The important question is: How do you feel about Mr. Marks switching his direction midstream and following the student questions rather than his lesson plan? The answer probably depends on whether you are teaching a lesson plan or teaching real students in a mathematics class. When interest and curiosity have been generated, it is desirable to follow the path that the students view as important and worth exploring. So, we need to keep in perspective that a lesson plan is just that—a plan. It must be focused, with objectives and specific activities, but also be flexible enough to allow for modifications as students react to the activities. And, as we discuss in the next chapter, the real issue in this example is the task that the teacher provided for the class. It was during the process of working on the task of drawing and measuring five right triangles and generating subsequent classroom discussion (discourse) that students began to raise questions of their own. Instead of the teacher telling students what they were supposed to know, student opinions and questions were valued and used to redirect the instruction. Mr. Marks’s lesson plan for the next day will need to be carefully crafted to give students an opportunity to discuss their conjectures about acute and obtuse triangles, while also taking the time to put some closure to a statement of the Pythagorean Theorem and explore some of its applications. So, in the end, Mr. Marks’s objectives will be met, but like the road map analogy, the class will not follow the roads that he had intended.

There is no universal structure or framework for lesson planning; however, most teachers use the following components of a lesson plan: general considerations, goals and objectives, materials and resources, motivation, lesson procedure (including transition statements), closure, extension (optional), and assessment. After teaching a lesson, a teacher should also reflect on its implementation, which is discussed at the end of this chapter. We now explore each of these major components.

**General Considerations**

Because the reader of a teacher’s lesson plan is often an administrator, an evaluator, or a substitute teacher, it is important to begin by identifying some general information that frames the lesson. These general considerations include the following:

- The date that the lesson will be taught
- The intended grade level
- The intended course title (e.g., Integrated Math III, Sixth Grade Mathematics, etc.)
- The amount of time allotted for teaching this lesson (e.g., the length of the period)
- The approximate number of students in the class

These five items serve as a starting point for the writing of the lesson plan.

**Goals and Objectives**

As we discussed in Chapter 5, every effective instructional episode begins with clearly stated goals and objectives that delineate exactly what it is that the student is expected to feel, know, or be able to do at the end of a lesson or unit. Ordinarily, these goals and objectives are not actually written by the teacher; instead, they are pulled from the district-adopted graded course of study. The goals are big-picture statements of learning outcomes; objectives are specific statements of what a student should feel, know, or be able to do. A reasonable rule of thumb is to include at least 1, but not more than 3, goals for a given lesson, as well as from 1 to 5 objectives.
The number of goals or objectives for a lesson will depend on the content of the lesson, the needs of the students, and the amount of time the teacher has for the lesson. A teacher, for example, who is planning for a class period that is blocked for 90 to 120 minutes every other day is likely to address more objectives in a single class period than a teacher planning for a traditional schedule with a 40- to 50-minute slot of teaching time.

The goals and objectives should be the basis of all unit and lesson planning, and everything from the activities or tasks selected to the way that the class is run should flow from a statement of what is expected of students. Remember, also, that teaching mathematics transcends content and should include processing skills, as described in Chapter 1. So, when thinking about the intended outcomes for the lesson, a teacher should always be thinking about how the lesson will advance the problem-solving skills of the students, as well as the students’ ability to reason, communicate, connect, and generate multiple representations. In a lesson plan, the goals are often directly linked with specific NCTM Standards and should provide direction for the lesson, keeping both the teacher and the students focused on the key issues. It is not unusual for a teacher to actually explain the main goals and objectives to a class when initiating a new unit or lesson to make clear to everyone what is expected of them and what they are intended to learn. Some teachers even present a conceptual map, such as the one shown in Figure 6.1, to help students visualize the direction that the unit will take.

**Materials and Resources**

When an activity is selected for a lesson, it is likely to involve the use of tools, such as calculators, rulers, graph paper, a videotape, and so forth (see Chapter 7 for further discussion of tools). The lesson plan, therefore, should completely describe the materials necessary for the presentation. When appropriate, it should also refer to the location of materials and how many are required per class, per learning team, or per student. For example, a plan may state that the lesson requires “6 sets of algebra tiles (1 for each group of 4 students), graph paper (1 sheet per student), and 6 graphing calculators (1 for each group of 4 students).” This listing helps ensure that the activity will be organized and smooth. There is nothing worse than getting to the middle of a lesson and realizing that each student needs a pair of scissors, but you didn’t bring a box of scissors today because it wasn’t in the plan. As a result, the lesson falls apart, and so does the behavior of your students. So, be prepared by including a detailed listing of materials in the lesson plan.

Also, because many lesson ideas come from outside sources, such as the Internet, journal articles, or resource books, this section of the lesson plan should cite the sources of the activities in the lesson. The URL (Web site location and title), journal article citation, or resource book citation should be included here, along with a copy of any reproducible page (e.g., an activity page or worksheet) that the class will be required to use in the lesson from a source other than the textbook. This component communicates to the reader where “borrowed” teaching ideas came from that are included in the next three sections of the lesson.

**Motivation**

Every good lesson should open with an attention grabber that gets students thinking about the topic for the day’s lesson while also sparking their curiosity and interest, making them want to engage in the learning process. Let's face it: How excited
do you get when the teacher walks in and says, “Good morning. Open your books to page 147 and take out your homework”? If students are invited to engage in an interesting lesson right away, you have them in the palm of your hand. Otherwise, your students may shut down within the first 5 minutes, and you will have lost them for the entire period. So, arguably the most important task of the planning process is to think of a short activity that will motivate the lesson.

Sometimes, the motivation—also referred to as an initiatory activity, engagement, or springboard—can be a book that is displayed or partially read to a class; at other times, it's a problem that is posed, a newspaper clipping that is displayed, or some other visual aid or activity that evokes interest and curiosity. For example, one teacher who was about to conduct a lesson on three-dimensional geometry brought in a sack of mineral crystals, leading the students to a discussion about how geologists classify minerals based on the shape of their crystals as they occur in nature. The students were fascinated by the shape of calcite and quartz crystals and were immediately drawn into the geometry lesson introduced by the solids. Another teacher, wishing to motivate a discussion of the trigonometric functions, presented the class with a graph of the average monthly high temperatures in their area over the course of 5 years. As the students viewed the graph of the temperatures, they recognized the cyclic behavior of the weather, and the teacher had set the stage for the discussion of the sine curve as a periodic function. A third teacher brought in an ad from a local department store and, displaying it to the class, asked what it means for the store to “take off an additional 20 percent on all sale items.”

The motivation for a lesson can be brief, usually lasting only a few minutes, but it should be linked to the lesson content and give the students a reason for studying what they are about to encounter. The rest of the lesson becomes considerably easier to teach if the students are engaged from the beginning. However, most experienced teachers find the motivation to be the most difficult part of the lesson to plan because you have to know your students enough to understand what will get their attention and make them want to engage in the lesson for the day. This is one of many reasons why it is important for teachers to have a firm grasp of adolescent development and learning psychology. Keep in mind that opening a lesson by stating that “Today, we're going to study rational functions,” or “We're going to study polygons today, and I think you'll find them interesting,” or, simply, “Take out your homework” is not motivational, and you will probably turn off your students from the start.

**Lesson Procedure**

The lesson procedure, a set of instructions for the teacher, is the heart of the lesson plan. Generally, the lesson procedure is an outline, a step-by-step description of what the teacher and the students will do in the lesson. The procedure should be detailed enough to give the teacher very specific directions on what to do and flexible enough to allow for student interactions and redirections along the way. The teacher writes a lesson plan for personal use in the classroom. However, particularly when you are first learning to write lessons, it is often useful to think of the audience as the principal or a supervisor, who may walk into class that day and want to read about what you are doing. Or think of the audience as a substitute teacher, who will be called on to teach your lesson if you are ill. You certainly can't make any major assumptions about a principal or substitute's ability to read into a lesson and ad lib. The plan needs to contain carefully written procedures so that one could pick it
up and teach it without wondering what the writer meant by a particular step. Consequently, vague phrases such as “show the students how the distance formula works” should be avoided because this statement does not help the teacher to prepare for how to develop the distance formula with a class. Likewise, instead of a step that says “ask the students some questions about the diagram,” the plan should include a list of specific questions to ask the class during that step of the lesson.

It is important that students recognize the connection between parts of the lesson and the sequencing of examples and experiences. Therefore, the lesson plan should include transition statements throughout the lesson procedure that are used by the teacher to assist students in moving from one activity to the next. Something as simple as saying, “Let’s see how the game we just played relates to number theory” can help students recognize that the discussion will shift from a game to a discussion about the Real Numbers. If you just say, “Take out your notebooks” after playing a game, students will have no idea what the focus of the next discussion will be. The beginning teacher often includes transition statements throughout the lesson plan, before and after each major activity, so that the plan progresses smoothly and coherently. Without these transition statements, the lesson can feel very choppy to the students, who might see it as nothing more than a series of disconnected activities and pieces. Following are additional tips to keep in mind when writing the lesson procedure component:

- Include statements about what the student will do as well as what the teacher will do throughout the lesson. A common flaw of lesson plans is that they often focus almost entirely on the teacher’s actions, virtually ignoring the anticipated role of the learners in the lesson. A grid can even be used for planning, where each statement about what the teacher does is complemented by a statement of what the student does.
- Include descriptions of how students will be assessed on their understanding throughout the lesson. For example, if the teacher will be observing students as they work, or students will be asked to conduct a free writing in their journals during the lesson, these steps should be included in the procedure section. Chapters 9 and 10 address the area of assessment in detail.
- The lesson should demonstrate flexibility. This flexibility is often expressed with statements indicating that “if the students do X, then ... but if they do Y, then ... .” Remember that the plan is a road map, and teachers need to be prepared to take side trips that students suggest.
- Recognizing that the needs of students will differ within a class, include modifications that may be necessary to address various cultural or learning differences in the lesson. See Chapter 11 for additional information.

Veteran teachers become very adept at writing plans as outlines in less detail, but beginning teachers need to spell out specific examples, questions, and comments to make the lesson flow. We discuss how veteran teachers “lesson image” instead of lesson plan later in this chapter.

**Closure**

When the bell rings as the teacher is in the middle of an example, the class is left hanging, and the teacher does not always know whether the students understood the major concepts. Just as an effective lesson begins with a motivational activity, the lesson should be carefully planned to conclude with a logical wrap-up activity,
known as the closure. The closure gives the teacher an opportunity to assess the progress of the students through a series of specific questions, a journal prompt, or one final problem to solve. In many cases, the closure is a problem or set of questions that is linked to the original issue or problem posed in the motivation at the beginning of the lesson. Students view the lesson as a unified whole if the opening and closure are related in some way. For example, the teacher who began the lesson with an ad from the local department store might close the lesson by displaying three actual prices from the ad, asking the students to determine the new price after an additional 20 percent discount.

In other cases, teachers use the closure as a time to raise a final thought or question that may set the tone for the next class period. For example, a teacher who is concluding a lesson on measures of central tendency—mean, median, and mode—might put up a transparency bearing this statement:

*A person can drown in a lake with an average depth of one inch.*

Then, either students could be invited to comment on the statement in the last 5 minutes of class, or they could be asked to reflect on it in a journal entry as a homework assignment. Class-ending statements such as “Close your books,” “Your homework is . . . ,” or “See you tomorrow” should not be confused with the closure of the lesson; they are statements a teacher might make after the lesson has been concluded.

**Extension**

The extension component of a lesson plan is an activity that provides the teacher with an option if students catch on more quickly than anticipated or are in need of an additional challenge. Veteran teachers know that there is probably nothing worse than having a classroom full of students with nothing to do when there are 15 minutes to fill after a lesson has concluded. Sometimes, teachers in this position will ask students to begin their homework, but most students resist this request and proceed to get into trouble. If an extension is planned, and it’s clear that the lesson will run short, then the teacher has an option on how to proceed. The extension might be another deeper problem to explore or might involve an examination of a different representation of a problem solved in class. As such, the extension goes beyond the lesson and is only used if needed. If the teacher does not get to this activity, it can always be moved into the following day’s lesson or simply deleted altogether. As a general rule of thumb, it’s better to overplan with an extra activity “in your back pocket” than to have extra time and wish that you had brought something more for the students to do.

**Assessment**

A teacher should think through the process of how to most accurately measure student understanding whenever planning a lesson. As the lesson proceeds, students are often informally assessed by simple observation and monitoring of their answers to questions. In turn, these *formative* assessments help the teacher to decide how much time to spend on an idea, whether to skip or resequence steps or the lesson plan, whether to use the extension, and so forth. More formal assessments, such as carefully designed checklists or journal entries, may also be used in the lesson. Assessment of student understanding is pivotal in the teaching process and, therefore, planning for assessment in the written lesson plan is essential. These assessments
are often summarized as a separate statement near the end of the lesson plan. The main idea here is that the lesson plan began with a listing of objectives to be achieved by the students, so it is important to identify, in advance, how the teacher will know if the learners have met those outcomes. Additional detail on assessment strategies is provided in Unit 4.

The lesson plan components described here are generalizations of how most teachers plan their class time. However, it is not unusual to find that 3 teachers in a mathematics department have 3 different formats for writing their plans, but the elements described here are typically included. A lesson-planning format that is popular among science teachers, for example, is called a 5-E lesson plan. In this formatting model, the plan includes 5 stages: engage, explore, explain, extend (or elaborate), and evaluate. Although, at first glance, these steps may seem different from the ones we just discussed, engage is another word for motivate; explore and explain are part of the lesson procedure and closure steps; extend is, of course, somewhat analogous to the extension (although it is not viewed as an optional step in the 5-E lesson plan); and evaluate is the assessment component. Activities in the NCTM Navigations books (discussed in Chapter 5) include three steps—engage, explore, and extend. So, the language varies from one content area or source to another, but the basic components of a lesson plan are always essentially the same.

While planning a hands-on lesson, teachers frequently include some sort of activity that involves the collection and analysis of data. The use of technology can enhance lessons so that students can collect considerably more data in a shorter period of time than would be possible solely through the use of manipulatives. Consider this example:

A cereal company produces a set of 6 commemorative cards containing pictures of wild animals. The cereal boxes have a message on the outside saying: Special free card inside. Collect all 6!

This classic probability problem centers around students trying to determine how many boxes of cereal they should buy at the store to make it almost inevitable that they will actually collect all 6 cards. Of course, one could buy 6 boxes and get a different card in each, but this is possible, not probable. One could purchase 100 boxes of cereal and still only get 5 of the 6 cards, but if equal numbers of the cards are randomly distributed, this isn’t very likely either. So, how many boxes will maximize the chances? Probably the best way to approach the problem is to have students model the purchasing of boxes of cereal and record their results. Using a bag with 6 different-colored cubes in it, students can draw a cube, record the color, replace it in the bag, and continue this process until they have chosen all 6 colors at least once. Another way to model the problem is to roll a fair number cube until all 6 faces have shown at least once. In either case, students collect classroom data to refine their predictions about the optimal number of boxes of cereal to purchase.

Another way to have students model the problem is to visit the problem on the Internet. At http://mste.uiuc.edu/reese/cereal/cereal.html, there is a simulation of the problem. Students select the total number of cards that a child would want to collect, and, by clicking on RUN SIMULATION, activate software that generates and logs the data so that students can use the Internet as their software source. The software runs a random selection process and tells the students how many boxes of cereal were needed to collect all of the cards. Figure 6.4 shows an example in which 19 boxes of cereal were needed for the buyer to eventually collect all 6 cards.

Many such Web sites contain software that sketch graphs, draw fractal designs, compute statistics, run simulations, and perform a host of other applications. Therefore, the school does not have to purchase the software; it is already available and able to be run from a site on the Web. Some sites also contain free software packages (sometimes called “shareware”) that can be downloaded onto a computer and run locally by students in a school.

Another way to simulate the problem without using computers or the Internet is by running software on a graphing calculator. An application program called
Probability Simulator is available for the TI-84 Plus SE graphing calculator. The home screen, shown in Figure 6.5, shows that the software can be used to simulate tossing coins, rolling number cubes, choosing marbles, spinning spinners, drawing cards, or simply generating random numbers.

By selecting the second menu item, a student can count how many times the number cube has to be rolled before all 6 numbers appear at least one time. Again, the simulation could be done by hand, but the calculator or computer simulation allows the students to gather more data in a shorter period of time than is possible using manipulatives alone. Often, teachers allow individual students to use a physical model to collect a few samples and then to turn to the technology to generate a larger pool of data for analysis by the class.

**Sample Lesson Plans**

In order to make you think about the issue of lesson planning, two plans are presented here. Lesson Plan 1 is an example of a flawed plan. As you read it, think about the components of effective lesson planning as discussed and make a list of potential weaknesses in this plan. Lesson Plan 2 is an example of a well-constructed lesson plan. Again, think about what makes the plan useful and complete. In both cases, a standard lesson planning format has been used.
SAMPLE LESSON PLAN

Name: Brian Pack
Date: 11/11/07
Grade Level: 7
Course: Seventh Grade Mathematics
Time Allotted: 45 minutes
Number of Students: 23

I. Goal(s):
- To develop the concepts of perimeter/circumference and area

II. Objective(s):
- The student will learn about π.
- The student will work with another student.
- The student will use string to measure circles.
- The student will use a calculator to find the ratio of circumference to diameter.
- The student will complete a worksheet involving the measurements taken from several circles.

III. Materials and Resources:
- Several circular objects
- Pieces of string
- Calculators

IV. Motivation
1. Hold up a piece of string and say, "What do you think we'll use this string for today?"
2. Explain to the class that they will be using it to measure the circumferences of several circles today.

V. Lesson Procedure
3. Have students work in pairs. Give each pair of students a piece of string, a ruler, and a calculator.
4. Distribute copies of the worksheet that contains lines on which to record the diameters and circumferences of the circles. Show the students where the circles are and tell them to measure the diameter and circumference of each. Then they should write those numbers down on the worksheets and use their calculators to figure out the ratio of the 2 numbers.
5. Ask if there are any questions.
6. After the students have finished collecting all of their data, ask the class several questions to see what they noticed.
7. Tell the class that the actual value of π is about 3.14. Do several examples of circumference problems using π.

VI. Closure
8. Give the class their homework assignment. They will do page 89, numbers 1–22. If they don't understand how to do the problems, do a couple of them on the board.
9. Ask if there are any final questions before the period is over.

VII. Extension

VIII. Assessment
Circulate throughout the classroom as students work. Ask questions to check understanding.
Name: Katherine Bronson  
Date: 10/2/07  
Grade Level: 9  
Course: Algebra I  
Time Allotted: 50 minutes  
Number of Students: 27

I. Goal(s):  
- To develop an understanding of functions as applied to authentic data (NCTM algebra standard: “Understand patterns, relations, and functions”) (NCTM, 2000, p. 296)

II. Objective(s):  
- The student will collect and organize real-life data from an experiment.  
- The student will represent a function as a table, an equation, a graph, and with a verbal description.  
- The student will describe the meaning of the slope and y-intercept for a linear function involving real-life data.

III. Materials and Resources:  
- Each team of 3 students will need (1) a meter stick; (2) a superball, a golf ball, a Ping-Pong ball, and a tennis ball; (3) a sheet of centimeter graph paper; and (4) a ruler.  
- Each student will need a graphing calculator.  
- The teacher will need a superball and 27 playing cards—one each of a 6, 7, 8, 9, 10, jack, queen, king, and ace in the suits of hearts, diamonds, and clubs.

IV. Motivation  
1. Bounce a superball on the floor and tell the class about how “we used to skip these off the elementary school building when I was a kid” and how the older children would try to throw them on the roof.  
2. Raise the question, “But I’m wondering... just how ‘super’ is a superball, really? Does it have more bounce than, say, a golf ball?” (Let the class discuss how they think a superball bounce compares to the bounce of a golf ball.)  
3. Ask the class how we might design an experiment to find out. (Lead them to think about how a number of different balls could be dropped from a given height to determine how high they bounce.)

Transition: Explain to the students that they will be working in teams, so I will randomly hand out playing cards to establish the working groups.

V. Lesson Procedure  
4. Deal out one card to each student, randomly. Ask the students who received the same kinds of cards to sit together (e.g., a 10-team, a king-team, etc.).  
5. Describe the experiment that the class is to conduct, as follows: Each team will be given a superball, a golf ball, a Ping-Pong ball, and a tennis ball as well as a meter stick. Placing a meter stick along the wall, each team should drop each ball from at least 5 different heights, and each height should be attempted twice for accuracy. Each time, the height from which the ball was dropped and the height to which it
bounced should be recorded in a table until 4 data tables—one for each ball—have been produced. Before beginning, each team should have one person in charge of dropping the ball (the one holding a heart), one person to measure the heights (holding a diamond), and one person to record the data in a table (holding a club).

6. Ask the class if they have any questions about the procedure before moving ahead.

7. Ask the person in charge of dropping the ball to come to the front table and pick up a meter stick and one of each of the four balls. After the team has collected all necessary data, it should return to the front of the room for further instructions. Teams should now collect their data. (Circulate through each of the teams, listening to comments and keeping students on-task. It may be helpful to prompt teams to retry some of the drops and/or to attempt more than 5 drops of the ball to more accurately depict the characteristics of the ball. Record anecdotal notes of significant comments made by individuals or discussions within teams.)

8. As each team returns to the front of the room, give the data recorder a piece of centimeter graph paper and a ruler. The person who recorded the data is to draw a graph of each set of data points, where $x$ is the height from which the ball was dropped and $y$ is the height to which it bounced. The data for all 4 balls should be recorded on the same sheet. The other 2 team members should enter the data into their graphing calculators so that the technology can display the picture as well. The team should, then, come up with a linear equation to describe the bounce of each of the 4 balls. When all of the groups have finished, each will be asked to identify which ball had the "best bounce" and how they knew that.

9. Allow each of the 9 groups to briefly present its picture and findings to the class. Encourage debate among the class by asking appropriate questions, such as, "Why do you suppose that their golf ball bounced better than yours?" or "Why didn't we all find the same ball to have the best bounce?" (Flexibility will be important here because the data from all five groups may be very similar or very different and require much discussion.)

Transition: "Let's compare the class's data a little more formally now."

10. On the chalkboard, make a table:

<table>
<thead>
<tr>
<th>Team 1</th>
<th>Super</th>
<th>Golf</th>
<th>Ping-Pong</th>
<th>Tennis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>etc.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Ask each group to write down the slope of their equation for each of the 4 balls. As a class, compute the mean slope for each ball and discuss how the class results may have deviated from what individual teams found.

11. Ask the class to state the equations describing the bounce of each ball. What is the meaning of the slope? (They should note that the slope is a ratio, in this case, comparing the amount of bounce per
unit of height dropped. Thus, the greater the slope, the steeper the line, and the more bounce the ball has.) What is the y-intercept? (The y-intercepts should all be 0 or very close to 0. This means that if the ball isn’t dropped, it doesn’t bounce.) Can you use the equation to predict the height each ball would bounce if it were dropped from higher than you actually measured? How? Is this prediction realistic? (Students should recognize that dropping the ball from a mile-high cliff may not have the same result because the data may change dramatically with extremely high or low numbers.)

VI. Closure
12. We started the class today by asking if a superball is really all that super. Do you think so now? Why or why not? Take out your journal and spend the last 5 minutes of class writing a paragraph that starts with the phrase, “The most interesting mathematical idea that I learned today was . . . .”

VII. Extension
If time allows, prior to Step 11, have students look at the data on their graphing calculators. Using an overhead, enter the class averages for the slopes and have the calculator draw the 4 graphs. Switch back and forth between the equations, tables, and graphs, and use the graphs to trace each function to make predictions about dropping the ball from heights other than those used in the experiment.

VIII. Assessment
Assessment in this lesson takes three different forms. First, anecdotal comments are written on sticky notes as students work in groups (Step 7). Second, specific questions (about slope, y-intercept, etc.) during the class discussion of the data are asked (Step 11). Third, students conclude the lesson by writing journal entries, which will be read tomorrow to measure their levels of understanding (Step 12).

These lessons both use a standard format, as we have discussed in this chapter, but the lessons are very different in terms of what they tell the reader and how they are written. What did you notice as you read them? Suppose that you were a substitute and were called on to teach either of these lessons. Would you consider one to be more clearly written and easier to follow? You might have noticed that both lessons are hands-on and actively involve students in the learning process. The intent here was not to differentiate between teaching philosophies but to illustrate the different ways that lessons are actually written.

Let’s look at Lesson Plan 1. Mr. Pack is teaching a middle school class about circumference and the value of \( \pi \). Although his overall goal appears reasonable, the objectives are far less useful. For example, the first objective, “The student will learn about \( \pi \),” is vague. What does it mean to “learn about” something? If the purpose of the objective is to say that “the student will define \( \pi \) as the ratio of circumference to diameter in a circle,” then it should have been stated as such. Otherwise, we are left to wonder what the student is actually supposed to know and how the objective would be assessed. As we discussed in Chapter 5, objectives need to be clear and are usually measurable. The other 4 objectives listed in Mr. Pack’s lesson are not really worthwhile either. They are simply statements about what the student will do in the
activities for today’s class—work in pairs, use string, use a calculator, and complete a worksheet—rather than statements of what the student should know by the end of the lesson. In reality, this lesson only has two major objectives. The first is the student’s ability to define π and use it to determine the circumference of a circle, and the second, which should have been included, is that “the student will collect and analyze real-life data from an experiment.”

A substitute (or even the teacher who wrote the plan) might find the materials and resources section confusing. First, we do not know what the writer means by “several circular objects.” If this item is to include plastic container lids, a pie tin, a bicycle tire, and a quarter, then they should be listed. Otherwise, the teacher would have no idea about which items to gather, how many items to use, and so forth. Also, the materials and resources section does not say how many pieces of string and calculators will be needed. We know that students work in pairs, and because there are 23 students in the class, we can determine that 12 pieces of string and 12 calculators will be needed, but this should have been included in the materials and resources section. Also, the lesson later tells us that students will use a ruler and a worksheet, but neither of these items were included in the materials listing.

What did you think of the motivation for Lesson Plan 1? Did it capture your imagination and make you eager to proceed with the lesson? Probably not. The teacher could have given the class the diameter of the earth and asked them if they could figure out the distance around the earth, given this information. When the class realizes that they have no method of doing this, the teacher could proceed by explaining that today’s experiment will give them the power to do this by the end of the period and return to that question in the closure. In the lesson procedure, students are to work in pairs, but the reader is not told how those pairs are formed. Are students already seated in pairs, or are they to select their own partner? Or will the teacher assign them to a partner? This needs to be spelled out in the lesson plan. In general, the lesson procedure is vague. For example, in Step 6, the reader is told to “ask the class several questions,” but the plan does not list any possible questions. If the teacher plans to ask, for example, “What was the smallest ratio value that anyone found?” then this question should be specifically stated; otherwise, the teacher is likely to forget to ask the question while teaching the lesson. The direction to “do several examples” is another common error of lesson planning by novice teachers. It is not a useful step because the specifics of which examples, how many, and in what sequence are critical to the success of the lesson. If the teacher plans to work two sample problems with the class, then those problems should be written and sequenced in advance, included in the plan, and not left to chance.

Finally, the closure for Lesson Plan 1 does not really close the lesson at all; it is simply a statement of the homework assignment. How does the teacher know whether the students understood the main message for the day? And what does “do a couple of them on the board” mean? The closure is unclear and does not allow the teacher to assess the progress of the students over this lesson. Also, the lesson does not include transition statements at all. The class abruptly moves from a discussion about a piece of string to measuring circles to a homework assignment and is in need of teacher statements to ease students from one step of the lesson into the next. Flawed because of a lack of detail, the lesson would be very difficult to implement, and it leaves more questions unanswered than it provides direction for a principal conducting an observation or a substitute replacing an ill teacher.
Lesson Plan 2 is a high school lesson prepared by Ms. Bronson for 27 Algebra I students, focusing on functions and, specifically, the slope and y-intercept of a linear function. The goal is linked to the NCTM Standards, and the objectives are clear in that they contain action statements, with words such as “collect,” “organize,” “represent,” and “describe the meaning.” There is enough detail in the materials and resources section to make it useful, including a description of the tools that each student and team will need to conduct the activity. The motivation for Lesson Plan 2 is almost certain to gain the attention of adolescents, as the teacher bounces a superball on the floor and asks students to design an experiment to determine just how “super” it is. This motivation is clearly intended to hook the students and involve them in the lesson that follows. In Step 3, the teacher has made a note to herself in terms of where she wants to lead the students in the discussion, so that the stage is set for the lesson procedures that follow. Placing a hint or reminder into a lesson plan can be very helpful, particularly for the novice teacher.

The lesson procedure is very specific in terms of what the teacher and the student will do. For example, playing cards are used to determine randomly selected teams and to assign responsibilities in the project. Contrast this to Lesson Plan 1 in which we were told neither how the pairs were selected nor what the role of each person was to be in the experiment. Notice, also, how Step 7 in Lesson Plan 2 gives the teacher a specific direction about what she is to do as the class is conducting the experiments. By noting that she will “record anecdotal notes,” the teacher is reminding herself of the assessment strategy to be used during the class period to ensure that students are on-task and are comprehending the major concepts.

The steps that follow serve as a logical extension to the collection of data. After the students have collected their team data, the lesson is completed by compiling class data and looking for patterns. Again, in Step 11, the teacher has provided herself with a note of what she hopes that students will realize about slopes and y-intercepts, which will be helpful in leading the class discussion. The last step of the lesson is a logical closure, which links the end of the lesson to the first question raised in Step 2 and allows students to reflect in their journals as a means to assessing their understanding. Finally, the teacher of Lesson Plan 2 has included an extension—a statement of what students (or the teacher) can do if there is extra time left in the period. Ms. Bronson has included it in her lesson to increase her flexibility. The final section on assessment summarizes the three strategies she will use to measure her students’ understanding—anecdotal notes, questioning techniques, and a journal entry.

Looking at these two lesson plans, you can see how, on the surface, they both appear to be mathematically solid. They both use an appropriate planning format, key in on a couple of major mathematical ideas, and use hands-on, minds-on instructional strategies and technology. However, a careful study of the details reveals that one lesson is vague and leaves much to the imagination of the reader, whereas the other is clear, coherent, and very user friendly. As is true for a blueprint for a house, the more detail we put into the planning process, the more likely it is that we will teach a successful lesson. The following checklist can be used by a teacher in the process of preparing a lesson or by a supervisor who is assessing the components of a teacher’s lesson plan. The checklist summarizes the major elements of each component, as described in this chapter.
General Considerations
- Include the date that the lesson will be taught
- Include the intended grade level
- Include the intended course title (e.g., Integrated Mathematics III, Sixth Grade Mathematics, etc.)
- Include the amount of time allotted for teaching the lesson (e.g., the length of the period)
- Include the approximate number of students in the class

Goals and Objectives
- At least 1 (no more than 3) broad goal(s) is/are clearly stated, often linked to NCTM standards
- Approximately 1 to 5 clear objective(s) is/are stated
- Objectives are measurable and relate to mathematics content (as opposed to statements about students working together, playing a game, using a manipulative, etc.)
- Objectives are drawn directly from the local course of study and coded accordingly (e.g., Geometry, 8.12—indicates the objective is from the Geometry Strand, Grade 8, Objective 12)

Materials and Resources
- A complete list of materials needed for the lesson is included
- The materials list is detailed and specific to the class (e.g., “one calculator for each pair of students,” rather than simply listing “calculators”)
- Ordinary supplies, such as a pencil, textbook, and chalkboard, are assumed and need not be listed
- If any outside resources—such as a Web site, resource book, or journal—have been used as sources for ideas in the lesson, a citation is to be provided in this section (include a complete bibliographic citation with author, publisher, date, etc.)
- If an activity page, worksheet, or other type of handout is to be used in the lesson, it is listed here as a required material, and a copy of the page(s) is/are included with the lesson plan

Motivation
- A brief motivational activity is included (usually only a few minutes)
- The activity is designed to capture the interest and curiosity of the students
- The motivation connects in a meaningful way with the mathematical content of the rest of the lesson
- The motivation is not a mundane routine, such as reviewing homework, giving a quiz, passing out manipulatives, or making a statement, such as “Let’s talk about triangles”

Lesson Procedure
- A detailed, step-by-step description of what is anticipated to happen in the lesson is outlined
- The procedure is written clearly enough for a principal or substitute teacher to follow
- Progression from one step to the next is logical and mathematically accurate
- Include statements of what the teacher will do throughout the lesson (sometimes including “quotes” of what the teacher plans to say, though the plan need not be merely a script)
- Include statements of what the students will do throughout the lesson
• Include examples of assessments the teacher will use to ensure that students are making sense of the lesson (e.g., observing their work, having students share answers at the chalkboard, students writing in a journal, etc.)
• Demonstrate a constructivist environment by having students actively engaged in the lesson (“hands-on” and “minds-on”)
• Key questions asked by the teacher are included throughout the procedure section
• Sample problems or any examples to be explored with the class or individually are clearly spelled out (i.e., do not simply say “go over a few examples with the class” because it would not be clear to the reader what it means to “go over” or what examples the teacher had in mind)
• Transition statements that contribute to the flow of the lesson are included to connect major sections of the lesson or activities
• Illustrate flexibility by including occasional statements such that “if the students do X, then the teacher will do this, but if the students do Y, then the teacher will . . .” (do something different)

Closure
• Include a brief conclusion to the lesson (usually less than 10 minutes)
• Assess whether students have achieved the intended outcomes for the lesson
• Lay the groundwork for the next day’s lesson
• Possibly relate back to the problem or issue raised in the motivation section
• The closure is not a mundane routine, such as giving a homework assignment, collecting papers, or telling students to “have a good day”

Extension (optional)
• An additional activity is included that can be used in the event that the lesson runs short (either because of a planning error or the ability of students to “catch on” quickly)
• The activity builds or goes into greater depth on an issue raised during the lesson
• Students are challenged to explore a topic more deeply than was originally intended in the lesson

Assessment
• Include a summary of how student understanding will be measured
• The summary illustrates more than one way of assessing student knowledge
• Assessments are woven throughout the lesson (as opposed to being included only near the end or in the lesson closure)
• If a checklist or some other type of assessment form is to be used in the lesson, it is described here, and a copy of the page(s) is/are included with the lesson plan

Someone once said, “Show me a classroom in which the students are misbehaving and off-task, and I will show you a teacher who does not know how to write a lesson plan.” Although we cannot attribute all classroom management problems to planning, we can certainly curtail a great deal of potential classroom disruption through effective planning. So, why is it that veteran teachers can plan very effective lessons without writing out all of the details? What happens when you practice detailing procedures, including specific questions and transitions? The answer is simple: You gain experience. Schoenfeld (1998) and others have written about how experienced teachers generate “lesson images” rather than “lesson plans,” something we discuss in the next section.
A mathematics teacher was leading the class through a problem in which they were designing a recipe for cookies. One part of the directions called for one-third of a cup of flour and one-fourth of a cup of sugar. The teacher led the following class discussion.

**Teacher:** Will the total amount of dry ingredients here be more or less than a full cup?

**Student 1:** It'll be less than a cup. The way I think about it is that one-third is less than a half, and one-fourth is also less than a half. So, if you add two things together that are each less than half, then the total will be less than a whole—a whole cup.

**Teacher:** That's a good way to reason it out. Did anyone else think of it differently? Or does anyone disagree with this answer?

**Student 2:** I pretty much did the same thing except I actually added the fractions and found it to be less than 1.

**Teacher:** How did you do that?

**Student 2:** Well, I took one-third and added it to one-fourth, and that gives you two-sevenths, which is definitely less than 1.

**Teacher:** I'm not sure that I follow how you did the addition. Can you show us?

**Student 2:** (goes up to the whiteboard and writes) $\frac{1}{3} + \frac{1}{4} = \frac{2}{7}$

Like that. You just add the fractions together.

**Student 3:** That doesn't seem right to me. Two out of seven is actually less than two out of six, and we know that one-third equals two-sixths. So, you added something to two-sixths and then actually got an answer that was less than what you started with!

**Teacher:** How did that happen? What went wrong here?

**Student 1:** I think you have to find a common denominator first, don't you?

**Student 2:** No, I don't think so. It's just like multiplication. When you multiply one-third times one-fourth, you just multiply the ones in the numerator and the three and four in the denominator, and you get one-twelfth. I just did the same thing here by adding the top and bottom numbers together.

**Teacher:** I can follow your thinking, but I think we already have a good argument on the table for why your answer doesn't make sense.

Mathematics teachers who are relatively new to the profession are often surprised by the difficulty that students have with understanding basic fraction operations, even at the secondary level. High school teachers do not generally see it as "their job" to teach fraction skills, yet most students struggle with adding, subtracting, multiplying, and dividing fractions. If you teach secondary or middle school mathematics, it is inevitable that you will need to teach or remediate students who do not understand the basics of working with fractions. In the case of this dialogue, it is clear that students do not have a firm grasp of how to add the fractions in the recipe problem. How would you handle the situation? What questions or examples might the teacher provide the students to assist them?

The students in this scenario are probably in need of a visual approach to help them see what is happening. The student's logic about why the answer does not make sense is a good start, and the teacher uses that comment to focus the class. But now the
class needs to look at how to find the correct answer. In Figure 6.6, a 3-by-4 portion of a geoboard (a square board with pegs) is marked off with a rubber band, with those dimensions chosen because the problem deals with thirds and fourths.

Students should recognize that each of the squares (made by the pegs) in the 3-by-4 region represents one-twelfth of the whole. So, in Figure 6.7, the top four squares that are shaded represent \( \frac{4}{12} \) or \( \frac{1}{3} \) of the whole. The next three squares represent \( \frac{3}{12} \) or \( \frac{1}{4} \) of the whole. So, if \( \frac{1}{3} \) is added to \( \frac{1}{4} \), the total shaded region represents 7 of the 12 squares or \( \frac{7}{12} \). Therefore, \( \frac{1}{3} + \frac{1}{4} = \frac{7}{12} \), and is certainly not the answer of \( \frac{5}{8} \) that was originally suggested. The geoboard’s area model also helps students to see how it was necessary to look at 12 regions to work through the problem, as 12 is the common denominator that is used to work the addition problem.

In general, when students have difficulty with operations on fractions, it is essential to go back to hands-on models that help them to visualize the problem. Too often, fraction operations are memorized as rules, and students do not have the conceptual knowledge to make sense of the problems. The use of geoboards, Cuisenaire rods, fraction pieces, and other such models is encouraged to assist students in understanding the underlying concepts and to eliminate misconceptions. Can you think of other areas of the mathematics curriculum that involve fractions and may also require this type of intervention? How important is it for students to be comfortable with fraction concepts and operations?
Lesson Imaging versus Lesson Planning

Suppose that Mr. Pack attempts to implement his lesson on circumference of circles, using Lesson Plan 1 as his guide. As the class period progresses, he realizes that his plan is not detailed enough and that his students are off-task and missing the point of the lesson. At the end of the day, he writes a brief reflection on his experience in a journal that he maintains throughout the year:

I just wasn't pleased with my lesson this morning. First of all, I realized that the motivating question did not motivate the class much at all, and I wish I had posed a real-life question that involved circumference instead. Then, I had several vague steps in my lesson, and I wasn't prepared enough to know what examples to explore with my class. I think they missed the point and still don't understand the formula for circumference or how to use it. I will need to approach the topic again tomorrow but from a different angle. Finally, we have a computer lab across the hall, and I have access to several handheld computers. I never thought about it at the time, but I could have used Geometer's Sketchpad or Geometry Instructor in the lab or the handheld computer in my classroom to have students measure circumferences and diameters on the screens—they really enjoy using technology—and I could have played to their interests. There is so much I would change next time around.

You can bet that before Mr. Pack teaches the lesson again, he will rethink the examples he uses and, perhaps, attempt to use technology to help him make his point. If the students use Geometer's Sketchpad on a computer to explore circle relationships, the screen might resemble Figure 6.8.

In Figure 6.8, the student has created a circle, and the software has measured the circumference to be 13.02 cm and the diameter to be 4.14 cm. Using the CALCULATE command, the student can find the ratio of circumference to diameter to be about 3.14 and test circles of other sizes to see if the relationship is always true. If
Mr. Pack has success with the revised lesson, it may become incorporated as part of his routine. Consequently, it will be much easier to plan in the third year because he has seen that the lesson worked much better on the second try when technology was used in addition to hands-on measuring of circular objects. But experience is the key, and after you have taught and retaught a lesson a number of times, you begin to picture the lesson in your mind.

This mental picture of the lesson includes the kinds of comments that the teacher needs to make in order to clarify the task and help students identify the major mathematical ideas; it includes the errors that students are likely to make and concrete ways to respond to those misconceptions, and it includes a sense of how long the lesson will take and what parts can be shortened or lengthened. The mental picture is often referred to in the literature as a lesson image, the sense that a teacher carries into the classroom of what to expect from students, how they are likely to react, and what the teacher can do to make the lesson work. The lesson image differs from a lesson plan, which is a written document that guides instruction. But although a plan can be prepared by the novice teacher, it takes an experienced educator to image a lesson, and the more experience you gain with teaching a particular lesson or teaching toward a certain concept, the closer you will come to being able to create a lesson image. Individuals who have had considerable experience can write a fairly sketchy lesson plan on paper and still teach the lesson with artistry because they carry a mental image into the classroom. As you teach, over the course of several years, you will watch your skills progress from planning lessons to creating lesson images, but only experience can teach you how to do that.

It is important to realize the distinction between plans and images, however, because novice teachers are often surprised by the brevity of lesson plans of veteran teachers and wonder why they are being asked to write out every step. Like a musician who has learned which song to save for last after seeing how audiences respond to that song throughout an entire tour, anticipating audience reactions in the classroom also becomes much easier when you have an experience base. It’s necessary not only to have the experience of teaching a lesson but also to take the time to reflect on its effectiveness, as we saw when Mr. Pack wrote his journal entry. In the next section, we discuss the final step in the planning and teaching of a lesson—reflection.

Reflecting on a Lesson

As we discuss further in Chapter 7, one of the things that good teachers of mathematics do is reflect on the effectiveness of their lessons. In describing the teaching principle (discussed in Chapter 2), the NCTM (2000) stated, “Opportunities to reflect on and refine instructional practice—during class and outside class, alone, and with others—are crucial in the vision of school mathematics outlined in Principles and Standards” and “to improve their mathematics instruction, teachers must be able to analyze what they and their students are doing and consider how those actions are affecting students’ learning” (p. 19). Perhaps you have heard the statement that “nothing ever goes as planned,” and this is often the case with planning a lesson in mathematics. One day, a teacher organizes what appears to be a simple review lesson and then discovers that the class has very little or none of the anticipated background. Another day, the lesson contains a seemingly complex task that the students complete in half the time allotted, leaving the teacher without a plan for
15 minutes or more. Earlier in the chapter, we discussed the issue of how to deal with student questions or misunderstandings, which, in some cases, may cause a teacher to put the plan aside and pursue a totally different direction. Of course, if we place students at the center of the teaching, we can expect and anticipate that their questions and concerns will often change the direction of our lessons. At the conclusion of the lesson, however, the teacher needs to return to the plan, think about how the class actually reacted to it, and address three key question areas:

1. What did I set out to do in this lesson, and why did I plan to do it that way?
2. Did I accomplish my goals and objectives for the lesson? How do I know (i.e., how did I measure the success of my lesson)?
3. What have I learned about my students and myself that will help me to be a better teacher tomorrow, next month, or next year? How would I change the lesson next time?

The answers to these questions will lead the teacher to write an even more effective lesson the next day and, certainly, the next year when another class studies the same content.

After the implementation of a lesson plan, the teacher should always reflect on or assess the plan and its effectiveness. If the students appeared to understand the content, was it because of the lesson itself or something that wasn't even in the plan? If the class was restless, confused, or off-task, can this be attributed to the students, or was it a flaw in the planning? Although it is sometimes difficult to be self-critical, examination of the plan may reveal gaps that could have been avoided or opportunities that should have been pursued. Over time, with experience, teachers create a collection of “best lessons” that work with their classes. Although some of these best lessons can be found in resource books or on the Internet, teachers begin to “own” a lesson only after planning, teaching, reflecting on, and reteaching it. As a result, the teacher becomes increasingly proficient in lesson imaging, anticipating student responses, and attaining the desired flow and success of the lesson. A well-planned set of lessons, then, becomes the cornerstone of coherent, meaningful units.

One form of professional development that has gained considerably in popularity in recent years is a lesson study group. In this model, a small group of mathematics teachers gather to write a lesson as a team. Then, one person teaches the lesson while the others observe. After discussing the strengths and weaknesses of the lesson, the study group refines the plan. Then, another member of the team retaches the lesson, and the group convenes to discuss it further. This study group process (as described by North Central Regional Educational Laboratory [NCREL], 2002, and by Stigler and Hiebert, 1999) allows teachers to work together in the process of planning, teaching, and reflecting, which can be considerably more powerful than one person working alone.

Conclusion

The ability to plan a good lesson is one of the most fundamental of all teaching skills. In this chapter, we explored the role of planning both long-term units and daily lessons. Frameworks for the construction of units and lessons were presented, with examples and analyses of poorly written and well-written lesson plans. (Additional examples of detailed lesson plans can be found in Chapter 8, where we explore the issues involved in teaching specific content areas.) We acknowledged that
the textbook and local course of study often drive the planning process but noted that teachers can supplement these with additional resources to make lessons more meaningful for students. We also emphasized the importance of assessing the strengths and weaknesses of the plan and its implementation. We only improve when we look back at previous lessons—individually or with a group of other teachers—and ask ourselves how the lessons could have been taught more effectively. Using our experience in the classroom, we develop our skills from planning lessons extensively on paper to imaging lessons in our minds, and our organizational abilities progress from the need to write out details to the ability to sketch outlines.

Throughout your career as a student of mathematics, you have inevitably experienced some very interesting and worthwhile lessons. Perhaps those lessons involved you actively in a cooperative learning team or required that you use manipulatives or technology in the learning process. Maybe you were challenged with thought-provoking questions and were expected to struggle somewhat to try to make sense of a problem. However, behind every one of those worthwhile lessons was a caring teacher who was responsible for planning, implementing, and reflecting on your classroom activities. So, what are “good” teachers, and what kinds of experiences do they provide for their students? These questions are pursued in Chapter 7 as we continue Unit 3 with a detailed discussion of the role of the mathematics teacher in the classroom.

**Glossary**

**Closure:** Closure is the final step of a lesson plan during which the teacher wraps up a lesson. Often, the closure includes an opportunity to assess student understanding of the lesson and may tie back to an issue raised in the lesson’s motivation or pose a question for students to consider for the next class period.

**Components of a Lesson Plan:** Although there is no universal agreement on a structure for all lesson plans, this simple outline and components may be helpful in constructing plans:

1. **Goal(s)**
2. **Objective(s)**
3. **Materials and Resources**
4. **Motivation**
5. **Lesson Procedure (including transition statements)**
6. **Closure**
7. **Extension (optional activity or teaching idea)**
8. **Assessment**

**Conceptual Map:** A conceptual map is a graphic organizer of how the content of a lesson, unit, semester, course, or even an entire program fits together as a whole. Figure 6.1 indicates how various concepts are connected and suggests a possible instructional sequence.

**5-E Lesson Plan:** Used extensively in the teaching of science, this model of planning is designed for teachers to think through the development of a lesson in five stages—engage, explore, explain, extend (or elaborate), and evaluate.

**Lesson Image:** A lesson image is a mental picture that is held by an experienced teacher of what is expected of students in a lesson, how the lesson is likely to progress, and what the teacher’s role will be in the teaching and learning process. Novice teachers spend most of their time writing lesson plans in detail on paper, but veteran teachers are more likely to be able to “image” a lesson and work from a more general outline for a plan.

**Lesson Plan:** A written document that details the goals and objectives, the necessary tools, and the activities to be used in a particular classroom teaching episode. It is a road map that can be used by the teacher to provide structure to the lesson. The main components generally found in a lesson plan include goals, objectives, materials and resources, motivation, lesson procedure (including transition statements), closure, extension, and assessment. Also, formal or informal reflections should follow the implementation of the plan. Prospective and less-experienced teachers must write extensive lesson plans that detail their classroom activities and attempt to anticipate student questions and misconceptions.

**Lesson Procedure:** The lesson procedure is a set of instructions for the teacher, generally written as an outline,
with step-by-step descriptions of what the teacher and the students will do in a lesson. The procedure should feature specific instructions but be flexible enough to allow the teacher to move in a different direction if the students raise questions or concerns during the lesson.

Motivation: As it pertains to lesson planning, the motivation is an activity used at the beginning of a lesson to gain the attention of the students. Taking the form of a problem, a visual aid, or an activity, the motivation is intended to set the stage for the lesson and to evoke interest and curiosity in the intended topic. The motivation is often the most difficult part of a lesson to plan because it depends on the teacher knowing the students well enough to understand what will get their attention. Sometimes, the motivation is also referred to as an initiatory activity or a springboard.

Prerequisite Knowledge: Prerequisite knowledge refers to the competencies and skills that students should already possess, prior to the beginning of an instructional unit. It is important for a teacher to identify the prerequisite knowledge of students prior to designing a unit so that the students can connect the new content to concepts they have developed in the past.

Teachable Moment: A teachable moment is a class situation in which a student has answered a question in a particular way or raised a certain concern that leads the teacher naturally into the discussion of an unplanned example or topic. Students indicate their interest in the topic by making comments in class, and the teacher decides that it is better for the class to pursue the issue than to leave it alone.

Transition Statements: Transition statements are statements included in a lesson plan that are intended to help students recognize how the activities in the lesson are connected. These statements, generally included in the lesson procedure, are often written as direct quotes for the teacher to say so that the plan progresses smoothly.

Unit: A unit is a set of learning experiences designed to address one or several goals and objectives over time. Generally, units are long term in that they may take several class periods or even several weeks to complete. A unit may contain several individual lesson plans with a common theme or general topic.

**Discussion Questions and Activities**

1. Choose a general unit topic, such as exponential growth or total surface area and volume of three-dimensional solids, and create a conceptual map indicating the possible components of the unit and how they are connected.

2. Examine a textbook unit in a small group and discuss the length of time it might take to explore the unit and the degree to which your group agrees with the suggested sequence of topics.

3. Sample Lesson Plan 1 was presented as an example of a poorly written lesson. Rewrite the lesson to address the weaknesses described in this chapter.

4. Obtain a copy of a teacher’s manual for a mathematics textbook. Identify and discuss the suggestions for lessons that are described in the manual. How helpful is the manual in the lesson-planning process for a novice teacher?

5. Run a search for mathematics lesson plans on the Internet in a topic area of your choice (or locate a resource book containing sample lessons). Evaluate the strengths and weaknesses of the lesson plans based on the criteria described in this chapter. To what degree do the lessons illustrate the lesson-plan components discussed in the chapter?

6. The motivation of a lesson—the activity conducted with a class in the first few minutes of a lesson—was identified as probably the most important yet most difficult part of the lesson plan to write. Generate several examples of questions, problems, activities, or situations that you could use at the beginning of a class to immediately engage your students in the exploration of a topic or topics of your choice.

7. View a videotape of a mathematics lesson. Then, in a small group, try to sketch out the teacher’s lesson plan. Identify the goals, objectives, materials and resources, motivation, lesson procedure, closure, extension (if any), and assessment. What transitional statements did the teacher use? Describe anything in the lesson that appeared to be unplanned or in which the teacher pursued as a student concern.

8. Most teacher candidates and inservice teachers are familiar with spiral-bound lesson planning books that have a grid of small squares (roughly 2 inches on a side) into which the plan for a given day is to be written. Do you believe that lesson plan books of this kind are ever appropriate? Why or why not?

9. View a videotape case or read a case study of a classroom teaching episode. Play the role of the teacher in the case study and write a reflection on the lesson. Be sure to include the three components of lesson reflection described in this chapter.

10. It has been said that there are teachers with 20 years of experience and teachers who have 1 year of experience, repeated 20 times. What does this statement suggest about the reasons for reflecting on lessons in the teaching and learning process?