Chapter 1

Thinking About Differentiation

This year Erin, a kindergarten teacher, has a student whose mathematical ability far exceeds any student she has ever taught before. Erin feels as if she is constantly working to challenge this student without using activities that the child will be exploring in future grades. She wants to provide the child with work that relates to what the other students are doing, but at a more sophisticated level. Erin finds this situation particularly difficult. Though she has a strong background in early childhood education, she has never been taught how to teach more complex mathematical skills. She worries that she is not serving this child well.

Kim, a second-grade teacher, is most concerned about a student who consistently needs additional instruction and modeling. The child has difficulty explaining his thinking or making connections among problems and ideas. Often, he is just beginning to understand one concept when the class is ready to move on to another one. He is starting to say he doesn't like math. Kim recognizes that the student does better when he works one-on-one with an adult, but an additional adult is not often available and she is trying to meet the needs of all of her students. Kim would like to help this child be more successful, but just isn't sure what to do.

Christa, a first-grade teacher, worries about a child who joined the classroom in November. The student is just learning English and Christa has noticed that the child often isn't able to concentrate for more than five minutes at a time. The child is able to focus longer when the class is using Unifix cubes to represent

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numbers or is building patterns, but much of the current content work is related to story problems. Christa isn't sure if the problem is rooted in learning a new language, a result of the child's level of attention, or caused by difficulty with understanding mathematics. She wonders if she should do a unit on geometry and not focus so much on word problems for awhile.

These three teachers are like most teachers of young children. They want to provide for the needs of all of their students. They want to recognize the unique gifts and developmental readiness each child brings to the classroom community. These teachers also realize that addressing the variety of abilities, interests, cultures, and learning styles in their classrooms is a challenging task.

Variations in student learning have always existed in classrooms, but some have only been given recent attention. For example, our understanding of intelligence has broadened with Howard Gardner's theory of multiple intelligences (Gardner 2000). Teachers are now more conscious of some of the different strengths among students and find ways to tap into those strengths in the classroom.

Brain research has given us further insight into the learning process; for example, it has shown us that there is an explicit link between our emotional states and our ability to learn (Jensen 2005, Sprenger 2002). Having a sense of control and being able to make choices typically contributes to increased interest and positive attitudes. So we can think of providing choice, and thus, control, as creating a healthier learning environment.

At the same time that we are gaining these insights, the diversity of learning needs in classrooms is growing. The number of English language learners (ELLs) in our schools is increasing dramatically. Classroom teachers need to know ways to help these students learn content, while they are also learning English.

Different values and cultures create different learning patterns among children and different expectations for classroom interactions. In addition, our inclusive classrooms contain a broader spectrum of special education needs and the number of children with identified or perceived special learning needs is growing. On a regular basis, classroom teachers need to adapt plans to include and effectively instruct the range of needs students present.

How can teachers meet the growing diversity of learning needs in their classrooms? Further, how do teachers meet this

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challenge in the midst of increasing pressures to master specified content? Differentiated instruction—instruction designed to meet differing learners' needs—is clearly required. By adapting classroom practices to help more students be successful, teachers are able to both honor individual students and to increase the likelihood that curricular outcomes will be met.

This book takes the approach that differentiated mathematics instruction is most successful when teachers:

- believe that all students have the capacity to succeed at learning mathematics;
- recognize that multiple perspectives are necessary to build important mathematical ideas and that diverse thinking is an essential and valued resource in their classrooms;
- know and understand mathematics and are confident in their abilities to teach mathematical ideas;
- are intentional about curricular choices; that is, they think carefully about what students need to learn and how that learning will be best supported;
- develop strong mathematical learning communities in their classrooms;
- focus assessment on gathering evidence that can inform instruction and provide a variety of ways for students to demonstrate what they know; and
- support each other in their efforts to create and sustain this type of instruction.

We like to think about differentiation as a lens through which we can examine our teaching and our students' learning more closely, a way to become even more aware of the best ways to ensure that our students will be successful learners. Looking at differentiation through such a lens requires us to develop new skills and to become more adept at:

- identifying important mathematical skills and concepts;
- assessing what students know, what interests them, and how they learn best;
- creating diverse tasks through which students can build understanding and demonstrate what they know;
- designing and modifying tasks to meet students' needs;
- providing students with choices to make; and
- managing different activities taking place simultaneously.

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Many teachers find that thinking about ways to differentiate literacy instruction comes somewhat naturally, while differentiation in mathematics seems more demanding or challenging. As one teacher put it, "Do we have to differentiate in math, too? I can do this in reading, but it's too hard in math! I mean in reading, there are so many books to choose from that focus on different interests and that are written for a variety of reading levels." While we recognize that many teachers may feel this way, there are important reasons to differentiate in mathematics.

There are several indications that we are not yet teaching mathematics in an effective manner, in a way designed to meet a variety of needs. Results of international tests show U.S. students do not perform as well as students in many other countries at a time when more mathematical skill is needed for professional success and economic security. There continues to be a gap in achievement for our African American, Native American, and Hispanic students. Finally, we are a country in which many people describe themselves as math phobic and others have no problem publicly announcing that they failed mathematics in high school.

In response to these indicators, educators continue to wrestle with the development and implementation of approaches for teaching mathematics more effectively. The scope of the mathematics curriculum continues to broaden and deepen. There are shifts in emphasis. For example, current trends stress the importance of algebra and, as a result, the elementary curriculum is shifting its focus to include early algebraic thinking. The way we teach math has changed, requiring students to communicate their mathematical thinking, to solve more complex problems, and to conceptually understand the mathematical procedures they perform. And, all of this is happening at a time when our national agenda is clear that "no child is to be left behind."

Even though teachers strive to reach all of their students, learners' needs are ever increasing and more complex to attend to in the multifaceted arenas of our classrooms. Considering the ways differentiation can assist us in meeting our goals is essential. Carol Tomlinson, a leader in the field of differentiated instruction, identifies three areas in which teachers can adapt their curriculum: *content, process,* and *product* (Tomlinson 1999, 2003a, 2003b). Teachers must identify the content students are to learn and then judge its appropriateness to make initial decisions about differentiation. The first step in this task is to read the local, state, or national standards for mathematics. A more in-depth analysis asks teachers to be aware of the "big ideas" in mathematics and then to connect

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the identified standards to these ideas. A decision to adapt content should be based on what teachers know about their students' readiness. Thus, the teacher needs to be aware of or to determine what students already know. Taking time to pre-assess students is essential to differentiated instruction. Based on this information, teachers can then decide the level of content that students can investigate and the pace at which they can do so.

Differentiation Within a Unit

Let's consider second graders who are beginning a unit on estimation and measurement. One of the standards of this content area is that students be able to estimate measures of length. The classroom teacher knows that a big idea in measurement is the relationship between the number of units and the relative size of those units. Understanding that one foot is longer than eight inches is confusing or counterintuitive for many children. They are swayed by the greater number and lose sight of the size of the unit. This teacher recognizes that young children need considerable exposure to different units of measure to comprehend this inverse relationship. She wants all of her students to build preliminary concepts related to this idea, even if it's as simple as recognizing that it will take fewer giant steps than baby steps to walk the length of the classroom. The teacher decides to incorporate this big idea into the estimation process, but first, she wants to informally pre-assess her students. She wants to capture an initial perspective on their thinking, a benchmark to which she can compare later.

She'll launch the unit by asking students to estimate the length of an object using different units of measure. The activity will allow her to get a feel for her students' common understanding and to identify those students who may need more or less support in this area. She'll observe her students carefully as they work and make anecdotal records. She'll be able to use these data to inform her planning of the subsequent lessons.

She asks students to get out their math journals and pencils and gather around the art table. She shows them a craft stick and asks, "How could we measure the length of this table in craft sticks?"

"We could get a bunch and line them up," offers Sandra.

"We could use one and keep putting it down," suggests Mark.

"We could measure the stick with a ruler. You use a ruler to measure length," explains Lynne.

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Already, the teacher is seeing variation in the students' thinking. Sandra's suggestion of repeated units is at a more concrete level than Mark's notion of iteration. Lynne is already thinking about the use of a measurement tool, though the teacher wonders what Lynne really means. Does Lynne realize that she can measure without a ruler as long as she uses a uniform unit? Might Lynne realize that if she finds that the craft stick is about four inches long, she can count by fours as she places the sticks end to end? The teacher makes a note to follow up on this with Lynne, but decides not to delay the start of the activity in order to do so now.

Next the teacher asks the children to imagine using one of these methods to estimate how many craft sticks it will take to measure the length of the table. She tells the students to "Look at the craft stick on the table and think about how many you would need to measure this whole length. Without talking to anyone, I want you to write that number in your journals."

Once the students have recorded their estimates, she puts six craft sticks end to end, along a portion of the table's edge. Some of the children express surprise at how much of the table's length these sticks cover. They squirm waiting to adjust their written estimates. Others look pleased, as if the placement of the sticks affirms their thinking. "Now," says the teacher, "I want you to look at these sticks and think about your estimate again. How many craft sticks do you think it will take to measure this whole length? Write your answer below your first estimate. Think, do you want to change your number or keep the same estimate?" Once the estimates are recorded, the teacher places craft sticks end to end until the entire length is measured. The children count together to find that the table is almost fifteen craft sticks long.

Next, the teacher asks the children to draw a line that they think is one inch long in their journals. After noting the different lengths the students have drawn, the teacher represents a length of one inch by holding up her thumb and pointer finger about an inch apart. "This is about an inch and now I want you to think about measuring the table in inches. How many inches long do you think this table is?" she queries. She asks them to record this answer in their journal as well. Once again a variety of answers are provided. (See Figure 1–1.)

Abby makes a drawing to decide the relationship between the length of an inch and the length of the craft stick. (See Figure 1–2 on page 8.) She traces a stick, estimates the distance of one inch from the bottom of the stick, and places a mark there. Based on this visual model, she decides that three inches is the same length

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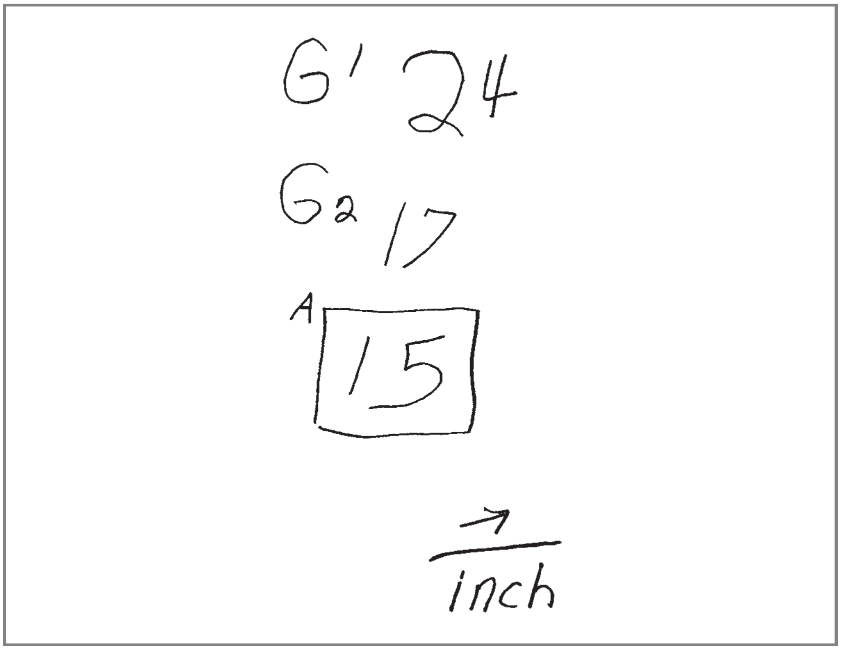

Figure 1–1 *Terrance's initial journal response.*

as one craft stick and begins to make a list of numbers, counting by threes. She makes a couple of false starts, becomes frustrated, erases her work and begins again. This time, she makes a list of the numbers one through fifteen. Her teacher overhears her say, "I know I need fifteen sticks." Next she draws a line to the left of her list and proceeds to count by twos to thirty. Finally, she makes a third column to the right by adding the two numbers to the left, for example, in the first line she adds two and one to get a sum of three. When the teacher asks about her thinking, Abby replies, "I don't know how to count by threes, so I counted by ones, and counted by twos, and put them together. So I got forty-five inches." The teacher is impressed with Abby's strategy for listing multiples of three. She also recognizes Abby's ability to use her understanding of the number of inches in each stick to estimate the length of the table in inches. Though the craft stick is closer to four inches long, three is a reasonable choice, particularly given that Abby overestimated the length of an inch in her drawing.

This activity quickly engages children in the measurement process and it gives the teacher some important information. Based on observations and student recordings, she can determine students' abilities to make initial estimates and whether their second estimates become more accurate. She has an indication of their abilities to estimate an inch. She can gain preliminary ideas

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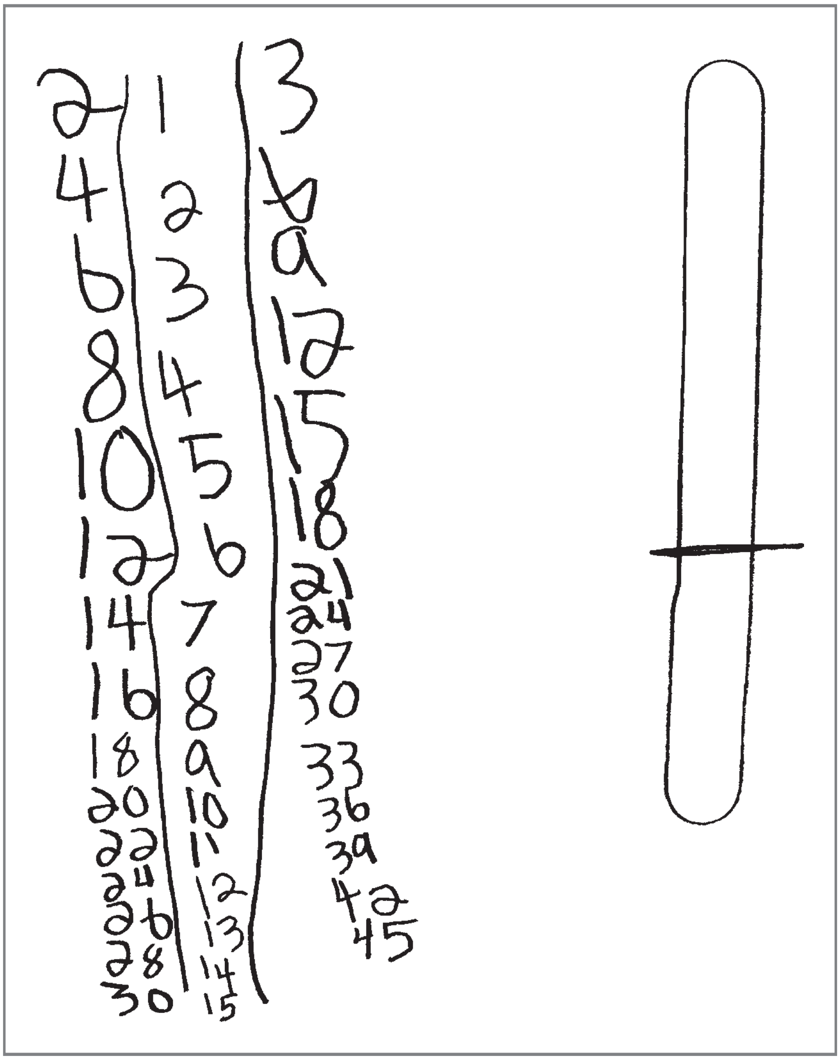

Figure 1–2 *Abby's chart and drawing.*

about which students recognize the significance of comparing the length of an inch to the length of the craft stick, whether they recognize that an inch is shorter than the length of the craft stick, and if they use the relationship between a craft stick and an inch to estimate the table's length in inches. While keeping the mathematical standards in mind, this cursory data can help her make initial decisions about adapting the *content* for different students. The lengths of items to be measured can vary. Some students can measure straight lengths while others could measure "crooked paths." She can have some students measure more lengths in order to better conceptualize the relative length of an inch while others work with different traditional units. Comparisons of *unit*

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lengths and *number of units needed* can involve informal or traditional units of measure.

Once content variations are determined, *process* is considered. The teacher has some students make "inch and foot strips" so that they can have a single model of each unit with them when they make their estimates. She posts some length measures around the room so that students can choose to use these visual images of length. She also makes inch and foot strips of Velcro® and puts them on the wall near the door. She has some of the students close their eyes and run their fingers along these strips whenever they enter or leave the classroom. She encourages these same students to pass their fingers over the lengths of the objects they are estimating before they make their estimates. Initially, she lets students choose the lengths they want to estimate, so that they can begin with items that are of interest. She provides some students with measuring strips cut to one-inch lengths and they are encouraged to use as many as needed, while others have only one strip and must reuse it to measure. She thinks about pairs of children that will work well together during this unit and subsets of students that she wants to bring together for some focused instruction.

Then the teacher must think about *product*—how her students can demonstrate their ability to estimate lengths at the end of the unit. For example, students might write an explanation of the estimation process, pretend they are interviewing for an estimation job and explain how their skills and experiences will help them to be an effective estimator, teach a kindergarten student something about estimation, estimate ribbon lengths needed for an art project, or participate in an estimation Olympics.

It's not necessary, or even possible, to always differentiate these three aspects of curriculum, but thinking about differentiating content, process, and products prompts teachers to:

- identify the mathematical skills and abilities that students should gain and connect them to big ideas;
- pre-assess readiness levels to determine specific mathematical strengths and weaknesses;
- develop mathematical ideas through a variety of learning modalities and preferences;
- provide choices for students to make during mathematical instruction;
- make connections among mathematics, other subject areas, and students' interests; and

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- provide a variety of ways in which students can demonstrate their understanding of mathematical concepts and acquisition of mathematical skills.

It is also not likely that all attempts to differentiate will be successful, but keeping differentiation in mind as we plan and reflect on our mathematics instruction is important and can transform teaching in important ways. It reminds us of the constant need to fine-tune, adjust, redirect, and evaluate learning in our classrooms.

Differentiation Within a Lesson

A kindergarten teacher is thinking about a mathematics lesson she often leads during a particular week of the school year. The lesson focuses on one-to-two or two-to-one correspondence. The teacher is aware that one-to-one correspondence is an essential understanding on which most of the mathematics instruction for her young students is based. But she also knows that many-to-one or one-to-many correspondence is an important concept on which to build future understanding, especially in relation to place value, and tries to present opportunities during the second half of the school year for children to encounter this new idea. Building on the knowledge that children know they each have two legs and two feet, she finds it challenging and enjoyable to apply this idea within the context of the Lunar New Year.

This teacher often chooses to connect learning mathematics with other aspects of the curriculum. As a way to learn about similarities and differences among groups of people, students are learning about how various cultures celebrate important events. As it is the week of Lunar New Year, she launches this lesson by reading *Dragon Feet* by Marjorie Jackson (1999). The story focuses on two children and their family's celebration of the New Year, culminating with them all going to the parade and watching the dancing dragon. The dragon is an important symbol for many people with Asian ethnic backgrounds. It is a symbol of strength, goodness, and good luck. Lunar New Year parades often feature dragons dancing down the street.

The story ends with, "The dragon twists and turns and rolls its eyes. It dances on a hundred feet . . . ." There is a pause as the teacher turns the page and reads the final phrase, "and they all wear sneakers." There is much giggling as the students realize that it is children under a dragon costume who make the dragon dance.

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Sharing this story as a class brings to life a special holiday several classmates celebrate at home, connects with the current theme in social studies, and contextualizes the mathematical questions that are the focus of the lesson: How many people? How many legs or feet?

The teacher turns to a picture of the two children in the story and asks, "If only these children were holding up the dragon costume, how many people would be making the dragon dance?" The children respond, "Two," in loud voices, the way children often do when they are positive about the answer. The teacher then asks Abdul and Ashley to come up and model the dragon. She hands Ashley a dragon mask made from a paper plate. Ashley holds the mask with the tongue depressor that has been attached to it and Abdul stands behind her. The teacher asks, "And how many feet would there be?" This time there is a pause and you can see several children moving their heads so that they can see each of the feet. Many children then raise their hands and the teacher calls on Megan who proudly announces, "There's four." Heads nod in agreement. "And how many legs?" asks the teacher. There is a momentary pause and then a confident response of "Four!"

The teacher is an experienced kindergarten teacher and knows that her students' quick identification of the four feet or four legs does not mean that this task is simple. She knows that her students will feel challenged as the number of people increases. Counting the actual feet or legs is one step in the process. Over time it is the one-to-two relationship of people to feet or people to legs that the teacher wants to focus on. Her students have worked hard at identifying one-to-one relationships, a correspondence that is more intuitive to young learners, but that still requires intensive investigations. For this reason, the teacher likes to connect the idea that there are four legs as well as four feet, when the visual representation of two people is prominent. She also likes to introduce legs into the situation as she knows that children find it easy to draw legs and that they sometimes forget to draw feet. When it comes time to make representations of the problem, she wants them to focus on the mathematics and not to struggle with their recording.

Breaking the one-to-one expectation is an important developmental stepping stone that helps students prepare for later work with grouping by tens. The teacher recognizes that even though the one-to-two ratio is the simplest of the one-to-many relationships, one that is helped immensely by the fact that all of her

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students have set recognition of two objects, it is far from an automatic association.

Next the teacher calls up three children and hands one of them the mask. After establishing that three people are making the dragon dance, the teacher again asks about the number of feet. First she calls on Lowell. Lowell comes up to the children and points to each foot with his index finger as he counts from one to six. He then turns to the class and says, “Six.”

The teacher thanks Lowell and asks what others are thinking. Rachel says, “It’s six, because that’s what I counted.” The teacher then asks if anyone has a different way to find the answer. Olivia responds, “It’s six because we had four and two more than four is six.” Aaron offers, “It’s six because three and three is six.”

Jessica comes up and again says the number names while trying to touch the feet one by one. One of the children steps back as she touches his foot and says, “Ouch!” It is important to give students opportunities to touch real objects, but in this case, some preparation is needed. Creating an environment where students feel safe with the idea that they can touch another child’s foot or that someone could touch their feet is one of the many issues teachers need to anticipate with this lesson. Appropriate behavior needs to be modeled and children need to be ready for this occurrence.

Another group of three children come up to act as the dragon and this time the teacher asks about the number of legs. Their response is quick and the teacher believes they are ready for greater numbers. As the children have been sitting for awhile, the teacher has them all get into groups of four and more dragon masks are provided.

Time is given for these groups to move together in a dragon dance. The energy level in the classroom increases, as does the volume, but this teacher knows how important it is to shift the pace of a lesson and accommodate for little bodies that can’t sit still for too long. Getting up and moving allows all of the children to refocus and consider the number of legs on each dragon they have created.

Once there is agreement that there are eight legs, the children are asked to reorganize themselves into groups of five. Though the teacher is aware that it is a relatively simple shift from five groups of four to four groups of five, she is curious to see how her students will work this out. Initially there is some confusion as there is now one too many masks. In time, the children essentially start from scratch to form four new dragons and one mask is

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dropped to the side. Ten legs becomes a resounding chorus as the children dance the dragon dance once more.

As the number of people in the dragon increases, so does the number of children who count directly to find the number of feet or legs. The teacher notes that Olivia holds on to her idea of two more each time and that Brad begins to use this strategy as well. There is much commotion and conversation. Mathematical disagreements arise naturally in this investigative environment and the teacher skillfully helps the children reach resolutions without taking over the discussions. The children are engaged throughout this process and enjoy taking turns at holding the dragon masks and walking in ways that "make the dragon dance."

In time the teacher brings them back to sit in their circle and they discuss what they discovered. She then poses one last question, "If there were four legs in the dragon, how many people would there be?" This question puzzles them at first; the inverse relationship is not nearly as obvious. It is much easier to visualize people and count their legs, than it is to think of legs and pair them to identify people. After a pause the teacher offers a hint. "How many people would there be if there were two legs?" Faces relax and "one" is identified by all. Stan then says, "So it has to be two people because we need two of the two-legs!"

"Do you agree with Stan?" the teacher asks. Children nod and then the teacher asks how they could *show* that Stan was correct. The idea of having two children stand up and then counting their legs is suggested and carried out. The teacher notes that the children have returned to counting people first and then legs, rather than counting legs by twos. She is not surprised. In the many years she has explored this activity or others involving one-to-many relationships, only one child has initially used skip counting as a way to investigate the relationship. The teacher believes this is another indication of how challenging this task is for young children.

Up to this point, the lesson has proceeded the same way as it has in previous years, but now it is about to change. Having just taken a workshop on differentiated instruction, she has thought about the lesson in new ways. She wants to provide more choice, more variations based on readiness, and more ways for her students to demonstrate their understanding of the concept. She feels that she is a novice in this area and unsure of where this will lead her and her students.

In the past, the exploration would continue with the teacher asking, "What if you were all part of the dragon, how many legs

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would there be?" The children would all stick out their legs and take turns counting around the circle. They would count as a group with one child saying "one, two" and the next saying "three, four." Along the way there would occasionally be a child who would say "wait, wait!" Such a child usually was confused and needed to go back to the first child and count from one, rather than from the last number said. The task provided a good counting activity, reinforced the one-to-two relationship, and provided a challenge to the students who had become comfortable with the smaller numbers in the dragon dramatizations. (See Dacey and Eston 1999, 103 for a description of this approach to the topic.)

Though she feels that offering choices to students has always been part of her kindergarten program, with the teacher's new focus on differentiation, she now realizes that the choices were not always connected to the learning goal. For this investigation she began to think about her planning and preparation with more focus on differentiation of the content, process, and product. At the same time, she did not want to take on too many new things or to overwhelm her students. She thought about other math activities that were currently being explored in the classroom and set out some familiar ones for the children so that she could focus her time and energy on more specific work around the dragon problem. Establishing an environment that supports choice is ever evolving in this classroom as the teacher needs to think about how independently children work, their interests, and the duration for which they can sustain a work session. After all, they are five and six years old, and learning how to work with others while engaged in learning about a focused idea is very new. The importance of and ways to plan and facilitate choices in math workshop are discussed throughout this book. They are an essential element of the differentiated classroom.

So with this in mind the teacher announces, "For the rest of our math workshop time, you must come see me as one of your choices. I will be at the bean table and we will explore some more dragon problems together. You can also choose to work with our number puzzles, our pattern blocks, our big blocks, or one of this week's two math games." As the teacher announces these activities, she points to the four icons for these choices that are shown on the bulletin board. "But remember," she continues, "you must see me as one of your choices." The children are used to a math workshop format that allows them to pursue different ideas or materials that have already been introduced. The teacher spends

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much of the fall helping her students to understand this format. This early work pays off; the children move easily to the different choices.

The teacher has a variety of materials available at the bean table including two word problem worksheets. The first asks "How many legs does the dragon have?" and allows the teacher to write a number—based on her familiarity with students' comfort levels with different-sized numbers—in the blank before the word *people.*

On Chinese New Year,
also known as Lunar New Year,
people celebrate with a dragon dance.

____ *people are dancing a dragon dance.*
How many legs does the dragon have?

The second, alternative handout identifies the number of legs, again with the teacher writing an appropriate number, and asks "How many people are dancing a dragon dance?"

On Chinese New Year,
also known as Lunar New Year,
people celebrate with a dragon dance.

The dragon has ____ *legs.*
How many people are dancing a dragon dance?

It is important to have this alternative form available to ensure that all of the students will be challenged at some level. When children explore inverse numerical relationships, they are developing their algebraic reasoning.

When the children receive their sheets, they work in a variety of ways. Many make drawings (see Figure 1–3) or use chips to represent the people and then say two number names per chip. Carl combines kinesthetic, visual, and auditory modalities to find his answer. (See Figure 1–4.) His task is to identify the number of legs for seven people. First he makes seven single tally marks spread out across his page. Then he taps his leg twice, counts, "one, two," and writes *2* under the first mark. He taps again, says, "Three, four," and writes *4* under the next mark. He continues until he identifies the fourteen legs.

Other activities also are available in an attempt to provide different levels of difficulty and a variety of ways in which students can demonstrate their understanding of this idea. For example, the teacher has prepared strips of paper about ten inches long with a

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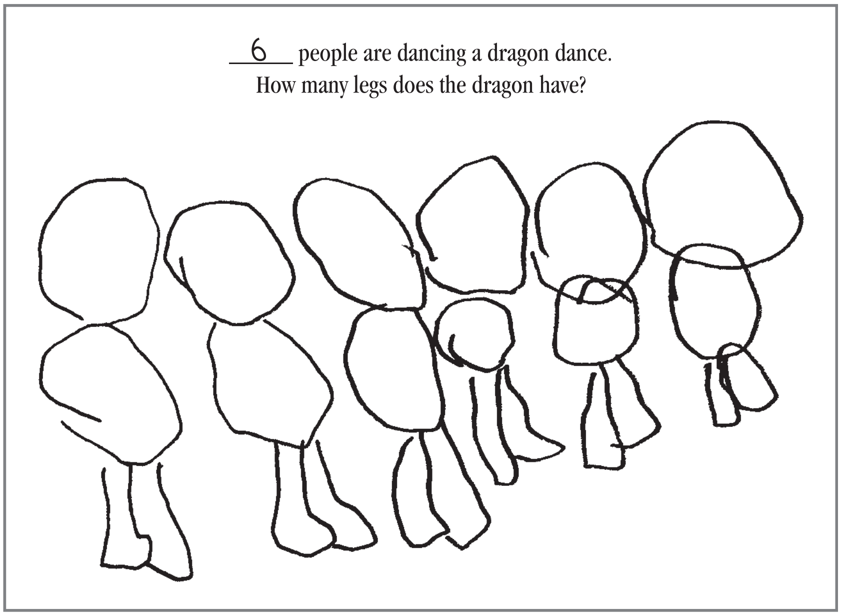

Figure 1–3 *One child's understanding of the relationship between the number of people and the number of legs.*

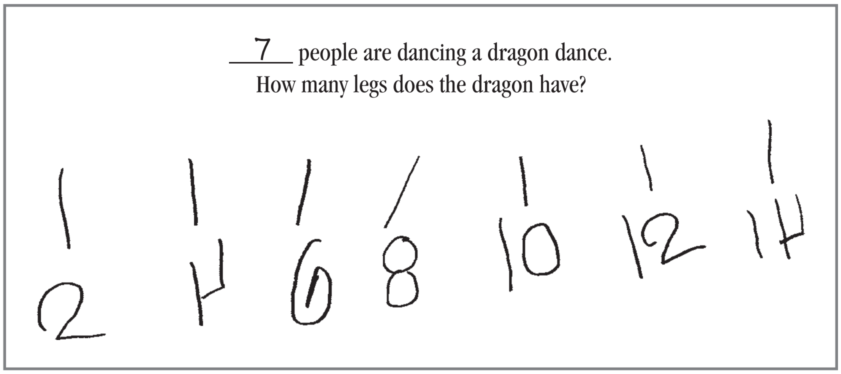

Figure 1–4 *Carl recorded numbers to keep track of the number of legs.*

dragon head pasted onto the left side of the strip. The children are directed to fill in some of the space on the strip with Unifix cubes and encouraged to think of the cubes as the people making the dragon dance. Then they are asked, "If each cube is one person, how many legs would there be?" At the bottom of the strip the children fill in the blanks to indicate the number of people and the number of legs.

The teacher designed this task hoping that the children would choose an appropriate number of people. She thought that

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Figure 1–5 *Students created take-home drawings of dragons using bingo markers.*

some students would pick a small number, such as three or four, if that fit within their comfort level. This is not, however, what happened. Instead, all of the children who explored this task placed Unifix cubes until they reached the end of the paper strip. After the fact, the teacher realized that she might have predicted this behavior. The space was there and so the children filled it. In retrospect, strips of different lengths would have provided the differentiation she had intended.

Some of the children ask to make a dragon picture that they can take home. Their teacher did not anticipate this request but wants to honor it. She begins to formulate ideas for an additional choice during math time tomorrow. She thinks about providing strips of paper with a line drawing of a dragon's head at one end. As the children love using bingo markers, she considers providing these for their use as well. She knows a prompt will be included on the paper to help the students focus on the number of people and the number of legs. (See Figure 1–5.)

Aaron is ready to be given the number of legs and asked to predict the number of people dancing a dragon dance. The teacher starts him with twelve legs as she knows Aaron might get frustrated with a greater number. He rubs his chin and sighs, gripping his pencil tightly. Then he smiles brightly and begins to draw twelve lines on his paper. "I just need to connect the legs," he announces proudly as he draws horizontal lines connecting each pair of "legs." He then counts his "people" and records *6*. (See Figure 1–6.)

Another approach to the problem is to build dragons with modeling clay and toothpicks. The teacher envisions that the children would roll balls to indicate the people and then stick two toothpicks into each ball. Another surprise, this is not what

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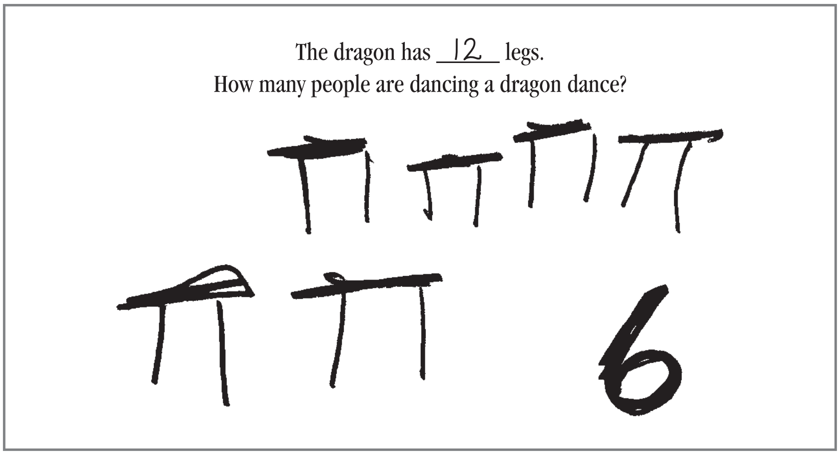

Figure 1–6 *Aaron drew twelve lines for the legs and then paired them to find the number of people.*

happened at all. Instead, many of the dragons looked more like porcupines with toothpicks sticking out all over one big ball of modeling clay! While building, the children talk about adding another person and two more legs, but the material is not structured enough for them to keep track of the relationship between the two variables. On the other hand, this lack of structure leads to an important mathematical insight for one of the students. After making her "dragon," Kim makes a chart. (See Figure 1–7). When she records *12* as the last number under the people heading, she returns to counting the toothpicks. After counting twenty-three toothpicks she proclaims, "This dragon needs another leg!" Her teacher asks how she knows that and she replies, "Twenty-three isn't even. It has to be even." She then adds one more toothpick and writes *24* on her chart.

Until this activity, the teacher was unaware that Kim knew that the number of legs would always be an even number or recognized twenty-three as an odd number. She was also intrigued with the chart Kim made. When asked about it, Kim replied, "It helps me keep track. I didn't have to make each one."

These tasks provided several types of differentiation. Even though the children were allowed to choose which of the tasks they want to complete, the activities still provided for different readiness levels, including a challenge for all students. A variety of materials were used in order to complete the problems and different products were produced to demonstrate understanding.

Following this work, the teacher leaves the masks in the meeting area. During exploration time, several children wander over and

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people	legs
1	2
2	4
3	6
4	8
5	10
6	12
7	14
8	16
9	18
10	20
11	22
12	24

Figure 1–7 *Kim made a chart to show the relationship between the number of people and the number of legs.*

"make a dragon." Then they announce the number of people and the number of legs making their dragon dance. Next, the teacher introduces two new math games. The first is a game in which the children roll one or two dice for the number of people and then determine the number of legs. In the second, a concentration-type game, children match the number of people written on a yellow card with a blue card that shows the corresponding number of legs, along with a picture of those legs. The teacher notices that a few of the children are beginning to be able to start with either color card and still find the correct match.

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Lucas begins to form a strategy for his play. He says, "I just double the number of people and that gives me the legs." His teacher prods his thinking by saying, "Tell me more." He replies, "It's like two and two is four and four and four is eight. You just double. It works every time!" The teacher smiles as she thinks about how much knowledge Lucas has gained and about how much he has taught her in the process. His "doubling" strategy helps her realize that it is a more concrete way of thinking about the one-to-two correspondence that has been the focus of this investigation. She also hears a level of confidence in his voice as he seems to recognize that it will work every time. She thinks about how Lucas has discovered a generalization or a way to think algebraically. He sees that this relationship is constant; it does not change over time.

After the activity, the teacher reflects on what she has learned.

Teacher Reflection

I don't think I would use the modeling clay again, although the children enjoyed working with it. It was just too open-ended. Some structure is needed in order to preserve the mathematical intention. I also think that I could have put out materials that would have been more helpful than the Unifix cubes. I have Teddy Bear Counters and Lakeshore People in my classroom and both clearly show the two-to-one relationship between feet or legs and people. I know some of my students would have found these helpful. It would have been interesting to see which children still chose the cubes, rather than a more concrete representation of the problem.

I was excited to see what emerged from the different problem setups. Before I began thinking about this problem, I didn't realize how many different ways children could represent their understanding. I was also surprised by how tired I was after the activity. This is the first time my students experienced multiple choices within one choice area. I needed to mediate a lot of different ideas at once! In fact one of my students was somewhat distraught at the end of workshop time. "But I didn't do all of them," he said in a frustrated tone. I wonder if this is because we usually complete the activity at a choice area or whether he didn't really recognize that each activity was just another way of solving a dragon problem. Maybe next time I should offer fewer choices, but it was really exciting to see the different ways my students were exploring this problem.

This teacher is not as much of a differentiation novice as she may have thought. This is true of most teachers. Every day teachers are trying to meet students' needs without necessarily thinking about it as differentiated instruction. Similar to this teacher, however, seeing teaching and learning through the lens of differentiation helps us to better meet students' needs and to do so

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more consciously. Over time, teachers can develop the habits of mind associated with differentiated instruction. Remember and think about the following questions as you continue reading and planning your lessons.

1. What is the mathematics that I want my students to learn?
2. What do my students already know? What is my evidence of this? How can I build on their thinking?
3. How can I expand access to this task or idea? Have I thought about interests, learning styles, uses of language, cultures, and readiness?
4. How can I ensure that each student experiences challenge?
5. How can I scaffold learning to increase the likelihood of success?
6. In what different ways can my students demonstrate their new understanding?
7. Are there choices students can make?
8. How prepared am I to take on these challenges?

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