Contents

6 Student Interviews

The Big Ideas

- A Student Interview is based on the belief that, through conversation and a student's demonstration of his thinking, we can begin to solve for why.
- Teachers report many positive benefits from the process of conducting and analyzing a Student Interview; these include greater insight into the process of preparing materials for an individual learner, refinement of questioning strategies, a greater propensity to listen to the student without preconceptions, appreciation for the variety of ways learners understand the same concept, and a clearer notion of how particular concepts develop in students' thinking.
- The five-step protocol for facilitating Student Interviews entails gathering student data, developing theories, collecting or creating problems to use, securing the logistics (consent, materials, and setting), and conducting the interview.

Chapter Outline

What Is a Student Interview?

Defined differently by various practitioners, a Student Interview is a structured dialogue, a flexible questioning approach, and a conversation with a purpose. A Student Interview is, perhaps, the most effective way for educators to understand a student's thinking. A Student Interview is based on the belief that, through conversation and a student's demonstration of his thinking, we can begin to solve for why.

One of the best-known resources on student interviews is Herb Ginsburg's book *Entering the Child's Mind* (1997). Ginsburg challenges the idea that standardized testing is the only "scientific" approach to understanding the thinking of children. He argues for deliberate nonstandardization of interviews (which he refers to as *clinical interviews*) in order to be flexible with questions and respond to each child's individual conjectures and conclusions.

Though standardized tests can be helpful in understanding children's thinking and proficiency, a Student Interview will almost always reveal much deeper insights on a student's understanding.

Student interviews share a common purpose with both CRAs and Collaborative Study. All three are aimed primarily at understanding student

My Story

PART 1: Jaime—A Candidate for a Student Interview?

Jaime, a sixth-grade student, was having consistent trouble with ratios. Jaime's most recent math grade was a D. Patti, Jaime's sixth-grade teacher at Redfield Middle School, felt that Jaime put forth effort, though he failed to make up missed work. Patti knew, from Jaime's class work and quizzes, that Jaime didn't know how to apply his understanding of ratios, but Patti was unable to figure out why. The worksheets that Jaime turned in contained both correct and incorrect answers. Patti was puzzled as to why Jaime was so inconsistent. Patti asked for a Collaborative Study of Jaime, which resulted in two interventions that seemed to have little effect. Patti wondered if a Student Interview would help.

Ease the Struggle

Quantitative Versus Qualitative Measures of Student Understanding

In the world of special education, assessments are standardized and normalized in an effort to give accurate and reliable results. These can be thought of as "quantitative measures" of student understanding. While there is a great deal of work being done to develop mathematical instruments for assessing understanding (Clarke, Baker, Smolkowski, and Chard 2008; Richardson 2003; Wright 1994; Wright, Martland, and Stafford 2006), few quantitative measures provide an in-depth picture of student thinking across the years of elementary and middle school.

An alternative to quantitative measures is a qualitative approach. Qualitative inquiry emphasizes probing student thinking through questioning, rather than analyzing scores on a test. The advantage to this approach is that the teacher-researcher can ask a student about his thinking as she watches him solve a problem, create a representation, or use a model. Having the ability to probe the student as he's thinking is a powerful tool in solving for why. ■

thinking (solving for why), rather than at trying to remediate first. Our goal with all these assessments is to create multiple theories for why a student might be struggling in order to find interventions that will work. Like CRAs and Collaborative Study, Student Interviews focus on using questioning to closely examine the students' mathematical reasoning and use of models, strategies, and algorithms to solve problems.

Student Interviews are also similar to the flexible interviews that often follow CRA assessments. The key differences are the levels of preparation and inquiry. Flexible interviews are based on a quick sorting of work from each of the three CRA stations and take five to ten minutes. Student Interviews require significant time to prepare and last much longer—often forty-five minutes to an hour.

Who Conducts a Student Interview?

Educators in three different roles most commonly conduct Student Interviews: learning specialists, math coaches, and classroom teachers. Learning specialists find Student Interviews a helpful tool for understanding student strengths and using these to set up Individual Education Plans (IEPs). For example, one learning specialist, Glenna, noted in a Student Interview with Candace, that she was very strong using place-value blocks but did

not understand how to use a number line model. The Student Interview led Glenna to link the number line to place-value blocks to help Candace improve her understanding of magnitude (for more on this case, see page 91).

Student Interviews often reveal that the challenge a student is actually facing is conceptual, not cognitive. Special educators conducting Student Interviews have found that it's more likely, for example, that a student struggles because she misunderstands place value than because she has a memory deficit (for more on cognitive challenges, see Chapter 7).

"Student interviews can be especially helpful in developing teachers' own understanding of how students think about math concepts. Teachers should be encouraged to conduct them whenever possible. A Student Interview may be one of the best professional development experiences a teacher can have at a personal level."

Despite having the most contact with students, classroom teachers are *not* the most frequent users of Student Interviews. There are a number of reasons for this; the most common is that Student Interviews require a substantial amount of time: usually an hour to prepare, forty-five minutes to an hour to conduct, and an hour or more to analyze. Classroom teachers can find that the time required to prepare, conduct, and analyze a Student Interview is overwhelming. However, student interviews can be especially helpful in developing teachers' own understanding of how students think about math concepts. Teachers should be encouraged to conduct them whenever possible. A Student Interview may be one of the best professional development experiences a teacher can have at a personal level. Teachers report many positive benefits from the process of conducting and analyzing a Student Interview; these include greater insight into the process of preparing materials for an individual learner, refinement of questioning strategies, a greater propensity to listen to the student without preconceptions, appreciation for the variety of ways learners understand the same concept, and a clearer notion of how particular concepts develop in students' thinking.

Ease the Struggle

Math Reasoning Inventory (MRI) by Marilyn Burns

Math Reasoning Inventory (MRI) is a free, Web-based, formative assessment tool that focuses on students' numerical reasoning strategies and understandings; in other words, it is an online tool for conducting Student Interviews. This tool may help decrease the time typically required to set up Student Interviews. Visit www.mathreasoninginventory.com to learn more. ■

Five Steps to Conducting a Student Interview

A Student Interview requires extensive preparation. Since the format is more or less open-ended, we need to be prepared to engage the interviewee in a variety of contexts so we can probe his responses. To make the process as user-friendly as possible, I use a five-step protocol for facilitating Student Interviews. This protocol was created with the understanding that Student Interviews must be flexible and tailored to the individual needs of the interviewees. There are, however, steps that all interviews share. These steps include gathering student data, developing theories, collecting or creating problems to use, securing the logistics for the interview (consent, materials, and setting), and conducting the interview.

Five Steps to Implementing a Student Interview

- **Step 1:** Gather Data ("Case History")
- **Step 2:** Develop Preliminary Theories for Why the Student May Be Struggling
- **Step 3:** Collect and/or Create Problems and Questions to Use in the Student Interview
- **Step 4:** Secure the Interview Logistics
- **Step 5:** Conduct the Interview

Step 1: Gather Data ("Case History")

Sometimes a student's math thinking evades understanding. When a teacher has asked a student about his thinking, conferred with other professionals, and used assessment and diagnostic tools but hasn't been able to create an intervention that moves the student's understanding forward, a Student Interview can help.

Once you've identified the student, you'll need to gather data. This step is similar to step one for implementing Collaborative Study (see Chapter 5, page 75). When conducting a Collaborative Study we gather data on an individual student's math progress. These data include assessments, report cards, and conversations with teachers. If the student identified for an interview has been through collaborative discovery, this information will already be available. If not, it must be gathered.

My Story

PART 2: Gathering Data for Jaime's Student Interview

With Patti's (Jaime's teacher) suggestion, the Collaborative Study team decided it would be helpful to conduct a Student Interview. They asked Bob, the learning specialist on the Collaborative Study team, to do so. The team had already collected some data to conduct the Collaborative Study (for more on this assessment, see Chapter 5). These data were helpful to get started with preparation for the Student Interview. The data included the following information.

Jaime was on a 504 plan (other health impaired) as a result of difficulties with Crones disease. Per parental consent, information from the 504 plan was released to the Collaborative Study team; the team thus had insights into the way Jaime's health concerns negatively affected his learning. Symptoms related to the Crones disease had necessitated medical treatments that had caused irregular attendance.

Jaime lived with his older brother and both parents. Jaime's mother reported that there was a family history of learning disabilities. Jaime's older brother had received academic support through IEP services. Jaime's parents did not graduate from high school and reported difficulties during their school years.

Step 2: Develop Preliminary Theories for Why the Student May Be Struggling

Student Interviews that are entirely open-ended are interesting and informative. However, for practical considerations most schools require a focus on particular concepts and/or understanding. The development of theories helps focus a Student Interview. These theories also guide the interviewer in creating interview questions. Preliminary theories for a Student Interview should always carry a caution sign—if we are too enamored with these

Jaime was reported by his parents to be very active and enjoyed basketball, baseball, and swimming. Patti reported that he had a stable group of friends and presented himself as a young man who was confident with individuals and groups of any age.

Jaime had participated in state testing since the fourth grade. He consistently scored substantially below proficient on the math tests. This result was mostly supported by district test results except in the area of "skills." Jaime's district conducted formative math assessments twice each year. They reported the outcomes in categories that included "skills," "concepts," and "problem solving." While Jaime's scores were consistently below proficient in concepts and problem solving, several of his assessments showed him as proficient with skills.

During a flexible interview conducted for the Collaborative Study by Patti, Jaime subtracted whole numbers by counting backward. Jaime subvocalized, often speaking aloud to himself while he worked. Jaime skipped one of the problems Patti provided because, Jaime said, "It would take too long." Jaime did not attempt any problems involving fractions or ratios. He did use skip-counting and counting on. When conducting a quick review of math facts for Patti, Jaime demonstrated almost instant recall of all his times table facts up to 10 times 10.

My Story

PART 3: Preliminary Theories for Why Jaime Is Struggling

Bob, the learning specialist, began his work on Jaime's Student Interview by reviewing the data and results from the Collaborative Study. He wanted to come up with initial theories for Jaime's Student Interview. Since Jaime was in the sixth grade, the Collaborative Study team decided it was important to focus on his understanding of proportional reasoning. The team felt that Jaime's access to higher math in high school would be dependent on his understanding of proportional reasoning; they wanted to begin intervention for this while he was still in middle school.

The Collaborative Study team recommended an intervention to improve Jaime's understanding of multiplication concepts. As Bob reviewed the results of that work, he noticed that Jaime had improved with facts, but his avoidance of problems with multiplication and with ratios made Bob wonder if Jaime really understood multiplicative relationships. Since this was a critical element for proportional reasoning, Bob developed his first theory:

Theory 1: Jaime doesn't understand multiplicative relationships and struggles to contrast them with additive relationships.

theories, we might miss what students tell us about their thinking. For this reason they should simply be considered a starting place. For detailed guidance on developing theories, see Chapter 3.

Step 3: Collect and/or Create Problems and Questions to Use in the Student Interview

One of the most important—and perhaps daunting—steps in preparing for a Student Interview is the collection of necessary problems that will drive the interview. The problems you choose need to test the preliminary theories you've developed (Step 2), focus on a particular mathematical concept (or concepts), and be complex enough to allow for a rich conversation with the interviewee. I usually plan on bringing at least ten problems to a Student Interview, though I may only use two or three of them.

Bob decided he would need to see if Jaime could detect the difference when comparing quantities additively and multiplicatively. Bob also wondered if Jaime's frequent absences might have created gaps in his understanding about multiplication and ratios. Bob created his second theory:

Theory 2: There are conceptual gaps in what Jaime knows about multiplication and ratios.

If this theory were true, Jaime might be hesitant or unsure when solving problems. Bob decided that he would explore this in the interview with some general questions about multiplication and ratios.

Finally, Bob wondered if Jaime might have a memory difficulty that was preventing him from putting together what he'd already learned. Nothing in the Collaborative Study had suggested that Jaime had memory challenges, but Bob made a note to be aware of signs that Jaime was having difficulty with memory:

Theory 3: Jaime has an as yet unidentified memory challenge that is making connecting new learning to old learning difficult.

The problems should connect to the student's real-life experiences—but be careful! If the problems are written down on paper and *look* like schoolwork (rather than a real-life situation) students may tend to approach them in the same disconnected way they sometimes work with other math problems (I've found that posing the problem as a verbal question before handing a copy of the problem to the interviewee can be helpful with grounding the problem in real-life experience).

The problems should also vary in complexity and contexts. In the "My Story, Part 4" example that follows, the money problems are

Ease the Struggle

Where to Find Problems for Interviews

One excellent source for both problems and protocols for interviews can be found at mathreasoninginventory.com. See Reproducible 6.1, Planning a Student Interview: Template and Reproducible 6.2, Conducting a Student Interview: Template for forms that support the collection and creation of problems for Student Interviews. ■

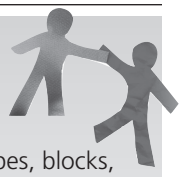
straightforward, though they could be answered from experience with money or use of multiplicative reasoning, or both. The *Orange Drink Problem* is a more complex approach to ratio and proportion. The interviewer won't necessarily use both these problems during the interview, but he has them ready so that his conversation with the student can go in a variety of directions.

I've found that problems for a Student Interview should range in difficulty from about two grades below the student's grade (a Student Interview for a fourth grader, for example, should include typical second-grade problems) to about one grade level above. The goal is flexibility in both contexts and difficulty. There are a number of websites that offer interesting math challenges for a variety of grade level, including The Math Forum at Drexel's Problems of the Week, AIMS Puzzle Corner, McRELS Math Mountain, NRich, and Aunty Math.

In addition to collecting problems, it's essential to prepare questions for the student as he explores the problems. I bring a list of questions with me during an interview. I print them out and keep them handy to remind me where to go when I get stuck.

The goal with all these questions is to try to make the student's thinking more explicit so you can get a better sense of what's actually going on in her mind. It's critical that we remember to listen with an open mind, rather than with our own ideas, so that we can hear and digest what the student is telling us. Preparation and practice with asking questions like these will lead to a more effective interview; the ability to be flexible comes from planning well before the interview begins.

Questions to Ask During a Student Interview



- What do you predict will happen?
- Do you see any patterns?
- Can you solve it a different way?
- What are you thinking?
- How did you figure it out?
- Why did you_____? [write that, draw that, etc.]
- You wrote _____. How did that help you?
- I noticed that you stopped what you were doing just now. What were you thinking?
- Why did you change your mind (answer)?
- I don't know what you mean by that. Will you show me?
- Will you draw a picture of that?
- Will you show me with _____? (cubes, blocks, a number line, etc.)
- You started with this (point) and then went to this (point). Tell me about your thinking.
- Can you tell me (show me) what _____ means?
- Are you right? How do you know?
- What do you notice?
- Is there another way to show me? What is it?

My Story

PART 4: Collecting Problems for Jaime's Interview

As we learned in "My Story, Part 3" (page 96), Bob (the learning specialist) developed three theories about Jaime's understanding:

1. Jaime doesn't understand multiplicative relationships and struggles to contrast them with additive relationships
2. There are conceptual gaps in what Jaime knows about multiplication and ratios.
3. Jaime has an as yet unidentified memory challenge that is making connecting new learning to old learning difficult.

Bob collected the following problems to explore these theories:

Comparing multiplicative and additive relationships:

Bus Problem

Mr. King's class has 10 students who walk to school and 10 students who ride the bus.

Ms. Queen's class has 8 students who walk to school and 16 who ride the bus.

Compare the classes. If all the buses broke down, which class would be affected more?

Investing Problem

Terry invested $20 in Smith-Pictures (a movie company). At the end of a year his investment paid him $40.

Alice invested $5 in Jones-Movies (another movie company). At the end of a year his investment paid $20.

Who made the better investment? Why?

continued

My Story continued

Caterpillar Problem

A monarch caterpillar was 4 cm long. A week later he was 8 cm long.

A gypsy moth caterpillar was 2 cm long. A week later he was 6 cm long.

Which caterpillar grew more?

Investigating gaps in understanding about multiplication and ratios:

Money Problems

How many pennies would I get if I traded pennies for 9 dimes?

Every online movie costs $2.99. If I buy 6, how much do I spend?

Month Problem

If a month has 30 days, how many days are in 7 months?

Orange Drink Problem

I'm making orange drinks.

Glass 1 is full of water. I add 3 spoonfuls of orange mix to it.

Glass 2 is half full of water. I add 2 spoonfuls of orange mix to it.

Glass 3 is ⅓ full of water. I add 1 spoonful of orange mix to it.

Which one has the strongest orange taste? (Is the most "orangy"?)

Field Trip Problem

Redfield School is going on a field trip. They will be taking mini-vans that can hold 7 children and a driver. Sixty-one children are going on the field trip.

How many mini-vans will the school need?

Traveling Problem

Gina is taking a trip. She is taking 3 shirts to go with each pair of pants.

If she packs 4 pants, how many shirts is she bringing?

Pizza Problem

If you liked pizza, would you rather have 4 slices of a pizza that was cut into 6 pieces or 5 slices of a pizza that was cut into 8 pieces?

There are several things to notice about these problems. First, the problems are grounded in Jaime's reported experiences. Jaime's sister's name is Gina; Jaime attended the Redfield School. Jaime's teacher, Patti, had mentioned (in a pre-conference interview with Bob) that Jaime liked to download games and movies from iTunes. Jaime's class had just gone on a field trip to Boston with parent drivers. Bob's goal as the interviewer was to add as much meaning as he could to the problems so that Jaime would approach the problems as he did a problem in real life.

Step 4: Secure the Interview Logistics

The final step before actually conducting the Student Interview is to arrange the logistics—from requesting permissions (parental consent) to attaining the appropriate materials to establishing where the interview will take place. Let's look at each of these logistics, one by one.

Schedule the Interview

You'll need to arrange an hour of time to conduct the interview. You might not need all of this time, but you'll find it's disruptive if the student has to leave before you're finished. For this reason it's better to conduct the interview in one setting. The exception to this is when working with very young children (seven and under). For this age span, thirty minutes is usually the limit for productive work. When interviewing a younger student, you may have to set up two sessions so that the child is not overwhelmed and you get good information to work with.

It's a good idea for the classroom teacher to let the student know about the interview—and to meet the interviewer, if possible—before the interview begins. Teachers generally introduce me to students as someone who "wants to help you with math." The students seem to accept this readily. The idea is to minimize anxiety about the interview as much as possible.

I have conducted interviews at different times throughout the school day. I would recommend, though, that interviews be scheduled for mid-morning, when students seem to be at their most attentive. I strongly

recommend that you *not* schedule interviews after school, or when the other students are at lunch or recess. While this is convenient (the student won't miss class) there can be a misunderstanding that the interview is a kind of punishment—something that should always be avoided. It's important to send the message that the interview is to help the student, not because he has failed in some way.

Request Consent for the Interview

Best practices from both the field of research and education suggest that parental consent should *always* be given before conducting a Student Interview. Even though a Student Interview is a less formal technique than standardized testing, it still represents research and testing. I've never had a parent refuse consent; usually parents are aware of their child's struggles and are relieved that the school is gathering more information to help them. Parents should sign consent forms (see Reproducible 6.4) that acknowledge that their child will be involved in an interview for the purpose of better understanding his/her mathematical thinking. I think it's always wise to have a personal conversation with at least one of the parents—either in person or by phone—before having them sign the consent form.

Ease the Struggle

Parental Consent

See Reproducible 6.4 for a helpful form in getting parental consent. ■

Attain Appropriate Materials

There are two main categories of materials to prepare for Student Interviews: recording devices and math manipulatives.

Recording Devices When I first began working with teachers to conduct Student Interviews, recording the interviews was optional. It didn't take long for us to realize that a recording of the interview was invaluable in recalling what was said (most of our insights come from listening to the recording; analyses that are not recorded almost never have the depth of those that are). In the digital age, an interviewer has a wide variety of recording equipment choices. In addition to the suggestions that follow, there are also extensive online discussions about recording equipment. (See the discussions at www.vermontfolklifecenter.org/archive/res_audioequip.htm and www.productiontranscripts.com/transcripts/tutorials/equipment-for-transcription.htm.)

I recommend the use of a recorder that can easily upload interviews to a computer (make sure the recorder is compatible with your computer's operating system). The recorder does not need to be large, expensive, or complex—you only need to be able to hear clearly what the student is saying. Pocket recorders and iPods work well. You might also bypass a recorder altogether and simply use a computer; many computers have microphones

and recording software built in. This will, of course, depend on the type of computer and the setting in which the interview will take place (laptops provide the most flexibility here).

Some interviewers prefer video recording; the advantage to this is that the recording will also capture a student's body language and expressions. Ideally, it's helpful to have a second person working the camera (in my experience I end up paying too much attention to the videoing logistics and hence my attention is detracted from the interview). There are many compact and easy-to-use video cameras on the market; attaining a tripod is recommended.

In the many Student Interviews I've done, having a second recorder on hand has saved me on a number of occasions (whether it be that the batteries died or the device got knocked over and stopped functioning—both of which have happened to me!). If you plan to use Student Interviews regularly, consider having a backup recording device.

Whatever device you use, be sure that you talk about it with the student before the interview begins. It can be intimidating to be expected to think when you have microphones and cameras pointing at you. Many teachers find it helpful to begin the interview by having students play with the recording equipment—giving students an opportunity to see how it works and record and play back their voice. Doing this can make the equipment seem less intrusive.

Math Manipulatives In addition to a recording device, make sure that math manipulatives of all kinds are readily accessible. It's important to think about the kinds of materials you *might* need and have them all on hand (be overprepared!). Consider all the materials that can be used as models for the math concept being explored, then plan accordingly. Here are some suggestions; however, any common materials that are used in your classroom should be made available for the interview. The idea is that students have whatever they need to demonstrate their thinking.

Suggested Manipulatives to Have on Hand for Student Interviews

- interlocking cubes
- base ten blocks
- tiles
- pattern blocks
- place-value chips
- money
- graph paper in various sizes (for primary children ¾-inch and ½-inch work well)
- colored pencils and markers
- rulers

Establish an Appropriate Setting

When I first started doing Student Interviews I was happy to interview students wherever a place could be found—from empty classrooms to offices to dining rooms. I quickly realized that the setting makes a significant difference, especially in student participation. The environment should be as familiar as possible and devoid of interruptions.

Anxiety is a concern for many struggling math learners. Care should be given to conduct the interview in a setting that will cause the student the least amount of anxiety. I have conducted a few interviews in the principal's office; while this environment is helpful for eliminating disruptions, some students find it stressful. Familiar environments, like the classroom or the school's resource room, tend to help students feel more at ease.

Whereas the familiarity of the setting is important, it's critical that the interview be devoid of interruptions. Many of my first Student Interviews were interrupted by other students wanting to talk with the teacher in the room, announcements over the intercom, and so forth. Interruptions disrupt a student's train of thought. When the interruption is over, the student has to backtrack to begin again. To prevent discontinuity and to support the student's best attempts at communicating her thinking, try to arrange for an environment that will be undisturbed for the duration of the interview.

Step 5: Conduct the Interview

Congratulations—if you've done Steps 1 through 4 you're now ready to conduct the interview! Student Interviews should begin by building trust with the student; hopefully you've begun to do this by selecting a familiar setting in which to conduct the interview. Being singled out, taken out of class, or brought to school at a special time can be scary for some children. I find that spending several minutes talking with the student about her interests, her school experience, and what we'll be doing helps put her at ease. Emphasize (repeatedly) that you're not very concerned with the correctness of the answers she gives, but are much more interested in her thinking. Tell the student that you want her to *think aloud*.

As you present the problems and listen to the student's reasoning, keep in mind the following list of things to look for. Know the question you'll start with and follow up with questions to improve clarity (recall the list of questions in this chapter, "Questions to Ask During a Student Interview," page 98). Reproducible 6.2 offers a template to help you conduct a successful interview.

Ease the Struggle

Your First Student Interview

Many teachers who conduct Student Interviews report that the first few are a bit chaotic. One teacher compared it to driving when you can only see about ten feet in front of your car. I feel this analogy conveys a good sense of the way student responses determine our questions. Most teachers report that having a clear focus is essential for a successful interview (it's easy to get pulled in several directions), but that flexibility is needed to adjust and adapt to the student's responses. ■

What to Look for in a Student's Explanations During an Interview

- Do any responses or behaviors suggest the student might struggle with memory issues?
- What models (if any) does the student use to think with?
- What kind of logic does the student apply?
- In what way(s) do the student's explanations make sense?
- Do any responses or behaviors suggest that the student might struggle with language issues?
- Do any responses or behaviors suggest that the student might struggle with affective issues (anxiety and/or attention challenges)?

Ease the Struggle

Avoid the Jurassic Park Route

Conducting a Student Interview can be challenging; students often surprise us with the way they think about, and understand, concepts. I've found that one of the most difficult elements of doing a Student Interview is to suspend my own expectations (as much as possible) in order to focus on what the student is telling me. If I know what I am looking for, I will either find it or not. This does not give as much information as seeing what we might find. I like to think of an example from the movie *Jurassic Park* for giving a good analogy of how expectations can be limiting during a Student Interview.

In *Jurassic Park* visitors were given a tour of the hi-tech monitoring facility that kept track of the dinosaur population on the island. The programmer at the facility told the visitors, "There are sixty dinosaurs; the computer makes sure all sixty are accounted for at all times." A mathematician in the group of visitors asked the programmer to clarify, "What does the computer look for?" The programmer emphasized, "It looks for sixty dinosaurs." The mathematician thought for a moment, then suggested that the programmer ask the computer to count all the dinosaurs in the park. At first, the programmer resisted, believing that's what the computer has been doing all along. To accommodate the visitors, the programmer rephrased his query and, to his astonishment, found that there were many more than sixty dinosaurs.

The programmer was looking for sixty dinosaurs and always got that answer. The mathematician was interested in a more open-ended question. As a result, he got a more accurate (and interesting) answer. As we approach Student Interviews we must always be on the lookout for questions or problems that lead us to a foregone conclusion or assumption. We must try, as much as possible, to continually ask questions that allow the student to give us a clear window into her thinking. *Don't assume that what the student said is the same thing as what you heard. Check!* ■

My Story

PART 5: A Student Interview with Jaime

Bob, the learning specialist, met Jaime in the math coach's office. The math coach, Beth, had set aside time so that we would not be disturbed. Because Bob didn't know Jaime well (the math coach did), and because Beth was interested in the Student Interview process, she stayed in the room during the interview. She asked Jaime if this would be OK and he agreed.

Bob started the interview by asking Jaime, "Why do you think we are meeting?" Jaime told Bob, "I'm not good at math and you're here to help me." Bob told him that, strictly speaking, he was only there to try to understand his thinking. Jaime's teachers would be the ones to help him. At that point (and several others during the interview) Bob made it clear that he wasn't focused on right answers; rather, he really wanted to know what was going on in Jaime's head while he was thinking about the answers.

For Jaime, the request to think out loud was easy. He was very articulate and he seemed to really like being able to share his thinking. He smiled often and watched Bob's face for clues about whether Bob had understood him. Several times he rephrased himself after checking Bob's expression.

Thinking aloud is not easy, or welcomed, for many of the students. It was a relief that Jaime was willing and able to tell Bob what he could about his reasoning. After probing Jaime's understanding of multiplication with some of the prepared problems, Bob decided to focus on Jaime's understanding of ratio and proportion. Bob asked Jaime to tell him about his thinking in solving the following Bus Problem:

Bus Problem

Mr. King's class has 10 students who walk to school and 10 students who ride the bus.

Ms. Queen's class has 8 students who walk to school and 16 who ride the bus.

Compare the classes. If all the buses broke down, which class would be affected more?

Jaime considered the problem for a moment and then pointed out that there were more kids who walk in Mr. King's class but more kids who take the bus in Ms. Queen's class. He also noticed that there were more kids in Ms. Queen's class. He paused for a minute and then wrote the equation in Figure 6.1.

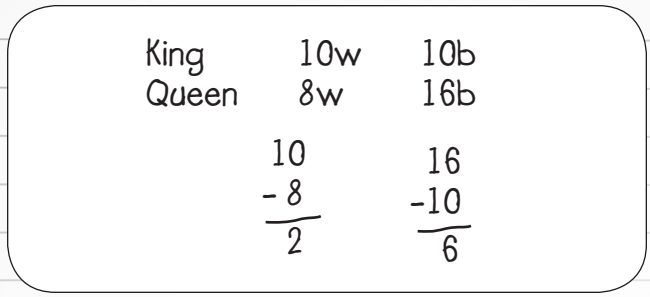


Figure 6.1 Jaime took an additive approach in his first attempt at solving the bus problem.

Jaime pointed out that there were more students who took the bus in Ms. Queen's class, so her class would be more affected. When Bob asked him if the number of kids who took the bus was the only part of the problem that mattered, Jaime considered and said, "There might be some kids who were absent." Jaime had taken an additive, rather than proportional, approach (many middle school students apply additive approaches instead of multiplicative when solving proportional problems). Though Jaime had used an additive approach, Bob didn't assume that this was his preference. Bob considered that Jaime might just be using an additive approach in this context, or he may have interpreted this particular problem in an additive way. Bob kept this in mind while probing more deeply to understand Jaime's thinking and reasoning in relation to ratios and proportions. Bob's next question was about ratios.

Bob asked Jaime, "Can you show me the ratio of kids who walk to school to kids who ride the bus in each class?" Without any hesitation he wrote what you see in Figure 6.2.

continued

My Story continued

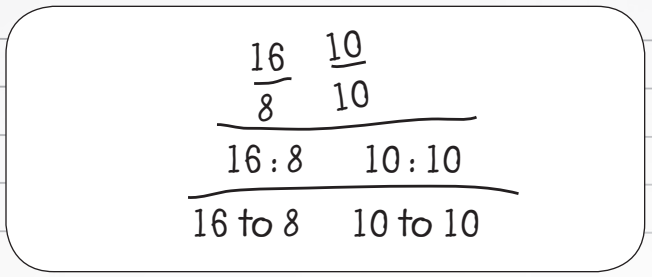


Figure 6.2 Jaime's work when asked to show the ratio of kids who walk to kids who take the bus.

Jaime's work showed that his teacher had worked with him on expressing ratios. Bob asked Jaime what his expressions meant. Jaime said, "They're ratios." He appeared to be confident that he had rendered the ratios properly as he had done it three different ways, almost automatically.

Bob asked Jaime, "What do the ratios mean?" Jaime pointed to one of the numbers and said, "This is how many bus riders are in Mr. King's class." He proceeded to do the same with all the other numbers. Bob was tempted, at this point, to conclude that Jaime knew what the ratios meant, but he pushed a little deeper by asking Jaime if the information about the ratios could be used to answer the question, "If all the buses broke down, which class would be affected more?"

Jaime smiled, nodded, and said, "Oh, I know what you want." He then wrote the equation in Figure 6.3.

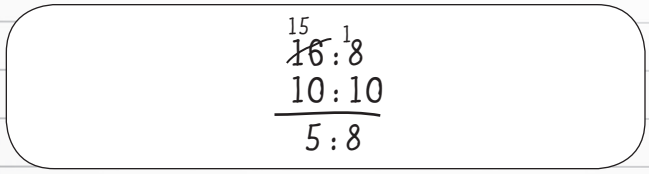


Figure 6.3 Jaime's second attempt at solving the bus problem.

Jaime's work was baffling. Bob asked, "Will you explain your thinking, Jaime?"

Jaime said, "I was comparing classes."

Still unclear about Jaime's thinking, Bob asked, "Will you explain your thinking out loud to me?" Jaime explained that he "didn't have enough" for the ratio on the right and so he had to

borrow from the ratio on the left. This was one of those situations where the answer was quite odd; Bob was tempted to point out that you can't borrow with ratios! Instead, he chose to move on to another problem to see if he could gain more clarity about Jaime's thinking.

Bob chose to use the *Caterpillar Problem* to see if Jaime's approach would be similar.

Caterpillar Problem

A monarch caterpillar was 4 cm long. A week later he was 8 cm long.

A gypsy moth caterpillar was 2 cm long. A week later he was 6 cm long.

Which caterpillar grew more?

Bob chose *not* to ask Jaime to create a ratio but simply to compare the growth rates of the two caterpillars. Jaime told Bob, "This one is easier."

Bob asked, "Why is this one easier?"

Jaime replied, "Because they both grew the same amount. They both grew four centimeters."

To be sure he understood, Bob asked, "How do you know that?"

Jaime looked exasperated by patiently explained, "Four plus four equals eight and two plus four equals six. They each grow four. It's kind of a trick question!" Bob probed, "Why a trick question?" Jaime answered, "Because they grew the same, but the question asks which grew more." Jaime's answer to the second question was providing evidence that Jaime was using additive reasoning. Finally, Bob asked, "Is there any other way to think about how these caterpillars grew?"

Jaime said, "What do you mean?"

Bob said, "Well, suppose they grew for two weeks instead of just one week. How big would each of them be?" By asking this question, Bob was probing to see if Jaime would change his mind and use a multiplicative approach to growth. Jaime replied, "The monarch would be twelve centimeters, because eight plus four equals twelve; and the gypsy moth would be ten centimeters, because six plus four equals ten. The monarch would still be bigger." Bob's questions added significantly to the conclusion that Jaime was using additive reasoning for proportional problems.

Sometimes you think you know how a student thinks, but a follow-up question paints a different picture. One second-grade student I interviewed, Lila, seemed capable of regrouping with addition. She had demonstrated her ability to "carry" from ones to tens and from tens to ones on three separate problems. I was about to conclude—without checking her use of models—that she understood this process when I asked her to solve the equation 17 + 17 + 17. She solved it this way:

$$\begin{array}{r} {\scriptstyle 1} \\ 17 \\ 17 \\ +\,17 \\ \hline 42 \end{array}$$

I had assumed that Lila knew why she "carried the one." Her solution gave me pause. I asked her to tell me about her solution and she replied, "I added the three sevens and I got twenty-one. I put down the two and carried the one. I added the four ones and put down the four."

Lila's answer suggested that she understood the *process* of adding, but not the underlying place-value concepts. When I asked her why she carried the one, she replied, "Because that's what you do when there's too much." By checking Lila's understanding with a follow-up question, I was able to get a clearer picture of her thinking. Her explanation showed me that she was not entirely clear what happened during regrouping._

Questions to Avoid During Student Interviews

These questions lead to teaching instead of the understanding of student thinking.

- What if you . . . ?
- You know that if you just . . .
- But you know that you're supposed to . . .
- And (what you've written) is just another way to say . . .
- Oh, I see what you did. You . . .

Resist the Temptation to Teach During a Student Interview

I have worked with close to two hundred teachers conducting Student Interviews with struggling students. Among the difficulties teachers have with the interview process, the one they report the most is resisting the temptation to teach students instead of understanding their thinking. Following is a list of typical "teaching" responses to students during interviews.

The temptation to make a misunderstanding clearer is second nature to us as teachers; we find ourselves teaching without even knowing we're doing it.

My Story

Karen's Interview: An Interview or a Teaching Moment?

Karen was working with her fourth-grade student, Theresa, to solve the following problem (involving functions):

The Restaurant Table Problem

A restaurant has square tables. Four people can sit at 1 table. Six people can sit at 2 tables. Eight people can sit at 3 tables. How many people can sit at 37 tables?

Theresa produced the table in Figure 6.4 after thinking about the problem for a moment or two.

Number of tables	Number of People
1	4
2	8
3	12

Figure 6.4 Theresa's chart to show her thinking about the *Restaurant Table Problem*.

Karen asked Theresa, "Will you tell me about your chart?"

Theresa responded, "Each table has four people, so you add four for every table: four, then four plus four equals eight, then eight plus four equals twelve. It's a pattern."

Karen queried further, "But what about the people in between each table?"

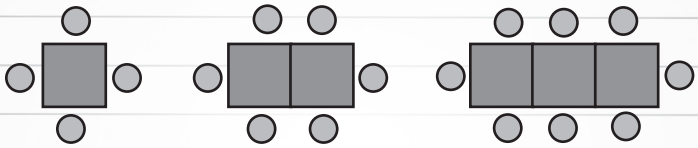
"What?" Theresa puzzled. Karen responded, "See, when you put two tables together you can't have people sitting in between them."

Theresa continued to seem confused and started to say, "I don't see what you . . ."

continued

My Story continued

Karen quickly drew one table, then two together, explaining, "When you put the two tables together you lose the people who were sitting on the ends."



1 table 2 tables 3 tables

Theresa exclaimed, "I get it! But you still have people sitting on these ends." She pointed to the beginning and end of the table. The teacher nodded yes.

Consider what transpired between Karen and Theresa in "My Story, Karen's Interview: An Interview or a Teaching Moment?" page 111. At what point does the interviewer, Karen, stop focusing on the student's thinking and proceed to insert her own expectations? Why does she do this? We can likely all relate; we want the student, Theresa, to see that the pattern she's created is wrong. We might feel that really, Theresa understands but has forgotten that part or tried to solve the problem too quickly. What happens between Karen and Theresa is an example of teaching rather than investigating during a Student Interview. The interview should remain focused on Theresa's thinking; teaching Theresa about the particular pattern, and/or noticing the elements of the problem, can come after the interview.

So what could the interviewer, Karen, have done differently? She could ask Theresa, "Will you draw a picture to go with your chart?" This gives Karen the opportunity to further explore the way Theresa is thinking about the problem. Perhaps Theresa planned to squeeze the extra people around what remained of the table. Perhaps Theresa didn't understand that the tables were contiguous. We don't know if any of these theories are correct unless we keep investigating and resist the temptation to teach. Now consider "My Story: Ginny's Interview: An Interview or a Teaching Moment?" Notice what happens. Could you see yourself doing this? As the interviewer, what could you do differently to investigate Ginny's thinking?

Remember, having theories before beginning a Student Interview is important. As we've learned, our preliminary theories tell us where our investigation might begin. However, once we've started the interview, we must remind ourselves that these theories are meant to inform, not to limit our inquiry. As interviewers it is our responsibility to put aside preconceived notions and listen fully to the student's explanation of her thinking.

"Remember, having theories before beginning a Student Interview is important. As we've learned, our preliminary theories tell us where our investigation might begin. However, once we've started the interview, we must remind ourselves that these theories are meant to inform, not to limit our inquiry."

My Story

Ginny's Interview: An Interview or a Teaching Moment?

During a Student Interview, Ginny, a seventh grader, seemed agitated and close to tears. She was trying to solve the equation 3½ ÷ ¼ = ____. She had written several equations and then erased them. "I can't remember," she said, "which one goes upside down."

"What do you mean?" asked Martha, the interviewer.

Ginny said, "You're supposed to flip one of them and then multiply but I can't remember which one . . . what's three and one-half flipped?"

Eventually Martha suggested restating the problem to try to make sense of it. Martha was trying to understand why fractions were so difficult for Ginny. One of her theories was that Ginny didn't understand the arithmetic operations with fractions. So far Ginny's responses were supporting that theory.

Seeing Ginny's frustration, Martha asked, "How many one-fourths are in one?"

"What?" Ginny responded.

Martha asked the same question differently, "How many quarters are in a dollar?"

Ginny replied, "Four."

"So," Martha continued, "how many one-fourths are in one whole?"

"Oh," said Ginny. "I know what you mean now. There's four one-fourths in one."

"So . . . ?" said Martha. "How many one-fourths in three and one-half?"

"I'm still not sure," said Ginny.

"How many quarters are in two?" asked Martha.

"There are eight quarters in two . . . and twelve quarters in three and two more for the half. Now I get it," said Ginny.

Three Steps to Analyzing the Results of a Student Interview

- **Step 1:** Listen to the recording and take notes. What patterns seem to emerge from the interview?
- **Step 2:** Create theories based on your notes.
- **Step 3:** Listen a second time to see if the theories still seem plausible; refine them as needed.

Analyzing the Results of the Student Interview

Once a Student Interview is complete and has been recorded, it's time to analyze the results. Listen to the recording; what patterns emerge from the interview? Create theories based on your observations. Listen to the recording again and revisit your theories—do they still feel plausible? Let's take a closer look at each of these steps. Reproducible 6.3 offers a template for analyzing the results of your interview.

Step 1: Listen to the Recording and Take Notes. What Patterns Seem to Emerge from the Interview?

While there are detailed ways to create notes from an interview (especially in formal qualitative research), the teachers I've worked with have found that simplicity is perhaps the best. To start, listen to the recording of the interview and take notes on the student's responses. Be sure to have copies of the student's written work in front of you while you do this. Look for patterns in the responses. Use the following three questions to guide your observations.

Three Questions to Ask Yourself as You Listen to the Student Interview Recording

- Does the student consistently avoid certain kinds of problems or techniques (like regrouping)?
- Does the student use a particular strategy (like counting on) on a wide variety of problems?
- Are the student's responses similar to your expectations based on a review of the student's math history? If there are differences, how are these evident in the student's responses?

Step 2: Create Theories Based on Your Notes

In step two we apply our knowledge of both math learning and child development to create theories that might give us a plan for intervention (these theories should of course be more refined than the preliminary theories we created to help structure our Student Interview). Theories can be created using the three frames: Learner, Math Content, and Instruction (see Chapter 2 for more about these three frames).

As we review data from the interview we can use the *Learner Frame* to consider theories that concern the learner's development: Is there any evidence of cognitive challenges? For example, was the student especially anxious when a problem was difficult, or did the student seem to be often distracted? Did we notice any issues with memory? Is the learner demonstrating that she has some kind of model to work from?

The *Math Content Frame* can be used with interview data to help develop theories about gaps in math—"missed" concepts: Did we notice consistent difficulty with place value, or with regrouping? Was the student applying additive reasoning (as in Jaime's case) when multiplicative reasoning was called for?

We can use the *Instruction Frame* to explore theories about inadequate development of models to think with; undeveloped computational or problem-solving strategies, or inaccurately applied algorithms fall into the Instruction Frame.

Sometimes it's difficult to tell whether a student's response is cognitive or mathematical. The three frames are a valuable tool for interpreting Student Interviews and for creating theories to help understand the struggling learner. For an in-depth look at developing theories, see Chapter 3, "Developing Theories for Why a Learner May Be Struggling."

Step 3: Listen a Second Time to See If the Theories Still Seem Plausible; Refine Them as Needed

This step originally was not part of the process; in my work with teachers I found that most listen to the recording just once. Teachers are always strapped for time and listening to a long interview twice is often unworkable. However, there are benefits from a second listen, most notably that it helps identify evidence to support or refine a developing theory.

My Story

The Importance of Listening to a Student Interview Twice

I once conducted a Student Interview with a learner, Al, who was deaf. We communicated through an interpreter who signed my questions and verbalized the student's responses. As I listened to the recording of our interview, I noted that Al had difficulty with problems involving money (this was an emerging theory that I came up with after I listened to the interview recording the first time). I noted that he took long pauses before answering questions that involved buying and selling, and he frequently asked me if he was supposed to add, subtract, multiply, or divide in these problems.

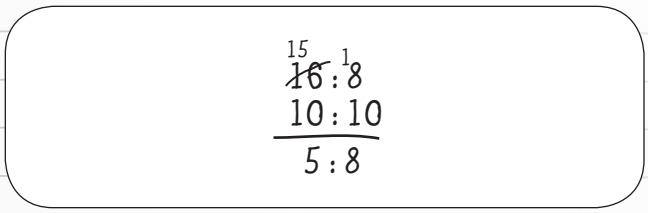
When I listened to the recording a second time, I noticed that Al had similar issues whenever subtraction was involved in solving a problem that wasn't money related. The fact that he asked about operations in the money problems may have been coincidence, because he was just as confused in other places; he just didn't phrase his confusion the same way. I believe I would have missed this if I hadn't listened to the recording a second time.

I also like to re-listen to interviews to look for evidence of cognitive challenges. During the first listen I don't always catch hints that a student's memory isn't working well or that she is showing signs of stress. While I try to pay attention to these issues during the interview itself (it's hard to notice attention issues unless you've videoed the interview), a second close listen helps me to be sure I've gotten all the information I can from the conversation.

My Story

PART 6: Analyzing the Results of Jaime's Interview

When Bob listened to the recording of Jaime's interview, he found out more about the logic Jaime was using to make the comparison. Listening to the conversation again, and even a third time, Bob noticed a pattern in Jaime's reasoning. Whenever Jaime was asked to compare quantities, he subtracted. This confirmed for Bob that Jaime was thinking of comparisons additively, rather than multiplicatively. It seemed to Bob that, for Jaime, comparisons were always a matter of subtracting the smaller quantity from the larger. He had applied this thinking to the *Bus Problem* (see "My Story, Part 5," page 106) while including some of what he had learned in class about ratios: how to write them. He wrote the ratios as if they were whole numbers and then went to work with subtraction.



Jaime's second attempt at solving the bus problem.

Bob's theory was that Jaime had a clear idea about comparing quantities additively, but he was muddled about how to do that multiplicatively. He seemed to know how to write ratios, but not what they represented. As a result, he wrote the ratios and then applied his subtracting strategy in his own way, using the colon as a marker for place value.

Jaime obviously had some serious confusion about ratios (and possibly place value) but he hadn't responded randomly. He was using a

continued

My Story continued

kind of personal logic that needed to be considered if he was going to progress from where he was to a clearer understanding of proportion. To ignore Jaime's thinking would be to lose the chance to build on his own thinking to a clearer understanding.

Bob's analysis of Jaime's interview led to a refinement of his earlier theories:

Theory 1: Jaime did not understand what ratios are and so was unable to use them for comparisons.

This was a theory that came from considering the Math Content Frame. Bob knew that Jaime would not be able to move forward with proportional reasoning until he had "filled the gap" around ratios.

Theory 2: Jaime has not developed the ability to think multiplicatively—and this is why he doesn't recognize these relationships in ratios.

Bob considered this theory, and the intervention that would follow, from the Instruction Frame. Bob believed that Jaime had not fully developed models that allowed him to understand the ways in which multiplicative reasoning was different from additive reasoning. Creating instructional opportunities for this could help to address the gap that was identified in the first theory.

Through the use of the Student Interview Bob had gained valuable information about Jaime's thinking that could lead directly to an intervention.

Using Student Interview Results for Intervention

The theories developed from listening to the interview recording and analyzing the results lead to interventions aimed at supporting the student. The process of creating and implementing interventions based on theories from Student Interviews—like all teaching—is more art than science. Empirical studies that connect specific student difficulties with associated remediation are few, though growing (see Gersten, National Center for Education Evaluation and Regional Assistance, and What Works Clearinghouse 2009). For now, we must rely on expertise from the field, existing remediation work, and conclusions that come from the Student Interviews themselves. The process is similar to how it's done with Collaborative Study (see Chapter 5, "Using Collaborative Discovery Results for Intervention," page 84). Focus on the central idea in the theories, then look for models, strategies, or algorithms that will support the learner (if the theories are correct). These three concepts are also addressed in Chapter 2, "Frame 3: The Instruction," page 19).

"The process of creating and implementing interventions based on theories from Student Interviews—like all teaching—is more art than science."

Interventions That Focus on Models

By far the most common interventions revolve around connecting students to more personally meaningful models. Struggles seem to occur when students have learned a formula or procedure without understanding the mathematics that underlies it. Models help students make connections from their own knowledge to new mathematical ideas. They give students "something to think with" (see Chapter 2, "The Use of Models in Instruction (Stage 1)," page 19).

After Jaime's interview, Bob's theory was that he did not understand the multiplicative relationships in ratios. Bob believed that Jaime had learned something about the formulas and facts for multiplication, but he did not have a strong model to connect them to the multiplicative relationships in ratios.

Bob suggested that Jaime's teacher, Patti, use ratios from the context of everyday life to give him a model to refer to and use when thinking about ratios; a more familiar context might help him make similar real-world connections to ratios when he was solving problems. Bob suggested that Patti ask Jaime to articulate both the additive and multiplicative differences in the real-world examples to be able to distinguish the difference. By doing so, Bob hoped that Jaime would be able to articulate multiplicative relationships need to work with proportions.

Patti was able to use a ratio that had meaning to Jaime (hot lunch: bag lunch) to create a model he could generalize to other, similar situations.

Patti aided his generalization by helping make explicit connections with comments like, "How is this (new) situation like matching hot lunches and bag lunches?" and, "What is the adding difference between hot lunches and bag lunches? What is the multiplying difference between hot lunches and bag lunches?"

Applying a model in a variety of new situations helps students create strategies they can use consistently. The model, in Jaime's case, was the lunch list. He was able to use the strategy of multiplicatively matching one group to another in other situations (see "My Story, Part 7").

My Story

PART 7: Jaime's Intervention Plan Focused on the Use of Models

Jaime's teacher, Patti, and Bob decided, based on the theories they'd created (see "My Story, Part 6," page 117), to spend some time with Jaime on ratios in meaningful contexts. They gave Jaime almost daily opportunities to create ratios and use them for comparison. This was similar to the instruction he'd been given previously, except that the context for these problems was always familiar to him and he was asked to articulate differences between the additive approach he had been using and the multiplicative approach that was required for ratios. The classroom paraprofessional also spent time with Jaime, asking him, "What does that ratio mean? What is the difference if you add? What is the difference if you multiply?" Patti worked with the paraprofessional to help her curb her natural instinct to explain each ratio to Jaime, as this would not allow him to make the connections he needed.

For example, Jaime was put in charge of the lunch list for his grade level (three sixth-grade classes). Patti would ask him, "How many kids are getting lunch today? How many kids are not getting lunch? How would you compare them?" Jaime was consistent in using a subtraction approach to tell Patti how many more students were getting lunch. His answers seemed to confirm that we were on the right track about his additive approach to comparisons.

Interventions That Focus on Strategies

Strategies come from the application of models. As learned in Chapter 2 (see "The Use of Strategies in Instruction (Stage 2)," page 21), a strategy is more complex than a model; a strategy uses models in a specific context to solve a problem. Problem-solving strategies are familiar to most math teachers: *Make the problem simpler, work backward, draw a picture,* and so on. When strategies are well-connected to context and make meaningful use of models, they help students develop a repertoire of generalizable approaches to mathematical problems. When a Student Interview reveals that a student has a workable model, but is unable to apply it to new situations, a focus on strategies may be called for.

To help Jaime progress to articulating multiplicative relationships, Patti manipulated the daily numbers in the list so that they were exact multiples. Early on in the process, she posed the problem, "Jaime, what if there were forty kids getting lunch and only twenty who didn't?"

Jaime responded, "There are twenty more kids getting lunch."

Patti asked, "How many times more is forty than twenty?" This question was confusing to Jaime, so Patti tried a different approach. "How many students getting lunch would match up with students not getting lunch?"

Jaime answered, "You mean if they sat together? There'd be two hot lunch kids with every bag lunch kid."

Patti asked, "How do you know?"

"Because," Jaime said, "there are twice as many hot lunch kids as bag lunch kids."

Patti reported this statement as a breakthrough *for her*. She said she began to think that Jaime actually did know about reasoning multiplicatively, but that he just hadn't made the connection to ratios. For the remainder of her remediation work on ratios with Jaime, she and the paraprofessional with whom Jaime worked continued to ask him what each ratio meant. They asked him to compare the groups by adding and then by multiplying. Patti also used the lunchroom problem as a model for other ratio problems by referring Jaime to it when he got stuck: "Which part is like the hot lunch group and which part is like the bag lunch group? How can you compare the groups by matching?"

My Story

Candace's Intervention Plan Focused on the Use of Strategies

I worked with a fourth-grade student, Candace, in a small, rural school. Candace used place-value blocks well. Candace was able to accurately represent numbers up to 1,000, and to regroup (though inconsistently) for addition and subtraction. The place-value blocks model had meaning to her, though she was not always able to use it in problem-solving situations. She also was perplexed by the number line. In my experience children generally understand the number line immediately. Her inability to work with the number line made us concerned about her sense of magnitude because she was unable to accurately order numbers on the number line.

The learning specialist, the classroom teacher, and I all worked with Candace. Our work involved helping her develop a strategy to connect her knowledge of the place-value blocks with the number line. We did this by having her represent numbers on the number line with place-value blocks (see Figure 6.5).

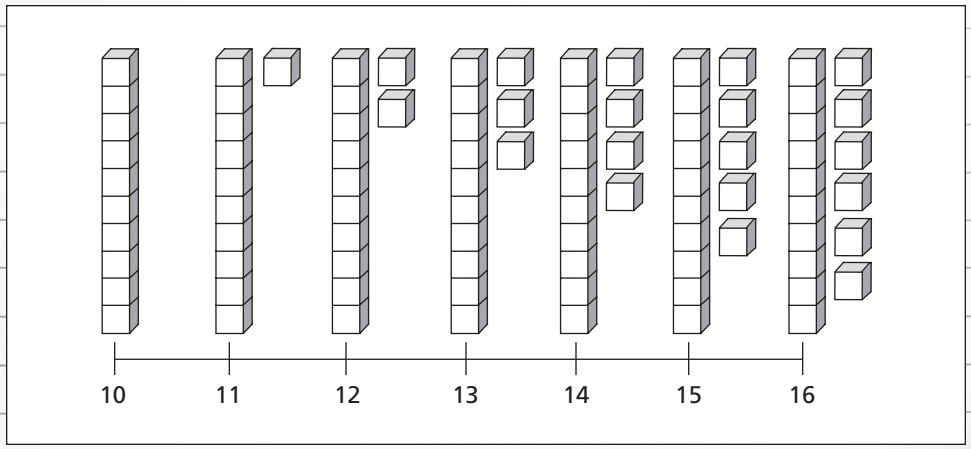


Figure 6.5 Candace connected her knowledge of place-value blocks with the number line.

Candace used this strategy to effectively negotiate values on the number line and connect the order and magnitude with her knowledge of place-value blocks.

We also had Candace use a number line that she could walk on to develop a strategy for moving along the number line and to connect these movements to addition and subtraction. We focused on having her find a "starting place" (the first number in the equation) and then move based on the operation. With this approach she was also learning "counting-on" and "counting-back" strategies. She learned that addition—at this point in her learning—meant she was walking from lower numbers to higher numbers and that subtraction meant she was moving from higher numbers toward lower numbers. While these understandings can present difficulties down the road (for example, when adding negative numbers), we chose to focus on the simplest explanation at this point. We showed her simple equations like 16 – 4 and asked her four questions:

1. Where will you start?
2. How many steps will you take?
3. In which direction will you move?
4. Where will you end up?

These questions helped Candace build a strategy for adding and subtracting using the number line model. They also helped Candace develop deeper ideas about magnitude of numbers; she noticed their position on the number line.

Interventions That Focus on Algorithms

As learned in Chapter 2 (see "The Use of Algorithms in Instruction," page 22), algorithms are the shortcuts—the procedures—we use to do something efficiently over and over. Rarely will the result of a Student Interview suggest that a student's difficulty is that she is not using an algorithm properly.

My Story

Angela's Intervention Plan Focused on the Use of Algorithms

Occasionally when a student first learns the standard algorithm for multiplication (after having developed strong models and strategies for applying them) her knowledge will "leak" into her work in addition.

For example:

$$\begin{array}{r} {\scriptstyle 1\,1\,1}\\ 368\\ +\ 25\\ \hline 923\\ 390\\ \hline 4823 \end{array}$$

In this case Angela used the order of steps from the multiplication algorithm to approach addition, even when she has been successful with addition previously. This particular example came from Angela's thinking aloud as she solved the problem. Angela said that she added the 8 and 5 and got 13. She carried the 1. (So far, so good.) Next she added the 6 and 5 to make 11 and then added in the 1 (as she would have done if she were multiplying). Finally, she added 5 and 3 and added in the 1 she carried. This gave her 923.

This is because difficulties with algorithms are usually noticed early in the solving-for-why process and are (generally) easily remediated. The general strategy for focusing on algorithms is to ask students questions about the reasonableness of their solutions and/or ask them to solve using a different strategy than the algorithm. Confusing the addition and multiplication algorithm provides a good example.

Angela's teacher knew that Angela understood place value and had good models for multiplication. Following the Student Interview, the teacher created a plan to help Angela focus on the reasonableness of her solution. The teacher resisted the temptation to simply tell Angela what to do. He was convinced that, if Angela understood the error herself, she would not continue making it.

Angela's teacher gave her the same problem he had given her during the interview. He asked her to estimate her solution before solving. Angela estimated that it would be about 400. When her teacher asked her, "How do you know this?" She replied that 375 and 25 was 400, and the problem was close. Next the teacher asked her to solve with the algorithm. She repeated her solution and looked satisfied. The teacher asked, "Is your answer close to your estimate?" At first Angela responded, "Yes!" The teacher paused to let Angela reconsider her initial reaction. Angela thought about it; then the light dawned. Angela corrected herself, saying, "No, wait . . . that's four *thousand*, it should be four *hundred*."

The teacher had Angela show him how to solve the problem using a number line strategy. When Angela was convinced that her algorithm was incorrect (she had convinced herself—this is very important!) she was able to work on correcting her misconception.

Looking Ahead

Though Student Interviews can take more time than other assessments, they are one of the most effective tools currently available to inquire deeply into students' conceptual understanding of mathematics. The result of these interviews, like Collaborative Study (see Chapter 5), is an intervention plan based on the theories that emerge. In the next section, we look at accommodating some of the particular cognitive challenges that learners face. We examine ways to support learners with memory difficulties, attention challenges, and math anxiety.

Reflection Questions

1. What makes Student Interviews different from standardized testing? How are the results from these two kinds of assessments different?
2. Think of a student you teach whose thinking is difficult to understand. If you were to interview him or her, what mathematical area would you focus on? What questions might you want to ask?
3. What aspects of the Student Interview process seem most interesting to you? What might you be able to learn from it? What seems daunting about the process?
4. When does questioning go from "probing thinking" to "teaching through questioning?" How do you know when you've crossed from inquiry to instruction?
5. What about Jaime's story is familiar to you? Can you recognize yourself or one of your students in the way it unfolds? How is Jaime's story like or unlike your experiences?