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Research Base

Teachers of mathematics have the dual challenge of managing the varying dynamics of their diverse classrooms as well as increasing student achievement across a wide range of mathematical concepts and skills. In the various mathematical subject areas, the TI-Nspire can be an important tool that teachers introduce to their students in order to meet these challenges. With proper use, handhelds can meet the needs of all students by promoting higher levels of thinking, increasing student performance in mathematics, and allowing access to mathematical exploration, experimentation, and enhancement of mathematical concepts (Waits and Pomerantz 1997). Graphing calculators were first introduced in 1986 by Casio, and they started a dynamic change in the way that mathematics was taught and learned (Waits and Demana 1998). As these tools improved and as researchers studied their effectiveness in mathematical instruction, well-known mathematical organizations, such as the National Council of Teachers of Mathematics (NCTM), have recommended that appropriate types of calculators be used in mathematics instruction from kindergarten through college (NCTM 2000).

The TI-Nspire is the next step in handheld technology. It dynamically links spreadsheets, graphing environments, geometry settings, and symbolic expressions, allowing students to take meaningful actions on mathematical objects and immediately see the consequences of those actions (Burrill 2008). Students can interactively study the relationships between the graph of a function, the equation of the function, and a table of values on the same screen. They can also manipulate circles, triangles, and quadrilaterals, automatically transfer measurements to a coordinate grid and spreadsheet, and then investigate the geometric properties algebraically. The handheld includes many features that allow students to learn and use accurate mathematical expressions. TI-Nspire technology allows more effective linking of key mathematical expressions, allowing students to grasp mathematical concepts more readily with deeper understanding (SRI International 2006).

However, this tool will not achieve the lofty goals that educators have for student success all by itself. It is not enough to simply provide students with technology. Teachers need access to effective, research-based strategies so that they can provide for comprehensive mathematics instruction while using the technology (NCTM 2003).

TI-Nspire Strategies: Geometry offers the foundation that teachers need to translate the use of the TI-Nspire into actual student comprehension of mathematical concepts, as well as the ability to perform mathematical skills. With the lessons provided in this book, teachers are given valuable techniques for integrating the TI-Nspire into their instruction. *TI-Nspire Strategies: Geometry* directs teacher instruction in maximizing student use of the handhelds while processing and learning geometrical concepts.

The lessons in this book are designed to give new and veteran teachers the best strategies to employ. How well students understand mathematics, their abilities to use it to work out problems, and their confidence and positive attitudes toward it are all shaped by the quality of teaching they encounter in school (NCTM 2005). Teachers no longer have to construct well-planned handheld lessons unaided. Besides lesson descriptions and materials lists, this book offers step-by-step instructions for four key instructional phases: Starting the Lesson,

Research Base (cont.)

Explaining the Concept, Applying the Concept, and Extending the Concept. Each phase has an easily identified title heading.

The *TI-Nspire Strategies: Geometry* lessons move students from the concrete understanding of mathematical concepts through the abstract comprehension level and on to real-life application. At the same time, they allow students to develop skill in the use of the handheld. For teaching to be effective in a mathematics classroom, it is necessary to provide focused instruction that moves the student from the concrete to the abstract to the application of the concept (Marzano 2003). The TI-Nspire technology can build on conceptual understanding by allowing students to dynamically interact with numerous representations of concepts and experiences in a way that is not possible with paper and pencil alone. As a result of this technology, teachers are able to engage students more effectively by addressing different learning styles and developing understanding that leads to higher-level thinking.

In the Starting the Lesson section, students are reminded of important button-pushing sequences on the handheld that they will use throughout the lessons. In the Explaining the Concept activities, students move toward abstract understanding. The lessons offer guidance in directing the students to practice using their handhelds and improving their skill levels. The Applying the Concept and Extending the Concept sections bring the students to the real-life applications and further practice. As students move through each phase of learning, they are exposed to a concept or skill numerous times.

Per research, students should have multiple experiences with topics, allowing them to integrate the topics into their knowledge base (Marzano 2003). Overall, the challenging and interesting tasks found in application problems help teachers engage students in learning as they actively apply their knowledge (Seely 2004). As a result, students take ownership of new strategies and gain greater understanding of the ideas and concepts. Through the lesson extension ideas and the activity sheets, the students gain ample opportunities to practice. This is important because students need to have extra time to process concepts and look at problems in different ways (Sutton and Krueger 2002).

Many teachers dread handheld use because of the classroom management issue; however, with proper use, handhelds allow teachers to spend more time developing mathematical understanding, reasoning, number sense, and application (Waits and Pomerantz 1997). These lessons help teachers respond to that concern by including an introduction with easy-to-follow tips for differentiating the lessons, grouping students, managing the handhelds in the classroom, planning the integration of these lessons with standards-based curriculum, and using the handhelds in activity centers. The skills reinforced throughout *TI-Nspire Strategies: Geometry* teach multiple representations of mathematical concepts so that students thrive in the mathematics classroom.

Midpoint of a Line Segment

Mathematics Objectives

- Students will analyze relationships to define *midpoint of a line segment*.
- Students will recognize that the distance to the midpoint is half the distance between the endpoints and connect this knowledge to the formula for midpoint.
- Students will use coordinates of the endpoints to find the coordinates of the midpoint for a line segment and understand that the midpoint bisects the segment.

Applications and Skills

Graphs and Geometry
Constructing segments
Measuring

Lists and Spreadsheet
Manual data capture

Calculator
Midpoint

Materials

- TI-Nspire handhelds
- TNS file: lesson01.tns
- *Midpoint Investigation* (pages 37–38; page037.pdf)
- *Terrific Triangle* (page 39; page039.pdf)
- *Understanding Midpoint* (pages 40–41; page041.pdf)

Starting the Lesson

After loading the TNS file (lesson01.tns) on each handheld, begin the exercise by instructing students to do the following.

1. Turn on the TI-Nspire by pressing (off on).
2. Press (home) and choose **My Documents**.
3. In the folder *Geometry TCM*, choose *lesson01*.
4. Remind the students how to navigate through the TNS file. To move forward through the pages, press (ctrl) ▶. To move backward through the pages, press (ctrl) ◀. To choose a particular page, press (ctrl) ▲, position the cursor on the desired page, and press (enter). To undo previous steps, press (ctrl) (Z) or (ctrl) (esc). Show students that any time they are using a menu that they wish to exit, they should press (esc).

Note: *Page numbers refer to the TI-Nspire file lesson01.*

Explaining the Concept

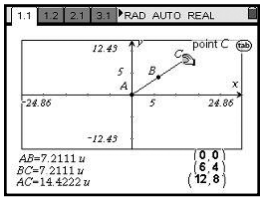
Problem 1—Midpoint Investigation

Step 1 Distribute copies of *Midpoint Investigation* (pages 37–38) to students, and have them open page 1.1.

Step 2 Explain to students that the graph shows $\overline{AC}$ with midpoint B, the coordinates for each point A, B and C, and the lengths of each segment $\overline{AB}$, $\overline{BC}$, and $\overline{AC}$.

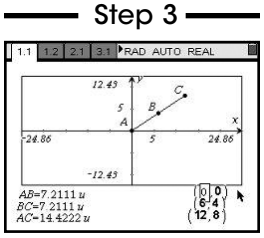
Step 3 Tell students that there are two methods to manipulate endpoints A and C.

Step 3



The first method is to drag either point. To drag a point, tell students to use the NavPad to hover over the point with the cursor (↖). When the cursor turns into an open hand (✋), press and hold (ctrl) and the hand closes (✊), grabbing the point. Next, tell students to use the NavPad to move the point. When students are ready to release the point, they must press (esc).

Step 3



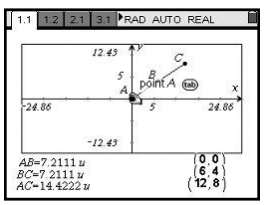
The second method for moving the points is to change their coordinates. To do this, tell students to move the cursor (↖) over the *x*-coordinate for point A. When the coordinate blinks, tell students to press (ctrl) two times quickly to make it editable. A text box and cursor (I) will appear, and the students must press (clear) to clear the number in the text box. Instruct students to type a new number in the box and press (enter) to secure the change.

Teacher Note: The coordinates for point B cannot be manipulated because they are constructed as a dependent of points A and C.

Step 4 Allow students to examine the lengths of $\overline{AB}$, $\overline{BC}$, and $\overline{AC}$ in the graph on page 1.1. Have them drag points A and C and continue to study the lengths. Then, allow students to answer questions 1 and 2 on their activity sheets.

Step 5 For question 3, instruct students to place point A at (0, 0) and point C at (12, 8) by using either method described in step 3. Allow them to record the coordinates of these points and the midpoint B in the table on their activity sheets.

Step 5



Midpoint of a Line Segment *(cont.)*

Note: *Page numbers refer to the TI-Nspire file lesson01.*

Explaining the Concept *(cont.)*

Problem 1—Midpoint Investigation *(cont.)*

Step 6 Next, have students drag point A into quadrant I so that all three points are in quadrant I and record the information in the table on their activity sheets. On their own, students should selectively place points A and C anywhere in the plane and record three more entries in their tables for question 3.

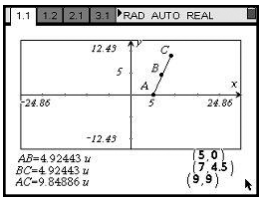
Step 7 Instruct students to complete question 4 on their activity sheets in pairs.

Step 8 Lead a discussion about students' conjectures from question 4.

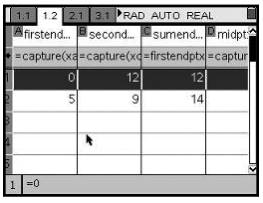
Step 9 Have students press (ctrl) ▶ to tab to page 1.2 and look at the spreadsheet. Tell them that this spreadsheet will allow them to determine the relationship between the coordinates of the endpoints and the coordinates of the midpoint. Discuss the components of the spreadsheet. Columns A and B are set up to capture the *x*-coordinates of the endpoints. Column C finds the sum of the *x*-coordinates as they are captured, and column D captures the *x*-coordinate of the midpoint.

Step 10 Show students how to add 20 rows of data to their spreadsheets. To add data to the spreadsheet, press (ctrl) ◀ to tab back to the graph on page 1.1. Tell students to manipulate endpoints A and C to coordinates they wish to capture using either method in step 3. Once the points are in the desired place, have students press (ctrl) (.) to capture the data. Instruct students to complete this procedure 20 times. Have students return to the spreadsheet on page 1.2 by pressing (ctrl) ▶ and observe that the data was added.

Step 10



Step 10



Step 11 Now, have students answer questions 5–7 on their activity sheets.

Step 12 Tell students that, to answer question 8, they need to view columns E, F, and G on page 1.2, which are set up to capture the *y*-coordinates of the endpoints and the midpoint. Tell students that those columns can be accessed by using the right arrow (▶) on the NavPad. Now, have students answer question 8.

Note: *Page numbers refer to the TI-Nspire file lesson01.*

Explaining the Concept *(cont.)*

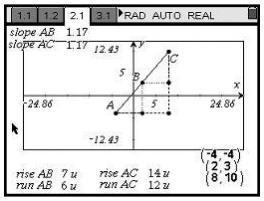
Problem 2—Terrific Triangle

Teacher Note: You may need to support students' thinking about the relationship between rise and run and finding the midpoint. It will be challenging for students to write explanations about this relationship.

Step 1 Distribute copies of *Terrific Triangle* (page 39) to students so that they can record their findings. Have students press ctrl ▶ to tab to page 2.1.

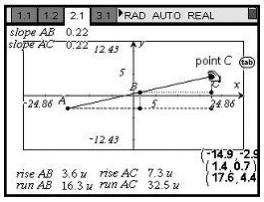
Step 2 Tell students that the graph shows $\overline{AC}$ with midpoint B, the coordinates for each point A, B, and C, and the slopes for $\overline{AB}$ and $\overline{AC}$. It also shows the rise and run for $\overline{AB}$ and $\overline{AC}$.

Step 2



Step 3 Instruct students to examine the measurements given for the rise and run of $\overline{AB}$ and $\overline{AC}$. Have students drag points A and C to observe how the rise and run of $\overline{AB}$ and $\overline{AC}$ change. To do this, have each student use the NavPad to hover the cursor (↖) over point A. When the cursor turns into a hand (☜), instruct students to press and hold ⬤ until the hand closes (✊) and grabs the point. Tell students to use the NavPad to move the point. When they want to release it, remind them to press esc.

Step 3



Step 4 Instruct students to answer all of the questions on their activity sheets.

Applying the Concept

Problem 3—Understanding Midpoint

Step 1 Conduct a class discussion of the key points from problems 1 and 2. Of particular note should be defining midpoint, the relationship between the sum of the x-coordinates of the endpoints and the x-coordinate of the midpoint (also for the y-coordinate), and the idea that to find the midpoint you travel half the rise and half the run from one endpoint to another.

Midpoint of a Line Segment *(cont.)*

Note: *Page numbers refer to the TI-Nspire file lesson01.*

Applying the Concept *(cont.)*

Problem 3—Understanding Midpoint *(cont.)*

Step 2 Distribute copies of the *Understanding Midpoint* (pages 40–41) activity sheet, and have students press ctrl ▶ to tab to page 3.1.

Step 3 Tell students that page 3.1 is a calculator page and can be used for any calculations they need to perform to complete the activity sheet.

Differentiation

- **Below Grade Level**—Have students work the problems in pairs. Once pairs are finished, allow them to form groups of four and discuss their answers. If a group cannot come to consensus on a particular answer, spend time explaining the correct answer to that group.
- **Above Grade Level**—Have students complete only questions 4–6 on the activity sheet. Then, have students pair up, and instruct pairs to write their own real-world problems where finding the midpoint is used.

Extending the Concept

- Find midpoints of segments forming polygons in a coordinate plane.
- Examine points along a perpendicular bisector for a segment to determine that, though they are all equidistant from the endpoints of the segment, the midpoint is the shortest distance from the two endpoints.

Name _____

Midpoint Investigation

Directions: Follow the steps below. The page numbers refer to the TI-Nspire document *lesson01*.

1. Look at the graph on page 1.1. Drag points A and C to investigate the lengths of $\overline{AB}$, $\overline{BC}$, and $\overline{AC}$. Describe the relationships between the lengths of the segments.

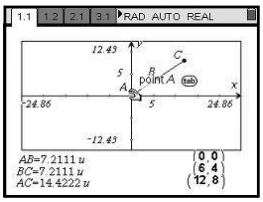
_____

_____

_____

_____

Step 1



2. What does the midpoint B do to $\overline{AC}$? How would you define *midpoint*?

_____

_____

_____

_____

_____

_____

3. Manipulate points A and C on page 1.1 to record five entries below.

Column A	Column B	Column C	Column D	Column E	Column F	Column G
Point A *x*-coordinate	Point C *x*-coordinate	Sum of *x*-coordinates	Midpoint *x*-coordinate	Point A *y*-coordinate	Point C *y*-coordinate	Midpoint *y*-coordinate