

## **Exemplar 4: Graphical Representation of Linear Equations**

**Learning Dimension:** Number & Algebra

**Learning Unit:** Linear Equations in Two Unknowns

**Key Stage:** 3

**Objective:** To explore the graphical representation of linear equations in 2 unknowns with the help of IT tools

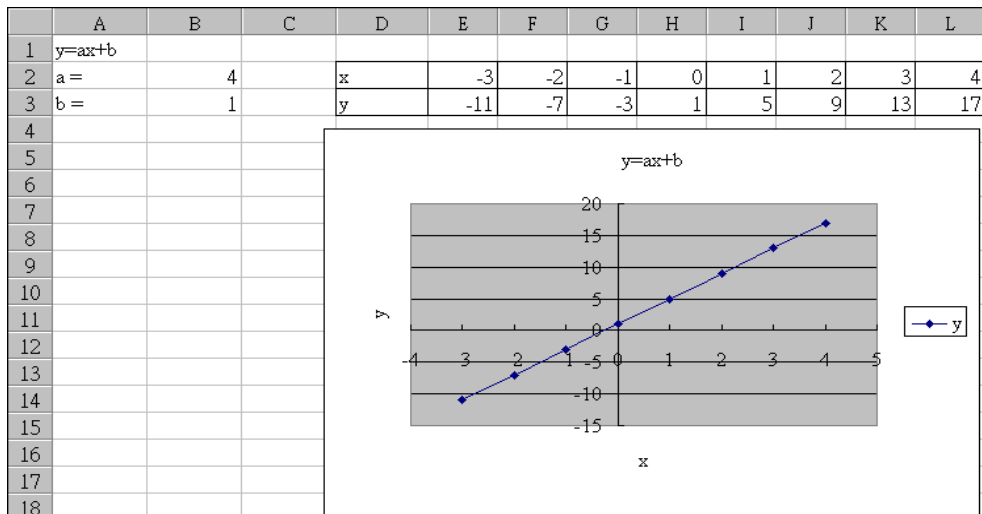
**Prerequisite Knowledge:** (i) Using paper and pencil to plot graphs of simple linear equations in 2 unknowns  
(ii) Basic manipulation skills using the hardware and spreadsheet software or graphing calculators

**Teaching Resources:** Spreadsheet software such as EXCEL or graphing calculators

### **Description of the Activity:**

1. After asking students to plot the graph of the simple linear equations with paper and pencil, the teacher can then ask students to explore graphs of different linear equations with the software EXCEL or with graphing calculators.
2. The following worksheet is prepared. A brief explanation of the set-up of the worksheet is given. It includes:
  - the set-up of cells A1, A2, A3 for the text of the equation name and the values for a and b;
  - values of x to be keyed in or pre-set in the worksheet;
  - values of a and b to be keyed in;
  - the definition of y from the corresponding values of x.

Besides the algebraic language, the teacher may introduce the definition of y in EXCEL language.

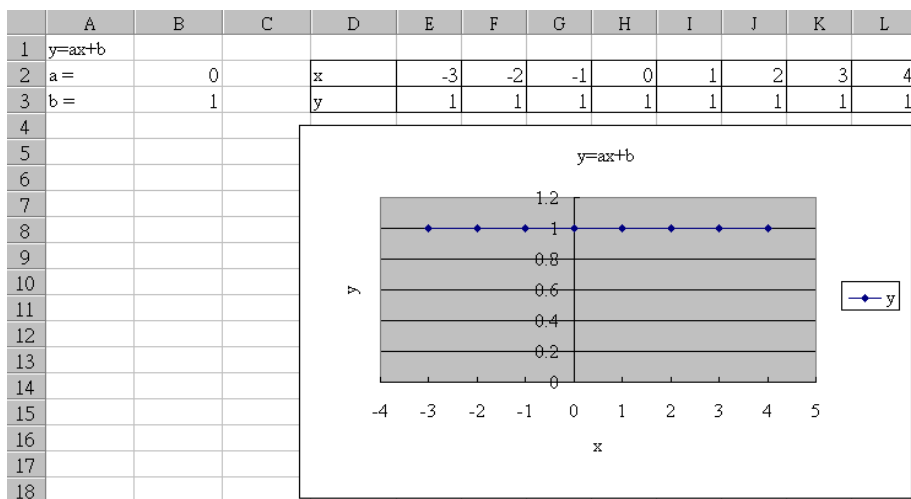


3. Students are asked to explore graphs of different equations in the following categories:

- Set  $b=0$  and explore the shape of the graphs of  $y = ax$  by changing values of  $a$ .
- Set  $a=1$  and explore the shape of the graphs of  $y = x + b$  by changing values of  $b$ .
- Set  $b$  to any constant values and explore the shape of the graphs of  $y = ax + b$  by changing values of  $a$ .

Students are asked to contrast the steepness and the intercepts of the resulting graphs.

Discussion on the graphs of these categories of equations can then be held.

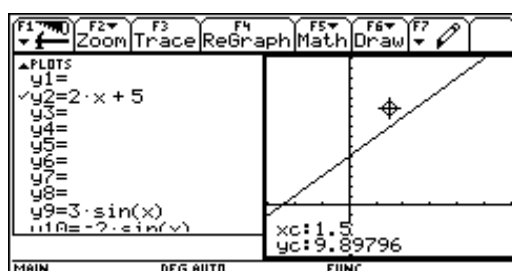


### Notes for Teachers:

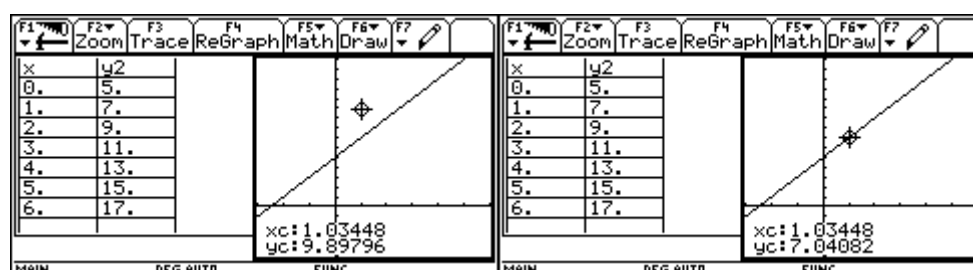
1. The teacher can prepare the worksheet prior to the lesson so that students can spend more time exploring graphs of different equations. The steps in preparing the worksheet are as follows:

- Define A1 as " $y = ax + b$ ".
- Define A2 as "a=", A3 as "b=", D2 as "x" and D3 as "y".

- Key in values of cells B2 and B3 as 0 and 1 respectively.
  - Key in  $-3, -2$  to the cells E2 and F2 and then copy these to other cells in the row.
  - Define the values of y in the cell E3 as “ $=\$B\$2*\$E\$2+\$B\$3$ ”.
  - Copy this definition to other cells of y. The values of y will be generated automatically by the software.
  - Highlight values of x and y and then use the SCATTER LINE GRAPH graphing facility to draw the graph.
2. Other graphing software such as WinPlot.exe, which can be downloaded from the Internet, can be used to serve a similar purpose. Keying the equation into the software will allow the students to draw the graph. Alternatively, some graphing calculators also provide such facilities. EXCEL is used for this demonstration because of its availability in most schools. Its facility in showing tables and graphs of different equations on one screen is an advantage to facilitate students to visualize the change of equations on the numerical and graphical values simultaneously. Below are some examples using graphing calculators in the exploratory activity. Students can use the TRACE function built into the graphing calculators to explore points on the line and the relation of the coordinates of the points with reference to the equation.



Students then observe the coordinates of points not lying on the straight line and compare the coordinates with those on the straight lines.



The teacher should remind students of the problems they will encounter when tracing the coordinates of the points on the straight line. (e.g. It is not easy to “trace” a point on the

straight line and  $y$  does not equal  $ax+b$  exactly, due to rounding error.)

3. Students familiar with the EXCEL platform can set up their own worksheet. They can design their own styles of graphical presentation and tabular representations. The program is then no longer a black box to students. The definition of  $y$  also enhances students' understanding of the concepts of variables and constants.
4. The program can be modified to have the tables and graphs of 2 equations (or more) appear simultaneously on one screen. This helps students compare the graphs of different equations.
5. After this activity, students are expected to recognize that
  - the shape of a linear equation in 2 unknowns is a straight line;
  - the line with the equation  $y = ax$  passes through the origin and the inclination of the line depends on the values of  $a$ ;
  - the equation of  $y = b$  is a straight line parallel to the  $x$ -axis;
  - the value of  $b$  is the  $y$ -intercept of the equation  $y = ax + b$ .

This exemplar mainly involves the following generic skills:

1. Information Technology Skills
  - Use computer software EXCEL or graphing calculators to carry out the exploratory activities
2. Numeracy Skills
  - Use different values of  $a$  and  $b$  for  $y = ax + b$  to investigate the effects of changes in these values on the shape of the graph
  - Observe the graph and estimate the values of  $b$
3. Critical Thinking Skills
  - Compare the values used for  $a$  and  $b$  in  $y = ax + b$  and note the effects of the changes in these numbers on the shape of the graph and draw conclusions about their findings in discussion
4. Problem-solving Skills
  - Explore the first part of the problem (i.e. by setting  $b = 0$ ) following the procedures suggested in the exemplar
  - Adjust the strategy of exploration, for example, using ascending numbers or descending numbers.

- Plan and adopt an appropriate strategy by designing their own styles of graphical presentation and tabular representation

**Remark:** At present, teachers quite often use a graph board or overhead transparency to illustrate the graphs of linear equations in two unknowns. However, these are not effective methods as only a few equations can be drawn in a lesson and it is not flexible enough for students to do explorations. The following merits can be obtained with the use of IT:

- A great variety of graphs can be shown within seconds
- It allows students to propose their own equations and make guesses at the shapes of the graphs
- With the numerical (tabular), graphic, and algebraic representations of the equations shown on one screen, students can see the changes in the numerical and graphic forms of the equations simultaneously whenever there is a change in the algebraic form. This presentation facility can help students build up a stronger sense of the meaning of algebraic forms of equations