reproduced), there is comparatively little danger that one who is himself enthusiastic will communicate too much concerning a topic" (270).

How much information to share is at the heart of the dilemma identified earlier. We agree with Dewey that the teacher should feel free, and obligated, to share relevant information. Too much information is being shared only if it is interfering with opportunities for students to problematize mathematics. In other words, information can and should be shared as long as it does not solve the problem, does not take away the need for students to reflect on the situation and develop solution methods that they understand.

Sharing Mathematical Conventions

Teachers can provide several kinds of useful information: One is the conventions that are used in mathematics for recording and communicating actions and ideas. These include the names and written symbols for numbers, operations, and relationships (e.g., equality), and special terminology used in the wider mathematics community (e.g., words like quotient and variable, and formats for writing equations). These are social conventions and students cannot be expected to discover them. However, we often make the mistake of burdening students with these conventions, rather than providing them as beneficial aids. Rather than presenting them as things to be memorized, they should be shared when they can be used by students to record what they already know and communicate it to others. This issue will be taken up again in Chapter 5.

Sharing Alternative Methods

A second kind of information that teachers can provide could be called suggestions for helping students improve their methods of solution. In order to assist students without interfering, we can suggest the following guidelines based on our experience. First, it is usually *not* a good a idea to recommend that students change their own methods to bring them more in line with the standard algorithms. For example, if a student is adding 17 + 54 by adding 10 and 50 to get 60, then adding 7 and 4 to get 11, and then adding 60 and 11 to get 71, we would advise against saying, "Why don't you start with the ones and then add the extra ten to the tens?" Such suggestions can easily be interpreted by students as critiques on the deficiencies of their methods and requests to follow the teacher's method. Students then shift their focus from reflecting on mathematics to searching for what the teacher wants.

Teachers can enter the discussion by suggesting an alternative method to the methods shared by the students. If students are struggling with cumbersome or flawed methods, a teacher's suggestion can invigorate the discussion and move it forward. If done carefully, students can accept the teacher's method as another method to consider and analyze. There can be a problem, however, if students receive the teacher's presentation as a preferred method simply because the teacher presented it. The bottom line is why students are choosing particular methods. Students should use methods because they understand them and can defend them, not because they feel obligated to use them or to please the teacher. Methods should be preferred based on their merits as discussed in class, not based on who presented them.

Another way in which teachers can help students improve their methods is by suggesting more efficient or clearer recording techniques. When students work through solutions on paper, they can develop quite cumbersome and confusing notation. Without changing their methods, teachers can suggest recording techniques that would be easier for everyone to understand. This is part of helping students communicate their methods to others.

Articulating Ideas in Students' Methods

A third kind of information that teachers can, and should, share with students is the way in which students' methods capture powerful ideas in mathematics. Students can invent appropriate methods for solving problems without being aware of all the ideas on which the methods are built. Helping students reflect on these ideas by pointing them out can be empowering for students. For example, a very common method that students develop for adding mulitdigit numbers is to decompose them into tens and ones, combine like units, and then recombine them. This kind of transformation is, in general terms, an extremely powerful method and reveals important properties of numbers (and all mathematical expressions). Indeed, we do all arithmetic by decomposing the quantities in some way so we can combine like units. Given an appropriate time and opportunity, it would be useful to initiate a discussion with students about this feature of their methods. In how many ways could the numbers be decomposed and recombined to yield the same result?

By restating and clarifying students' solution methods and the ideas on which they are built, teachers not only highlight the mathematical ideas, but also endow the method with some importance. By selecting certain methods for examination, teachers show that they value the methods or ideas. Teachers can use this to help guide students' attention toward particular ideas and relationships. This provides teachers with a powerful way to direct the mathematics that is encountered in the classroom. But teachers must also be aware that students can misinterpret a teacher's clarification of a method as instructions to abandon their own sense-making and follow the highlighted procedure. So, teachers need to be aware of these possibilities and guard against misinterpretations. This is simply part of the dilemma for teachers identified earlier.

Summary

When thinking about how to guide the mathematical activities of the class, teachers are always faced with a dilemma: how to support students as thinkers and creative problem solvers and how to help them learn important mathematics. These dual aims can create real tensions. The system of instruction we are describing deals with the dilemma by asking the teacher to accept two responsibilities: selecting appropriate tasks and providing relevant information. Neither of these are easy because they need to be carried out with an appreciation for both sides of the dilemma and a deep knowledge of the subject and the student. But both responsibilities provide ways for teachers to treat the dilemma as a positive force and deal with it constructively.

Guiding the Development of Classroom Culture

The second major role for the teacher is to establish the kind of environment or culture in the classroom that supports reflection and communication. This means establishing a classroom culture that treats tasks as genuine mathematical problems. We will discuss the social aspects of such an environment in the next chapter. In this section we focus on what the teacher must do to guide the development of the culture. We will highlight two responsibilities: One is to focus the mathematical attention on methods of solving problems. The second is for the teacher to make clear (to herself or himself and to the students) in what sense she or he is an authority.

Focus on Methods

We borrow again from John Dewey (1929) who pointed out that the central feature of communities that work together to investigate a subject and seek to understand it is a focus on methods used to solve problems. The methods used by different individuals should be open for examination, and discussion, and the goal of all participants should be to search for better methods. No one should be tied too closely to their own method, but should be looking for ways to improve it. Engaging in open, honest, public discussions of methods is the best way to gain deeper understandings of the subject.

Similarly, classroom mathematics discussions should be about sharing, analyzing, and improving methods of solving problems. The teacher must take the lead in directing students' communications toward conversations about methods. This means that students must first be allowed and encouraged to develop their own methods of solution. For example, suppose second graders have just been solving 53 – 18. A good deal of class time should be devoted to students sharing methods of solution, clarifying their descriptions so everyone understands, and comparing different methods. Preferences for particular methods should be elicited and discussed. Students should retain the option of choosing their own method, but everyone should share the goal of searching for the method that works best for them.

Focusing the discussions on methods has both intellectual and social purposes: Intellectually, it is the best way of focusing students' attention on what is mathematically important and encouraging them to reflect on mathematical relationships. Such activity is essential for building understanding. Socially, it establishes a common goal toward which everyone can work and to which all can contribute. The analysis of all methods, both flawed and appropriate, contributes to finding better methods. In addition, discussions of methods focus attention on ideas rather than people. Features of methods, not their presenters, become the currency of the classroom. Of course, this kind of shared culture is not developed automatically (Lampert et al. in press). Teachers must work carefully and over time to lead the class toward such a culture.

Adopt Appropriate Position of Authority

Teachers have numerous responsibilities in the classroom that place them in positions of authority. They are, of course, responsible for the safety and general welfare of the students while in the classroom and they become the authority on these matters. They also are responsible for many managerial aspects of the class and must assume an authoritative role to carry out some of these responsibilities. With regard to both the mathematical and social aspects of classroom life, the question of authority does not have a simple answer. As we argued in the previous sections, teachers are responsible for guiding the mathematical activities of the class and for establishing the tone and focus of classroom interactions. However, these responsibilities must be discharged with a continuing sensitivity for the autonomy of students' intellectual activity. Authority, in these cases, does not mean unilateral imposition. It means taking the initiative to work with students toward a shared goal.

There are some areas in which teachers should explicitly remove themselves from a position of authority, one of which is deciding whether answers are correct. In traditional systems of instruction, teachers are asked to provide feedback on students' responses, to tell them whether or not they are right. In the system we are describing, this is almost always unnecessary and usually inappropriate. Mathematics is a unique subject because there is often only one right answer, and because correctness is not a matter of opinion; it is built into the logic and structure of the subject. In other words, everyone will agree on the right answer to a problem if they understand the problem and think about it long enough. Part of what it means to understand mathematics is to understand the problem and the method used to solve it. When this happens, the solver knows whether the answer is correct. There is no need for the teacher to have the final word on correctness. The final word is provided by the logic of the subject and the students' explanations and justifications that are built on this logic.

Many teachers worry that if they do not step in when a wrong answer is given or a flawed method is presented, students will be led astray and develop misunderstandings. Our experience is if the tasks are appropriately challenging, that is, if they link up with students' thinking and

allow students to use familiar tools, and if there is full discussion of various solution methods and solutions by the students after they have completed the task, then sound mathematical thinking and correct solutions eventually carry the day. Inappropriate methods rarely go unchallenged by other students; the most convincing arguments are those that make mathematical sense.

A change from traditional instruction in the locus of authority in this area has profound ramifications throughout the system. If teachers remove themselves from adjudicating correctness of solutions, students will be more inclined to look to their own arguments to decide on correctness. They will be free to develop confidence in their own methods and their own monitoring skills for deciding whether something makes sense. They will be less inclined to try to uncover what the teacher wants or to guess what the answer key says. They will be free to focus their attention on developing justifications for their methods and solutions based on the logic of mathematics.

Teachers Make the System Work

In the system of instruction we are describing, the teachers play an active and central role. They are responsible for guiding the mathematical activities of students and for establishing a classroom culture in which students reflect on and communicate about mathematics. For the system to work, teachers must act on these responsibilities in ways that honor students as thinkers and mathematics as a discipline. Although this is not easy, we believe it provides the right target toward which we should be moving.

materials can be a starting point for customizing lessons to fit particular students. Teacher and coach collaboratively design or redesign a particular lesson or aspects of a lesson. Developing a shared view of the understanding, strategies, concepts, and skills that students are working toward, together with agreeing on a lesson design, makes it possible to have postlesson discussions focused on student learning. Establishing clear, explicit learning goals related to specific content also increases the likelihood that the lessons will revolve around important mathematical ideas and that the coach and teacher will work together effectively during the lesson.

The Lesson

A coach's role during a lesson can vary considerably. She or he may enter different kinds of collaborations with the teacher and take on the responsibility for conducting different parts of the lesson. A coach's involvement may increase from *observing* only, to *coteaching* the lesson, to *modeling* the lesson while the teacher observes. Because lesson plans are shared or coconstructed during the preconference, the coach and the teacher are to some extent jointly responsible even for lessons that are taught solely by the teacher. Teacher and coach negotiate how they will collaborate during a specific lesson based on the teacher's needs (stated by teacher and perceived by coach) and on what will make the lesson one in which students learn.

Modeling is especially appropriate when a coach wants to demonstrate specific teaching strategies or methods (such as ways of leading accountable talk in the classroom). The goal of modeling is for the teacher to build an understanding of new teaching moves. Modeling often is the start of a longer process during which the teacher learns to use the new strategies.

Even during lessons that are taught primarily by the classroom teacher, the coach's role is collaborative. This may mean, for example, that the coach intervenes during the lesson—but only in a particular way. The coach negotiates in advance whether the teacher is comfortable with this kind of intervention. The intervention is never directed toward something the teacher may have done inadequately; rather, the coach addresses students' understanding and learning, perhaps by asking a question related to a student's crucial idea or particular misconception. Coaches and teachers are jointly accountable for initiating and assisting effective student learning. The coach is a partner with the teacher in working toward the shared goal of student learning, not a critic of the teacher's practice. Over time, the coach will decrease and eventually phase out modeling and situation-specific interventions.

The Postlesson Conference

After the lesson, the teacher and the coach talk about how the lesson went. How successfully was the lesson plan implemented? What problems arose? More important, did the students learn what they were supposed to? This joint evaluation often includes looking at student work. If necessary, the conversation also addresses the lesson's appropriateness to the goals set—and even the appropriateness of the goals themselves. Postlesson conferences often segue into a prelesson conference for the next lesson.

What Should Coaching Conversations Focus On?

Different issues emerge during coaching conversations. In the preconference, teacher and coach mostly deliberate goals and lesson plans. During the lesson, they participate in classroom talk and perhaps have a brief private exchange about a whole-class teaching move or how to help individual students. During the postconference, student learning and challenges met during the lesson come to the fore. Whatever the setting, there are an infinite number of potential issues that can be addressed.

A Framework for Lesson Design

Teaching is a very complex activity (Bromme 1992; Stigler & Hiebert 1999; Leinhardt 1993). It can be looked at from many perspectives and discussed at different levels of abstraction, depending on one's knowledge, theories, and beliefs. The conceptual frame presented here reflects a profound change in the definition of teaching—from teaching as *mechanically implementing* curriculum to teaching as *mindfully making use of* curriculum. Teaching requires sophisticated reasoning in choosing and prioritizing lesson goals and designing lessons that enable a given group of students to reach given standards. At the core of this kind of reasoning are two basic questions:

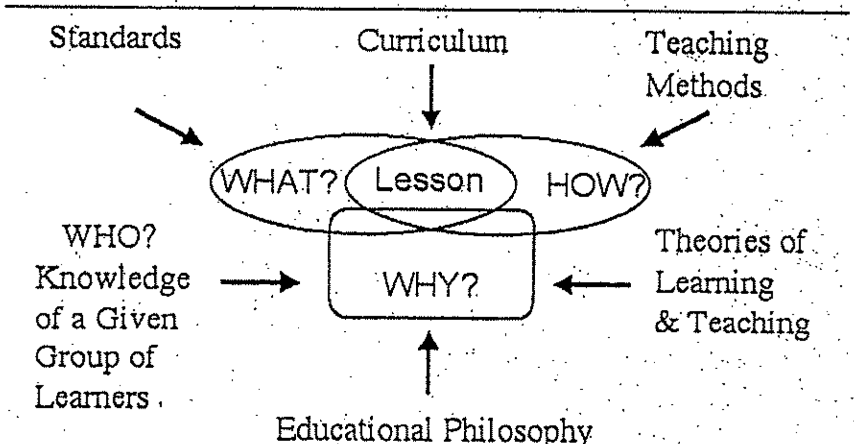
1. *What is the curricular content to be learned by the students?* This question is often answered by naming curricular themes, tasks, or activities, or by describing instructional strategies. Although all of these relate in various ways to what students are to learn in a particular lesson, they do not fully capture the subject matter to be learned. Goals for what students are to learn at a given grade level are delineated in district, state, or national standards. In order to state the learning in a lesson specifically ‿achers must

know—thoroughly—the particular content and how it relates to the standards.

2. *How is this content to be taught?* What are the teacher's underlying teaching methods and strategies? The execution of a lesson can be described and discussed in terms of specific practices and general teaching methods, such as inquiry-based learning, using worksheets, and cooperative groupings. The teacher's repertoire of methods and strategies determines the number of potential teaching moves he or she has to choose from.

Lesson design takes place at the intersection of *what* and *how.* What is the relationship between curriculum and teachers' work in the classroom? In the United States, curriculum is most often thought of as an "organizational framework, a 'curriculum-as-manual,' containing the templates for coverage and methods that are seen as guiding, directing, or controlling a school's, or a school system's, day-by-day classroom work" (Westbury 2000, 17). In other words, these manuals set forth *what* to teach and *how* to teach it. For a time, it was even hoped that a "technology of teaching" would lead to fully specified curricula that would guarantee effective teaching no matter who the teacher happened to be. The aim of constructing "teacher-proof" curricula, however, has turned out to be out of reach and based on a naïve conception of what effective teaching involves. Even when curriculum materials specify lessons in some detail, a competent teacher still needs

Figure 1–1
Framework for Lesson Design and Analysis
(adapted from Staub 1999, 2001)



to adapt a given lesson to the context of the particular classroom and to the individual characteristics, needs, and backgrounds of the learners in it.

When teachers are encouraged to be thoughtful professionals who do more than follow their intuition based on experience and traditions, then they deliberate about and debate *why* they choose particular content or methods. There are therefore two more basic questions at the core of teachers' professional reasoning:

3. *Why is this specific content to be taught?*
4. *Why will it be taught in this particular way?*

In addressing these basic questions, teachers choose the subject matter, transform it into lesson content, and design lessons that help students reach standards. We don't mean that these basic questions need to be posed literally in this abstract form. The general *what, how,* and *why* questions are guiding heuristics for thoughtful teaching. Taking up these questions in connection with each other leads to new learning and new insights about how particular content can be taught effectively to the students of a given classroom or why a specific method is especially suited to a particular learning goal. In addressing these questions, coach and teacher also draw on available research about which strategies and methods work effectively for specific purposes. Posing the generic questions alone, however, doesn't get the work done. For teachers to recall or construct appropriate answers, they must be knowledgeable about content, standards, teaching methods, curricula, assessment, the theory and psychology of learning and teaching, and educational philosophy.

When *why* questions cannot be answered by referring to an existing standard, a curriculum, or regularly practiced teaching methods, teachers need to reason deliberately about their design choices. Such deliberation, however, presupposes criteria and theories. By what criteria do we decide on the particular content and a specific design for a lesson? Teachers have a lot of leeway in how they choose to help their students achieve a given standard. How we deliberate about *why* a particular method is useful for teaching specific content to a given group of students depends on our beliefs and theories about learning and teaching, our knowledge about research on effective practices and about the particular learners to be taught, and on our educational philosophy. What teachers believe about the learning and teaching of a specific subject matters not only to how they behave in the classroom but also to student achievement (Staub & Stern 2002). While districts can mandate particular instructional programs and approaches, a change in teaching practice will only be sustained over time if it is supported by coherent underlying beliefs.

Only part of the knowledge that is relevant to lesson design can be acquired through experience and experimentation. It is primarily through interaction with knowledgeable others, texts, and tools that teachers revise their beliefs and develop habits of mind and knowledge relevant to effective lesson design.

An Orientation Toward the Content of Learning and Teaching

During much of the twentieth century, the dominance of behaviorist and associationist theories of learning meant that content and pedagogy were often dealt with separately. European theories of education and teaching rooted in philosophy (Klafki 1963) and based on a cognitive view of learning and teaching (Aebli 1951, 1983) argued against this separation between teaching methods and content. Klafki's and Aebli's general theories of teaching (known as *Didaktik*) share an orientation toward the content of learning and teaching. Effective and responsible teaching requires educators to thoroughly think through the meaning and the structure of the content to be taught. Clarifying the underlying structure has primacy over questions about how to teach a particular content. When designing lessons, clarifying the *what* usually precedes specifying the *how.* To grasp the design of a given lesson unit from curriculum manuals, teachers must clearly understand the intended *what,* as well as *why* an already given *how,* supports learners in reaching the goals. Such reasoning may lead teachers to modify the *how* or even to change the lesson's goals. Teachers' anticipation of and planning for specific teaching–learning processes are intimately related to the content. The teaching of subject matter has to be understood in relation to the particular content and the learners being taught.

Cognitive psychology has demonstrated the important role of knowledge in reasoning, thinking, and learning (Aebli 1981; Resnick 1987). Learning is an active process of interpretation and inference based on what people already know. Resnick and Hall (1998) refer to the core of this theory of learning as *knowledge-based constructivism.* There is no thinking without content, and without thinking there is no acquisition of new knowledge. There is no direct transmission of knowledge. For the cognitive-constructivist, learning is an active process through which learners construct new knowledge on the basis of the cognitive structures already available. The teachers' role is to initiate learning and to prompt and assist particular learners as they construct rigorous, specific knowledge. Coaching conversations that are meant to help teachers develop practical ways to initiate and guide student learning thus need to be very content specific.

Knowing what methods and teaching strategies are useful for helping students learn a specific content and how to adapt these methods and strategies to particular learners is the pivotal ingredient in teaching expertise. Shulman (1987) calls this kind of knowledge *pedagogical content knowledge,* "the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organized, represented, and adapted to the diverse interests and abilities of learners, and presented for instruction" (8). Not all of this knowledge is explicit. Some of it is based on experience alone and remains implicit. It is the coach's role to focus on and make explicit those aspects that are highly relevant in a given situation.

A knowledgeable other (the coach or the teacher, in Content-Focused Coaching) can introduce any knowledge related to the *what, how,* and *why* of a specific teaching situation. Elements brought up by a coach or through discussion or her or his own teaching may lead to teaching situations that are different from what the teacher would have arrived at alone. Coaching conversations that address and relate the *what, how,* and *why* of lessons can foster learning that goes beyond situation-specific assistance and therefore builds explicit pedagogical content knowledge.

Core Issues in Lesson Design

A set of research-based principles of learning proposed by Lauren Resnick (Resnick 1995a, 1995b) and further developed by the Institute for Learning (Resnick & Hall 2001) succinctly captures pivotal theories of learning and teaching that are believed to be relevant for an educational system designed to enable all students to achieve a high level of performance. Figure 1–2 depicts three of these principles (see Appendix 1 for the list of all nine principles).

For these principles of learning to be of practical use in lesson design, they need to be related to the kind of reasoning teachers use daily in the classroom. Therefore, the coach participates on the job, helping the teacher deliberately plan and teach lessons that produce student learning. The principles of learning are general and abstract. In order for coaching conversations to reach a content-specific level when designing and reflecting on lessons, Content-Focused Coaching makes use of an additional kind of tool, the Guide to Core Issues in Mathematics Lesson Design (see Figure 1–3). The questions in this guide prompt the coach and teacher to address issues at the heart of instruction in content-specific ways (Staub, West, Miller 1998; Staub 1999).

The idea for such a tool is based on a set of questions, developed by Klafki (1958, 1995), that is meant to ensure that teachers' long-term

Figure 1–2
Three of the Institute for Learning's Nine Principles of Learning
(Resnick & Hall 2001)

Clear Expectations

If we expect all students to achieve at high levels, then we need to define explicitly what we expect students to learn. These expectations need to be communicated clearly in ways that get them "into the heads" of school professionals, parents, the community, and, above all, the students. Descriptive criteria and models of work that meet standards should be publicly displayed, and students should refer to these displays to help them analyze and discuss their work. With visible accomplishment targets to aim toward at each stage of learning, students can participate in evaluating their own work and setting goals for their own effort.

Academic Rigor in a Thinking Curriculum

Thinking and problem solving will be the "new basics" of the twenty-first century. But the common idea that we can teach thinking without a solid foundation of knowledge must be abandoned. So must the idea that we can teach knowledge without engaging students in thinking. Knowledge and thinking are intimately joined. This implies a curriculum organized around major concepts that students are expected to know deeply. Teaching must engage students in active reasoning about these concepts. In every subject, at every grade level, instruction and learning must include commitment to a knowledge core, high thinking demand, and active use of knowledge.

Accountable Talk℠

Talking with others about ideas and work is fundamental to learning. But not all talk sustains learning. For classroom talk to promote learning it must be accountable—to the learning community, to accurate and appropriate knowledge, and to rigorous thinking. Accountable talk seriously responds to and further develops what others in the group have said. It puts forth and demands knowledge that is accurate and relevant to the issue under discussion. Accountable talk uses evidence appropriate to the discipline (e.g., proofs in mathematics, data from investigations in science, textual details in literature, documentary sources in history) and follows established norms of good reasoning. Teachers should intentionally create the norms and skills of accountable talk in their classrooms.

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curricular and lesson planning is accountable to the underlying structures of the discipline, takes into account the learners' prior experience and knowledge that are relevant to the learning goal at hand, and anticipates future contexts in which the knowledge to be learned may lead to useful applications. The selection of the kind of theoretical perspectives taken up with the questions in the Guide to Core Issues in

Figure 1–3
Guide to Core Issues in Mathematics Lesson Design

What are the goals and the overall plan of the lesson?

- What is your plan?
- Where in your plan would you like some assistance?

(Based on the teacher's response, the coach focuses on one or more of the following ideas.)

What is the mathematics in this lesson? (i.e., make the lesson goals explicit)

- What is the specific mathematics goal of this lesson?
- What are the mathematics concepts?
- Are there specific strategies being developed? Explain.
- What skills (applications, practice) are being taught in this lesson?
- What tools are needed (e.g., calculators, rulers, protractors, pattern blocks, cubes)?

Where does this lesson fall in this unit and why? (i.e., clarify the relationship between the lesson, the curriculum, and the standards)

- Do any of these concepts and/or skills get addressed at other points in the unit?
- Which goal is your priority for this lesson?
- What does this lesson have to do with the concept you have identified as your primary goal?
- Which standards does this particular lesson address?

What are students' prior knowledge and difficulties?

- What relevant concepts have already been explored with this class?
- What strategies does this lesson build on?
- What relevant contexts (money, for example) could you draw on in relation to this concept?
- What can you identify or predict students may find difficult or confusing or have misconceptions about?
- What ideas might students begin to express and what language might they use?

How does the lesson help students reach the goals? (i.e., think through the implementation of the lesson)

- What grouping structure will you use and why?
- What opening question do you have in mind?
- How do you plan to present the tasks or problems?
- What model, manipulative, or visual will you use?
- What activities will move students toward the stated goals?

(continued)

Figure 1–3
(continued)

- In what ways will students make their mathematical thinking and understanding public?
- What will the students say or do that will demonstrate their learning?
- How will you ensure that students are talking with and listening to one another about important mathematics in an atmosphere of mutual respect?
- How will you ensure that the ideas being grappled with will be highlighted and clarified?
- How do you plan to assist those students who you predict will have difficulties?
- What extensions or challenges will you provide for students who are ready for them?
- How much time do you predict will be needed for each part of the lesson?

Mathematics Lesson Design, in addition to other sources, has been influenced by Aebli's general theory of teaching (Aebli 1983), which is grounded in cognitive psychology. Aebli's theory asks teachers to understand and thoroughly analyze the content to be taught and to think through and anticipate learning processes in content-specific terms. Teachers need to take into account that knowledge to be acquired is constructed using students' prior knowledge.

The coach should not use the questions in Figure 1–3 verbatim. The particular issues to be addressed and the wording of the questions used to address them need to be adapted based on the coach's knowledge of and relationship with the teacher. The questions are intended to prompt a shared understanding of the lesson's learning goals and a coordinated plan for and understanding of how students can be helped to achieve those goals.

Clarifying lesson goals is pivotal. For teachers to communicate Clear Expectations, they must be clear about the standards of achievement and specific goals of learning toward which their students are to work. Arriving at a clear understanding of the particular content-related goals of a lesson is also necessary to foster Accountable Talk[SM] and Academic Rigor in a Thinking Curriculum. Initiating and orchestrating talk that is truly accountable to accurate and appropriate knowledge and rigorous thinking requires the teacher to deeply know and have thought through the content of the discipline and to have clarified the learning goals. Teachers' explanations are also of great importance. The

Figure 1–4
Abbreviated List of Core Issues in
Mathematics Lesson Design

- Lesson goals.
- Lesson plan and design.
- Students' relevant prior knowledge.
- Relationship between the nature of the task and the activity on one hand and the lesson goals on the other hand.
- Strategies for students to make public their thinking and understanding.
- Evidence of students' understanding and learning.
- Students' difficulties, confusions, and misconceptions.
- Ways to encourage collaboration in an atmosphere of mutual respect.
- Strategies to foster relevant student discussion.

nature of classroom discourse contributes to or hinders students' socialization as intelligent and responsible members of their culture (Resnick and Nelson-LeGall 1997). In order to make reasoned decisions about appropriate learning goals and to fine-tune individualized student learning, teachers need to know about their students' prior knowledge as well as their difficulties and misconceptions. In order to assess student learning, teachers need to be clear about the evidence of successful learning and to think about how a lesson design will initiate and allow students to make public their thinking and knowing.

While a knowledge of all the Core Issues in Mathematics Lesson Design can be helpful to teachers and coaches, when first working with the Core Issues, it is impossible to focus consciously on all of them at once. Teachers and coaches are thus encouraged to concentrate on a few at a time. (An abbreviated version of the core issues is shown in Figure 1–4.) It is also important to understand that the core issues are *scaffolds:* prompts to get teachers to think through important aspects of learning and teaching. Scaffolds are by definition temporary. Once a new structure has been built, the scaffold can be removed. After coaches and teachers have worked with the Core Issues for some time, the related reasoning will ideally become second nature.

One way for coaches to learn to work with the Core Issues is to write and use their own summaries of the list shown in Figure 1–3. From time to time, however, it is helpful to go back to the original version and identify which issues they concentrate on in coaching conversations, then to make a conscious effort to incorporate the ones they tend to ignore.