Taking Time to Understand Telling Time

This department features children’s hands-on and minds-on explorations in mathematics and presents teachers with open-ended investigations to enhance mathematics instruction. These tasks invoke problem solving and reasoning, require communication skills, and connect various mathematical concepts and principles. The ideas presented here have been tested in classroom settings.

A mathematical investigation is—

- multidimensional in content;
- open ended, with several acceptable solutions;
- an exploration requiring a full period or longer to complete;
- centered on a theme or event; and
- often embedded in a focus or driving question.

In addition, a mathematical investigation involves processes that include—

- researching outside sources;
- collecting data;
- collaborating with peers; and
- using multiple strategies to reach conclusions.

Although “Investigations” presents a scripted sequence and set of directions for a mathematical exploration for the purpose of communicating what happened in this particular classroom, Principles and Standards for School Mathematics (NCTM 2000) encourages teachers and students to explore multiple approaches and representations when engaging in mathematical activities. In the November investigation, second-grade students explore seconds, minutes, hours, and the relationships among them. They connect their observations to the movements of a clock’s hands and to telling time. This investigation addresses NCTM’s Measurement Standard (NCTM 2000).

The Investigation

Learning goals, rationale, pedagogical context

Telling time is often taught as a rote skill, without ensuring that children understand the duration of time and its relation to the numbers and hands on a clock (Thompson and Van de Walle 1981). This investigation provides opportunities for children to investigate time units, experience events lasting set amounts of time, and develop personal referents for standard time units. The typical approaches to teaching time do not highlight the differences associated with the two hands of an analog clock. The hour hand simply points to the hour, but the minute hand must be understood in terms of the distance it has moved around the clock from the numeral 12. For this reason, this investigation has students work with two types of one-handed clocks to meaningfully discover both differences and connections between the two clock hands. The sixteen students in the investigation were in a diverse second-grade class at the Samuel S. Gaines Academy in Ft. Pierce, Florida.

Objectives of the investigation

Students will—

- develop personal referents for one second and for one minute;
- discover the relationship between seconds and minutes;
- investigate the connections between the movements of a clock’s hands;
• connect the numerals on a clock face to groups of 5; and
• tell time to the nearest minute.

Materials

Lesson 1
1. A clock with a second hand.
2. Each student will need one copy of activity sheet 1 (activity sheets follow this article).
3. Each activity station will need the materials necessary for the one-minute activities that you choose, such as Unifix cubes, balls, or jump ropes.

Lesson 2
1. Each student will need a slit clock.
2. The teacher will need—
   • a slit clock;
   • a piece of rope with evenly spaced knots; and
   • candles of different widths with evenly spaced notches or lines.

Lesson 3
1. Each student will need—
   • 5 connected Unifix cubes;
   • a cutout of 5 connected Unifix cubes; and
   • a copy of activity sheet 2.
2. The teacher will need tape and a clock without numbers.

Lesson 4
1. Each student or pair of students will need a clock with moveable hands that maintain the correct relationships as they are moved.
2. The teacher will need—
   • a slit clock;
   • a clock without numbers;
   • a transitional clock; and
   • a regular clock.

Previous knowledge
The students in this investigation could tell time to the nearest hour, and many of them could tell time to the nearest half hour. They had little or no formal experiences with fraction representations, and they had just completed a unit on money.

Lesson 1
The purpose of the first lesson is for students to develop personal benchmarks for one-second and one-minute time spans and discover the relationship between them. Begin the investigation by asking students to think about how long one second is and share what they could do in one second. About half of our class offered reasonable ideas, such as turn on a light, do a front flip, walk one step, snap your fingers, throw a ball, write the numeral 1, do a cartwheel, flip the pages in a book [all at once], count to two, and count back to one. Nicholas connected time to distance by offering, “Move your finger a small amount,” as he showed about a one-fourth-inch movement of his finger on his desk. Other students offered less reasonable ideas of one second and shared responses such as “Count to one hundred,” “Go on a plane,” and “Drink a bottle of water.” If time permits, have your class verify how many seconds some of their suggestions actually take.

Students were then asked to put their heads on their desks and to raise their hands when they thought one minute had passed. As we had anticipated, most children underestimated the length of one minute. In our class, two students raised their hands in less than twenty seconds, seven raised their hands between twenty-one and forty seconds, three raised their hands between forty-one and fifty seconds, and four made good estimates of one minute, raising their hands between fifty-one and seventy seconds.

Have the entire class experience some one-minute events, such as running in place for one minute or sitting silently for one minute. Then ask them to predict the result of an activity the teacher

Second graders investigated connections between a clock’s two hands.
will do for one minute. Our students were familiar with the book *Are You My Mother?* by P. D. Eastman, so they were asked whether or not the entire book could be read aloud in one minute. Twelve of sixteen students predicted that it could be, but the teacher was able to read only one-third of the book during the minute.

Ask students to predict how many times they can repeat an activity during one minute. Give them an opportunity to try each activity for one minute and compare their predictions to the actual results. We gave our students an opportunity to cycle through four activity stations while working with a partner: bouncing a ball, connecting Unifix cubes, jumping rope or doing jumping jacks, and writing their name. The teacher announced the beginning and end of the one-minute time periods. Some students seemed to think that because the allotted time was the same for each activity, the number of repetitions for each activity would also be about the same (see fig. 1a). They made predictions that were consecutive numbers or were all very close to the same number. Other students seemed to lack both number sense and a one-minute reference frame and made unreasonable predictions (see fig. 1b). You may want to emphasize that they should continue the activity for the entire minute, not stop if they reach their predicted number of repetitions, as some of our students did at first (see fig. 1c). Also, some students used stacks of Unifix cubes that were already joined together, resulting in larger numbers than we had anticipated.

Guide students to discover the relationship between seconds and minutes. Be careful not to mention anything about discovering how many seconds are in a minute, because some students will likely already know. Ask the class to watch the second hand and count, as a class, how many times it moves while traveling all the way around the clock. The teacher should indicate when to start and stop counting. Repeat this activity several times, being sure to start with the second hand at different locations on the clock. After several repetitions, students should notice that it always takes sixty seconds. Have a class discussion to ensure that students understand that a minute is a standard measurement unit and must therefore always equal the same number of seconds, namely, sixty seconds. Ask how they can use the clock to tell when one minute passes. If necessary, prompt them to connect to their experiences with the second hand taking sixty seconds to travel the entire way around the clock face.
Next, share some common counting schemes, such as “one Mississippi, two Mississippi …” or “one one thousand, two one thousand …” to approximate one-second intervals. Have one student face away from the classroom clock and use one of the counting schemes to count out an approximation for one minute (sixty seconds) while the other students watch the second hand on the clock to determine the accuracy of the counting scheme.

After counting all the way to “sixty Mississippi,” our students came fairly close to one minute and decided these were “good” ways to approximate one minute. At the end of the Lesson 1 investigation, students reflected on their learning as they used their benchmark knowledge of second units and minute units to choose the most reasonable time for certain events (see activity sheet 1).

Lesson 2
The purpose of the second lesson is for the class to investigate what can be determined about time when a clock has an hour hand but no minute hand. Ask the class how people kept track of time before clocks were invented. Some children may suggest using daylight and darkness. You may want to discuss devices without clock hands, such as sundials and water clocks. In China, people burned ropes with knots at equal intervals. Similarly, some people marked equal intervals on candles. We showed our class candles of different widths, all with marked intervals of the same distance, and asked if it would take the same amount of time for each candle to burn from one mark to the next. Luis said, “No, because the red one is fatter, so it would take a lot longer.”

We shared the information that the first clocks were made in the fourteenth century and had only one hand. When asked if we would be able to tell time from a clock with only one hand, most students expressed doubt. We handed out the slit clocks (see figs. 2a and b) and told the class that the hand represented the hour hand—just like the first clocks from about seven hundred years ago. You may want to demonstrate how to move the slit.
clock: Tell the children to reach behind the clock and turn the circle from the backside with one hand while holding the full plate with the other hand. After allowing them a short time to move the clocks as they wish, ask students to point their hour hands directly at a number. Then ask a student to hold up his or her clock and tell what time it is. Our class quickly agreed that when the hand points directly at a numeral, such as 7, it is “that number o’clock” (i.e., 7:00). They spent a few minutes taking turns, with one partner moving the hand to point directly at a numeral and the other telling the time.

Next, we held up a clock with the hour hand just past the numeral 5 (see fig. 2b) and asked what time that could be. Several students told us that it was five o’clock and that the hand had “gone too far.” Others responded, “It is five o’clock and some more minutes,” and, “It is after five o’clock.” With prompting, the class agreed to call this “just past five” or “a little past five.” Similarly, when shown a slit clock with the hand just before the numeral 5, they described it as “a little before five o’clock.” We also displayed the slit clock with the hand halfway between the numerals 2 and 3. They described it as “between two o’clock and three o’clock” but never offered the idea of being halfway between two and three o’clock (i.e., 2:30). Rather than lead them to the idea of half hours at this point, we let them continue to investigate locating the hand just before or just after a numeral on the clock face. They seemed content to declare each location as closer to one of the two numerals.

As a whole class, students practiced describing several times on slit clocks held up by classmates. The rest of the lesson time was spent on the following five partner activities using the slit clocks. All students worked on the first two activities. Only students who were ready to move on tried the last three activities:

1. One partner sets a time on the slit clock, and the other partner names it using phrases such as “eight o’clock,” “a little before seven o’clock,” or “a little after three o’clock.”
2. One partner describes a time, and the other sets the time on the slit clock.
3. One partner asks a question such as, “When do you get up?” and the other answers by setting the time on the slit clock and naming it.
4. One partner sets a time on the slit clock and asks the other what he would be doing at that time.
5. One partner sets a time on the slit clock, and the other sets the time that is two hours later.

**Lesson 3**

This activity parallels that of Lesson 2, but the class investigates clocks with only a minute hand. The lesson emphasizes connecting groups of five to minutes on the clock face and using efficient counting strategies to tell time. To begin, give each student five connected Unifix cubes and point to children as you go around the room. Have them chant, counting by fives with you.

Then give each student a cutout of five connected Unifix cubes and repeat the counting by fives. Next, have a student tape his cutout cubes to the board. It works best to align the cubes horizontally even though this takes more board space. Draw a vertical line segment at the right end of the cubes. Ask the class how many groups of five cubes are on the board and write the 1 beneath the line segment. Then ask the class how many cubes are on the board and write the 5 above the line segment. Continue in this manner, having students add their cubes to the horizontal number line one at a time. Have the students report both the number of groups of five cubes and the total number of cubes. Some students may notice that the number of groups is the same as the number of students who have put up their cubes.

Once the number line is complete (see fig. 3a), have the class discuss the two sets of numbers and how they are connected. To start the discussion, we asked questions such as, “How many groups of five cubes make thirty-five cubes?” We also pointed to a specific cube (such as the twenty-third cube) and had the class count up to that cube. Some students counted by fives as long as they could and then by ones, but others counted only by ones.
Ask students how many numerals are on the face of a clock and then remove the section of the cube number line beyond twelve groups of five. Have the class discuss whether or not they could use their cube number line to tell time. Some of our students thought it would be too hard because there was “nowhere to go after you get to the twelve,” but others pointed out that you could just go back to the beginning and start over again. However, they all agreed that it was easier to tell time on a round clock face, so we rearranged the sections of the cube number line into an approximation of a round clock face. We again labeled with both sets of numbers, keeping the total number of cubes on the outside of the circle (see fig. 3b). This created a transitional clock showing numerals for both the number of groups of cubes (hours) and the total number of cubes (minutes).

Help children recall that in the previous lesson’s investigation, they used a clock with just the shorter hand. Today they will use a clock with just the longer hand. Ask, “Which numbers should you use to describe where the longer hand points?” Keyontay said it should be the numbers on the outside of the circle because the hand “has longer to go to reach them.” Although we referred to the hands only as shorter or longer in order to preserve the investigative nature of the lesson, some of your students will know them as the hour hand and minute hand and may use those names in their responses. For example, Roberto said the longer hand “has to be the minute hand, since there is not a thirty-five o’clock.” When a couple of our students used this vocabulary, we did not comment on it, but we continued to use the words shorter and longer in the hope of deepening students’ understanding.

We put a clock without numbers on the board next to the cube clock face. When we asked why the zero was written at the top of the clock, class members replied that was because they started the number line with zero cubes. We then asked what the lines on the clock meant. They quickly agreed that each short line was for one cube and that the longer lines were like the lines on our cube number line and signified five cubes or five lines. We asked how many minutes past the hour was shown on the numberless clock (see fig. 4). All the students counted by ones to conclude that it showed twelve minutes past the hour. After a couple more examples with a small number of minutes past the hour, the minute hand was positioned to forty minutes after the hour. As anticipated, the class generated several different answers as a result of counting errors. When asked to share their strategies, most indicated that they had counted by ones, but a few shared that they had counted by fives. All agreed that counting by fives was easier, and we then did...
several examples with the number of minutes as a multiple of five. Finally, the long hand was positioned at twenty-eight minutes past the hour. Most students started counting by fives. When they realized that they were not going to end on a multiple of five, some switched automatically to counting by ones, for example, 5, 10, 15, 20, 25, 26, 27, 28. However, many went back to the top and began recounting the entire sequence by ones. During the ensuing examples, we encouraged students to use more efficient counting strategies, but a few continued to count only by ones.

Our students used the remaining time to practice counting the minutes past the start of an hour with their partners and to complete activity sheet 2. The sheet also gave them the opportunity to draw a clock hand wherever they wished and then count the minutes. Several children enjoyed creating a large number of minutes past an hour, such as fifty-eight or fifty-nine. Jorge wrote sixty minutes and showed the long hand pointing to the top of the clock (see fig. 5a). He clearly explained that the hand went all the way around the clock, which was sixty minutes, but when questioned, admitted it did not look any different than zero minutes past the hour. Most of the children were comfortable working without numbers on the clocks, but a couple wrote in the numbers they needed as they completed each problem (see fig. 5b).

Lesson 4

Today’s activity begins by asking students to investigate the motion and location of the minute hand as it relates to the hour hand. As the children investigated, we continued to refer to the clock hands as the long hand and the short hand until it was time to connect the ideas and practice telling time. We started by asking students to use their individual clock (with hands that maintain the correct relationship), point the shorter hand directly at a number, and then share where the longer hand points. You may want to make a table showing the number for each hand and the resulting time (see table 1). Students should conclude that when the shorter hand points directly at a number, the longer hand points to the twelve and the resulting time is a time on the hour (an o’clock). Similarly, ask students to place the shorter hand halfway between two numbers and ask where the longer hand is pointing. In this instance, students should conclude that the longer hand will point to the six (or thirty) and the resulting times are times on the half hour (the thirties).

Table 1

Sample Chart of Clock Hands and Corresponding Times

<table>
<thead>
<tr>
<th>The shorter hand is pointing directly at</th>
<th>The longer hand is pointing at</th>
<th>The time is</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12</td>
<td>1:00</td>
</tr>
<tr>
<td>5</td>
<td>12</td>
<td>5:00</td>
</tr>
<tr>
<td>8</td>
<td>12</td>
<td>8:00</td>
</tr>
<tr>
<td>3</td>
<td>12</td>
<td>3:00</td>
</tr>
</tbody>
</table>
Next, ask the students to set the time as 2:00 and then to observe what happens when they move the hour hand to 3:00. Be sure that they move the hands correctly (in the clockwise direction). Have them try this with other times that are on the hour or the half hour. After they determine that the minute hand makes an entire revolution around the clock face in one hour, ask them to explain why. Students should realize that one revolution covers sixty minutes and recall that sixty minutes are in one hour.

It is now time for students to synthesize the individual ideas they have been investigating for the last few days and apply them to telling time on a transitional clock with both hands and two sets of numbers. Have students describe some times displayed on a slit clock. Ask which time unit the shorter hand points to. Next, show a clock without numbers. Ask students to determine the number of minutes past the start of an hour and which time unit the longer hand points to. Finally, set a time on a transitional clock. Ask students how to determine the time.

Our class counted the minutes first, then found the hour, and finally combined them, stating the answer in several ways: (1) It is eighteen minutes past the hour. (2) It is after seven o’clock. (3) It is eighteen minutes past seven o’clock. When asked how to write the answer, children responded with both “seven eighteen” and “eighteen seven” until Nicco reminded the class that the hour must always be written first. After his observation, some students switched to identifying the hour first and then counting the minutes past, but others continued to count the minutes first. Both groups seemed to be equally competent at writing the times correctly. After telling a number of times as a class, students practiced with their partners. One partner set a time on the clock, and the other told the time; then they switched roles. We did not identify minutes before the hour with the class, because all our counting on the clocks without numbers was minutes past the hour. However, if students identified a time as minutes before an hour, we did not ask them to change their response.

The investigation ended by asking the children to use their clocks to make times that seemed funny to them and identify the time. Some made random times, but others created times such as one minute after one, two minutes after two, 2:22, 11:11, and so forth.

Beyond the Lesson

Students can create a timeline for their day and then represent the time of various events using slit clocks, transitional clocks, or regular clocks as they progress through the investigation. The investigation could also be enriched by a discussion of impossible times such as 7:82 or 2:61. Similarly, students could be asked to explain why the minute hand cannot point at the six when the hour hand points directly at the three, or why the hour hand cannot be closer to the three than to the four if the time is 3:45.

Reflections

The activities from this investigation can also be used to address times with minutes before the hour. We deliberately omitted the phrases quarter past and quarter of and referred to such times only as fifteen minutes past and fifteen minutes of. The students had just finished a money unit that explained “a quarter” as 25 cents, and we anticipated that they would struggle with a quarter of an hour being fifteen minutes rather than twenty-five minutes. Students have not yet had experiences with different representations of fractions, so we did not attempt to reconcile fifteen minutes with one quarter of a clock face but will return to this concept after we introduce fractions. Similarly, if a class is only telling time to five-minute intervals, all of the activities in this investigation are easily adapted. It is not necessary to wait until the class is ready to tell time to the nearest minute.

This investigation is designed to provide students with a working understanding of time units and their connections to the hands of a clock. It provides opportunities for students to incorporate time concepts into their personal experience. As suggested by Principles and Standards, the activities emphasize the development of “concepts of time and the ways it is measured,” rather than learning just to tell time (NCTM 2000, p. 104).

Bibliography

Activity Sheet 1. Taking Time to Understand Telling Time

REASONABLE UNITS OF TIME

Circle the most reasonable time.
1. A bus ride to school takes
   10 seconds 10 minutes
2. Peeling an orange takes
   2 seconds 2 minutes
3. Tapping your foot once takes
   1 second 1 minute
4. Yawning takes
   4 seconds 4 minutes
5. Telling someone your name takes
   2 seconds 2 minutes
6. Brushing your teeth takes
   55 seconds 55 minutes

Fill in a number to make the sentence reasonable.
1. It takes our class _____ minutes to walk to lunch.
2. It takes me _____ seconds to stand up and push in my chair.
3. It takes _____ seconds to sharpen my pencil.
4. It takes _____ minutes to do our spelling test.

From the November 2008 issue of Mathematics

Activity Sheet 2. Taking Time to Understand Telling Time

PRACTICE COUNTING MINUTES

How many minutes have passed?

1
2
3
4
5
6

From the November 2008 issue of Mathematics