A9 – Teaching Algebra Using Cabri Jr. on the TI-84
(Activities created by C. Vonder Embse, NCTM Annual Meeting, 2006)

Equations of Lines

1. Construct:
   a. Open a new Cabri Jr. figure. Use the Hide/Show tool on the F5 menu to show the coordinate axes on the screen. Drag the origin to the center of the screen.
   b. Use the Line tool to draw a line in the plane such that it is not attached to the axes. (Figure 1a). (Note: A line is defined by two points; do not place either of these points on the axes when the line is first defined.)
   c. Drag one of the defining points of the line so that it is on the y-axis. (Figure 1b)
   d. Using the Coord. & Eq. Tool on the F5 menu, show the equation of the line and the coordinates of the point on the y-axis. Use the Slope tool on the Measure submenu of F5 to measure the slope of the line. (Figure 1c) The slope measurement can be labeled using the Alpha/Num tool on F5.

2. Investigate: The object of this investigation is to discover the relationships between the equation of the line, its slope, and its y-intercept.
   a. First, drag the defining point of the line, the one that is not on the y-axis, anywhere in the window. (Figure 2a)
   b. Second, drag the line by grabbing it anywhere other than one of its defining points. (Figure 2b)
   c. Third, drag the defining point on the y-axis up and down this axis only. (Figure 2c) As each aspect of the line is dragged, observe the changes in the equation, slope, and y-intercept. Make a general statement about the relationships you discover.
Parallel Lines
3. **Construct:**
   a. Use the **Point** tool on the **F2** menu to construct a point on the y-axis.
   b. Use the **Parallel** tool to construct a line through this new point parallel to the original line.
   c. Show the coordinates of the new point and the slope and the equation of the new line. (Figure 3)

![Figure 3](image)

4. **Investigate:**
   a. Drag the original line as in the previous investigation (3 ways).
   b. Drag the new line by its y-intercept.
   c. Explain any relationships you discover between the two lines, their slopes, and their y-intercepts.

Perpendicular Lines
5. **Construct:** First erase the parallel line constructed in the previous step by using the **Clear Objects** tool on **F5** to erase the point on the y-axis used as its y-intercept. Other items associated with this line, such as the measurements and the equation, will also be erased since they are dependent objects.

   a. Construct a point anywhere on the original line other than existing points.
   b. Use the **Perp.** Tool to construct a line through this point perpendicular to the original line.
   c. Measure the slope and equation of this new line. (Figure 4)

![Figure 4](image)
6. **Investigate:**

   a. Drag the original line in 3 ways.

   b. Drag the perpendicular line by the point on the original line.

   c. Explain any relationships you find between the slopes and equations of the two lines.

   d. Why is one slope positive and the other negative? Explain. Is this always true? Explain or give a counter example.

   e. Use the **Calculate** tool on **F5** to multiply the two slope values. Explain any patterns you see as you drag the lines around the screen.

**Horizontal Lines**

7. **Construct:** Use the **Clear Objects** tool on **F5** to clear the point constructed on the original line. This will erase the perpendicular line and all measurements related to it since they are dependent on the existence of the point cleared. At this point, only the original line, its slope, y-intercept, and the equation should be showing on the screen.

   Drag the point not on the y-axis until the line is horizontal. (Figure 5)

![Figure 5](image)

8. **Investigate:** Grab the line by its “body” and drag the line up and down the screen. Explain what happens to the equation, slope, and the y-intercept of the line in this position.
Vertical Lines

9. **Investigate:**
   a. Drag the point that has been on the y-axis so that it is now on the x-axis.
   b. Drag the other point that defines the original line so that the line becomes vertical. (Figure 6)
   c. Grab the “body” of the line and drag it left and right. Explain what happens to the equation, slope, and intercept of the line in this position.

Lines in a Plane

1. **Construction of figure LINES:**
   a. Get a new screen. Use the Hide/Show tool to show coordinate axes. Draw a horizontal segment in the lower portion of the screen. (Figure 7a)
   b. Construct a Point on the y-axis. Use the Compass tool to construct a circle centered at the point on the y-axis with the radius of the first segment drawn.
   c. Draw a Line from the center of the circle to a point on the circle such that the line goes off to the upper right of the screen. (Figure 7a)
   d. Drag an endpoint of the segment to enlarge the circle and place the point on the circle further out on the line. Hide the circle and the segment. (Figure 7b)

2. **Slope Investigation:**
   a. Construct two points on the line and label them points A and C as shown in Figure 7c. Do not use the points defining the line as either point A or C.
   b. Construct a line perpendicular to the x-axis through C by selecting the x-axis first and then the point. Construct a second line perpendicular to the y-axis through A. Label the intersection of these two lines point B. (Figure 7c)
c. Draw segments AB and BC. Hide the perpendicular lines. (Figure 7d)

d. Measure the length of segments AB and BC.

e. Use the **Calculate** tool from the **F5** menu to compute the value of the ratio \( \frac{BC}{AB} \). (Figure 7d)

f. Drag point C (or A) along the line to change the lengths of the legs of the right triangle ABC. Is there any variation in the value of the ratio? Explain.

g. Drag the second point defining the line (upper right portion of the screen) around the screen. Explain what happens to the ratio \( \frac{BC}{AB} \) as you drag the line so it rotates around the point on the y-axis (the y-intercept).

h. The ratio \( \frac{BC}{AB} \) is the ratio of \( \frac{\text{Change in y coordinates}}{\text{Change in x coordinates}} \) and is called the slope of the line. Use the **Slope** measurement tool from the **F5** menu to compute the slope of the line. (Figure 7e)

i. Explain how the slope of the line compares to the ratio \( \frac{BC}{AB} \) as the line rotates around the y-intercept. Are these two values always equal? Explain.

j. Drag points A and C and explain how the slope is affected and why.
3. **Slope and Equation of the Line:**
   a. Using the **Coord. & Eq.** tool from the **F5** menu, compute the equation of line AC. Explain how this compares to the ratio $\frac{BC}{AB}$ and the slope as you rotate the line around its y-intercept. (Figure 8a)
   
   b. Show the coordinates of the y-intercept of the line. How does dragging the y-intercept change the equation? (Figure 8b)
   
   c. Explain the relationship between the equation of the line, the coordinates of the y-intercept, and the slope of the line as the line is rotated and translated.

4. **Slope Investigations:**
   a. On a new screen with the coordinates axes showing, construct a line through the origin extending through the first quadrant. Measure the slope and show the equation of this line.
   
   b. Rotate the line around the origin and observe the value of the slope in various positions. When is the value of the slope positive and when is it negative?
   
   c. When does the slope have a large absolute value and when does it have a small absolute value? When is the slope zero? When is it one? When is it infinitely large?
   
   d. Determine a way to organize the different slope values so you can quickly estimate the slope of any line.
5. **Parallel and Perpendicular Lines:**
   a. Open a new screen and show the coordinate axes. Draw a line with a y-intercept and extending through the first quadrant. (Figure 9a)
   
   b. Using the **Parallel** tool, construct another line parallel to the first line with its defining point on the y-axis. [Note: when using the **Parallel** tool, select the line first and then place the defining point on the y-axis.] (Figure 9a)
   
   ![Figure 9a](image1)
   
   ![Figure 9b](image2)
   
   c. Use the **Slope** tool to compute the slopes. Use the **Coord. & Eq.** tool to compute the equations of both lines. Drag the original line and make a conjecture about the slopes of parallel lines.
   
   d. Delete the defining point for the parallel line (which will delete the line as well). Use the **Perp.** tool to construct a perpendicular line at any point on the original line. (Figure 9b)
   
   e. Use the **Slope** tool to compute the slope and the **Coord. & Eq.** tool to compute the equation of the perpendicular line. (You should already have the slope and equation of the original line.) Drag the original line and make a conjecture about the slopes of perpendicular lines.
   
   [Helpful hint: use the **Calculate** tool to compute the product of the slopes of the two lines.]

6. **Midpoints & Means**
   
   **Construction of figure AMIDPT:**
   a. Open a new Cabri Jr. figure and use the **Hide/Show** tool on F5 to show the coordinate axes. Using the **Line** tool on F2 draw a line across the screen from lower left to upper right. Label the two defining points of this line as points A and B.
   
   b. Construct the midpoint between A and B using the **Midpoint** tool on the F3 menu and label this point M. Display the coordinates of points A, B, and M and the equation of line AB using the **Coord. & Eq.** tool on F5. (Figure 10)
   
   c. Drag point A to the location (1, –1) and B to the location (5, 3). (Figure 10)
7. **Investigate:**

   a. Drag points A and B around the screen. As they move to different locations, make and test a conjecture about the coordinates of point M in relationship to the coordinates of points A and B. [Note: You may wish to display 2 decimal places of accuracy for this activity. With the dragging arrow active, point5 at a coordinate display and press the [+] key to display more accuracy.]

   b. Make up a formula that you can use to find the coordinates of the midpoint between any two points in the plane. Test your formula for several different positions of points A and B.

8. **Construct:**

   a. Using the **Parallel** tool on **F3**, construct lines through points A and M parallel to the x-axis. Through points M and B, construct lines parallel to the y-axis. (Figure 11a) [Note: the parallel lines in Figure 11a are shown as dotted lines by using the **Display** tool on **F5**.]

   b. Use the **Triangle** tool on **F2** to overlay the right triangles formed by these parallel lines with AM and MB as the hypotenuses of the respective triangles. (Figure 11b)

   c. Hide the parallel construction lines leaving only the line AB and the two right triangles showing on the screen. (Figure 11c)

   d. Drag points A and B around the screen. Make and test a conjecture about the relationship between the two right triangles. Explain why this must be true.
9. **Investigate:**
   a. Write down the equation of the line from the Cabri Jr. screen. (Figure 12a)
      Quit Cabri Jr. ([2nd] [QUIT] or Quit from the F1 menu.)
   b. Enter your equation on the Y= menu. (Figure 12b) Select the TBL SET menu.
      ([2nd] [WINDOW]) to set TblStart = 0 and ΔTbl = 1. (Figure 12c) Build a table
      of function values using the TABLE tool ([2nd] [TABLE]). (Figure 12d)
   c. Scroll up and down the table of function values. Explain how these values
      support your coordinate investigation in #7 above and your geometric
      investigation in #8d above. To help see and explain patterns, change the
      TblStart and ΔTbl values on the TBL SET menu (Figure 12e) and then rebuild
      your table (Figure 12f).

![Figure 12a](image1)
![Figure 12b](image2)
![Figure 12c](image3)
![Figure 12d](image4)
![Figure 12e](image5)

10. **Arithmetic Mean:** The arithmetic mean \( \bar{x} \) (read x-bar) of two numbers a and b is
    defined as \( \bar{x} = \frac{a+b}{2} \). Explain how this idea is represented in the geometric,
    algebraic, and coordinate representations from your previous investigations.
From the desk of Mr. Koestler...

Algebra and Geometry Come Alive with Cabri Jr.

I²T² Project

Year 7 -2006

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Lesson 1

OBJECTIVES: To be able to practice some of the basic functions of the Cabri Geometry software, including the use of the pointer, Point, Line, Measure, and Construct toolbars; to be able to select tools and options from a set of menus.

A. Installing Applications (Apps) Onto your TI84+.
   * Cabri Jr. Commands

B. Cabri Jr. Tool Guide.
   * Cabri Jr. Cursors

   * F1 File Menu
   * F2 Creation
   * F3 Construction
   * F4 Transformation
   * F5 Appearances

D. Cabri Geometry Tour.
   * Create Points; Intersecting Lines;
   * Create Angles; Measure Angles; Bisect Angles.
   * Create Parallel Lines; Perpendicular Lines.
   * Create and label a Triangle.

E. Simple Constructions.
   * Parallelogram.
   * Triangle altitude, angle bisector, and median.
   *** Slope and Area of Triangles.
Lesson 2

OBJECTIVES: To be able to investigate the sum of the angles of a triangle; to investigate the relationship between an exterior angle and the interior angles of a triangle; to investigate the relationships that exist in similar triangles.

A. Angles of Triangles Activity.

1) Find the sum of the measures of the three interior angles.
2) Find the measure of the third exterior angle.
   * $A + B + C = ???^\circ$  $360^\circ - 112^\circ - 122^\circ = ???$

B. Triangle Inequality Theorems.

1) Make a conjecture about the relationship between the measure of an angle and the length of the side opposite that angle.
C. Similar Triangles and Proportions.

1) Make a conjecture about the ratios.

*** Exploring the Incenter, Circumcenter, Orthocenter, and Centroid.

Lesson 3

OBJECTIVES: To learn to use the Transformations (F4) tool on Cabri Jr.

A. Transformations.

* Rotations in the Plane.

* Dilations in the Plane.

* Reflections in the coordinate Plane.
* Translations in the coordinate Plane.