Curriculum Unit on Linear Relationships for Juvenile Corrections Teachers

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These supplemental materials for teaching the slope-intercept form of linear relationships builds on recommendations from juvenile corrections education literature identified in the accompanying project narrative. Contents include five self-contained lessons with supporting resources and teacher notes.
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Overview

Why Linear Relationships?

The purpose of this curriculum unit is to provide materials that assist instructors of students in correctional facilities as well as teachers with a high proportion of students with learning and/or emotional/behavioral disorders as they work to teach linear relationships. The format is based on a review of literature, and the materials are designed to be shared freely on the internet, and modified by instructors as needed.

- Please see the accompanying Project Narrative for more information on the development of these materials.

Lesson Format

The lessons in this project are organized around principles of instruction that can help maximize students’ opportunities to master linear relationships in the context of a typical juvenile corrections school setting. The lessons include the following components:

- Pre-Assessments – provides formative information on where students are at before you begin teaching the lesson content.
- Cooperative Activities – helps students to master and retain the concepts and skills needed for using linear relationship skills over a long period of time.
- Technology – emphasizes graphing calculators to assist students to check their work and see multiple ways of representing and solving linear relationship problems.
- Guided Practice – provides additional exercises on core skills to help students to remember procedures.
- Assessments – give information to the instructor and students about which skills have been mastered, and which may need additional instruction and/or guided practice.

Scope & Sequence of the Lessons

Lesson 1 teaches the basic vocabulary on linear equations and graphing equations. Recommended instruction includes both direct instruction/lecture and cooperative activities.

Lesson 2 teaches how to find the x- & y- intercepts of a linear relationship. Recommended instruction includes starting with graphs, connecting graphs with equations, and eventually requiring students to graph equations by identifying the x- and y-intercepts.

Lesson 3 teaches how to find and interpret the slope of a line. Recommended instruction includes direct instruction/lecture, followed by guided practice on the slope formula, and graphical interpretations of slope.

Lesson 4 teaches the standard form and point-slope form of linear relationships. Recommended instruction will include both direct instruction/lecture and cooperative activities, and will include graphing lines and listing tables of values for linear relationships.

Lesson 5 teaches multiple representations of linear relationships using structured formats, including Walbey’s Table, Walbey’s List, and a Linear Function Web. It will be taught through lecture, cooperative activities, and one on one tutorials with the teacher.
Suggested Duration of the Lessons

This unit is designed to be completed over an 11-17 week time period for a math class of mixed-aged & mixed-ability students in a juvenile corrections center which meets 50 minutes, five days a week. Depending on individual students' backgrounds and prior performance, you may need more or less time to cover the content.

Note: Several of the lessons can be completed in a different sequence, and some students may be able to show mastery without completing all of the instructional materials in each lesson.

- Lesson 1  1-2 weeks   stand alone
- Lesson 2  2-3 weeks   builds on Lesson 1
- Lesson 3  2-4 weeks   stand alone
- Lesson 4  2-3 weeks   stand alone
- Lesson 5  4-5 weeks   builds on Lessons 1, 2, 3, 4
Lesson 1: Vocabulary of Lines & Graphing

_Laying the Foundation_

This lesson includes a pretest on graphing linear equations which teachers can use to understand their students' prior knowledge. There is also an introduction to some of the technical words students will need to know when describing linear relationships.
Pre-Assessment

Three assessments (on vocabulary, graphing without calculators, graphing with calculators) can be administered to see how much information your students have acquired from previous school years.

Activity

Part I: Vocabulary

Cooperative Activity
Have the students put their vocabulary words on index cards in big letters. Also, draw pictures or diagrams on different color on cards. Your students can be in groups of about 4. Give those groups instructions about what you want them to do. After about 15 minutes, each group will choose a speaker to answer your questions concerning the card game.

Part II: Graphing Equations

Technology Usage
Each student should be able to graph equations no matter which form the equation or function is given; therefore, they will be given a pretest on graphing equations without using the graphing calculator. If needed the teacher will reteach this skill and reassess the students.

Guided Practice
Practice sheets will be given on one day where the students will not be allowed to use the calculator, and the other day, they will be allowed to use the graphing calculator. Use cooperative learning techniques with these activities sheets because students will retain the skills which you want them to learn better.

Assessments

Administer another assessment to see if there is any growth, when you achieve about 85% of your students passing with above 80%, you can go on to the next lesson.

Duration

You will be on lesson 1 for about 1-3 weeks. It depends how weak your students are in their skills and after you assess them. It really depends how you feel as their instructor if they can go on to next lesson or not.
Pretest on Graphing Equations without a Calculator

Instructions: Complete the following by yourself without the help of a graphing calculator.

Graph the following equations on graph paper. Label each graph with the equation number.

1) \( x - y = 5 \)

2) \( x + y = -8 \)

3) \( y = -2x - 7 \)

4) \( y = 3x + 2 \)

5) \( 2x - y = 6 \)

6) \( 4x + 2y = 8 \)

7) \( x + 3y = 9 \)

8) \( 3y = 6x - 9 \)

9) \( 10x - 2y = 20 \)

10) \( 6x = -4y - 12 \)
Pretest on Graphing Equations with a Calculator

Complete the following by yourself with the help of a graphing calculator.

Graph the following and draw the graphs on graph paper. Label each graph with the equation number.

1) \( x - y = 9 \)

2) \( x + y = -6 \)

3) \( x = 7y - 14 \)

4) \( 2y = 6x - 8 \)

5) \( 10y = 20x - 40 \)

6) \( -3x - 4y = 12 \)

7) \( x - 3y = 6 \)

8) \( 2x = 6y - 18 \)

9) \( 3x + 5y = -15 \)

10) \( 5x - 4y = -20 \)
Graphing Lines

Graph the following equations using the given graph paper without the help of a calculator. After you finish your first three equations compare work with your partner. If you still have questions, raise your hand to get the attention of your instructor for assistance.

1) $6y = 4x - 12$

2) $-3x - y = 9$

3) $10x = 20y - 100$

4) $x = -y + 4$

5) $-2y = 4x - 8$

6) $3x + 9y = 18$

7) $4x - 6y = -24$

8) $5y = 10x - 15$

9) $7x + 8y = -56$

10) $9y = 3x - 3$
Graph Lines with a Calculator

Graph the following equations using a graphing calculator by first rewriting the equations as needed.

1) \( x - y = 14 \)

2) \( x + y = 2 \)

3) \( 2x - 3y = -6 \)

4) \( 4x = 2y + 8 \)

5) \( y - 5 = 10x - 20 \)

6) \( y + 2 = 4x - 6 \)

7) \( 3x + 8y = 24 \)

8) \( 5x = 5 - 2y \)
Pre/Post Assessment on Vocabulary

Instructions: Define the following terms and describe each one. Develop your own equations to use as examples and draw a diagram representing the terms if you can.

1) Y-axis

2) X-axis

3) X-intercept

4) Y-intercept

5) Slope of line

6) Slope-intercept form

7) Linear function

8) Dependent variable

9) Independent variable

10) Value table

11) Ordered pair

12) Origin
13) Standard form

14) Rise/run

15) Line

16) Linear equation

17) Variable

18) Function

19) Point

20) Graph an equation
1) Y-axis: The vertical axis in a coordinate system
2) X-axis: The horizontal axis in a coordinate system.
3) X-intercept: The point at which a graph intersects the x-axis
4) Y-intercept: The point at which a graph intersects the y-axis
5) Slope of line: \( \frac{y_2 - y_1}{x_2 - x_1} \)
6) Slope-intercept form: equation of a line in the form \( y = mx + b \)
7) Linear function: A function that can be expressed in the form of a linear equation (an equation in which a variable is raised to the first power)
8) Dependent variable: In a function of two variables, one variable is dependent and the other independent; for example \( y = 2x - 1 \)
9) Independent variable: same as #8
10) Value table (values of line): The data used to make a graph in the coordinate system
11) Ordered pair: A pair in which one member is designated as the first and the other member as the second.
12) Origin: The assigned to zero on the number line or the point where the x- and y-axes intersect in a coordinate system.
13) Standard form: A linear equation is in two variables in standard form as \( ax + by = c \); a or b cannot be 0 at same time
14) Rise/run: Rise is the difference of y-coordinates; run is the difference of x-coordinates
15) Line: A set of points that form a straight line path extending infinitely in two directions. The directions are opposite of each other
16) Linear equation: an equation in which the variables are raised to the first power. It may one variable or several variables.
17) Variable: A letter or other symbol that represents a number or other mathematical thing.
18) Function: a set of ordered pairs such that no two ordered pairs have the same first member.
19) Point: an undefined entity in geometry. It has position but no dimension.
20) Graph an equation: (1) Make a value table, (2) graph the ordered pairs, and (3) draw a line through these points.
Assessment on Graphing Linear Equations

Graph the following equations on graph paper. Show a table of values next to your graphs, and label each graph with the equation number. (You are allowed to use the graphing calculator).

1) $6x = -4y - 12$

2) $x + 3y = 6$

3) $x - y = 8$

4) $10x - 20 = 100$

5) $y = 5x + 10$
Lesson 2: Connecting Pictures with Symbols

Graphing, Intercepts, and Equations of Linear Relationships

This lesson provides an early, graphing-based lesson on how intercepts can be used to understand equations of linear relationships.
Teacher Notes for Lesson 2

Pre-Assessment

This assessment will be given to check if the students understand how to graph $x - \& y -$ intercepts.

Activity

Part I: Intercepts

Cooperative Activity
In groups of two, students will compare their $x - \& y -$intercepts and check if their answers are the same or not from the activity sheet “Intercepts”. During activity period, the teacher will monitor the groups, check for understanding and correct if the other partner is incorrect or not.

Part II: Equations

Technology Usage
Each student should be able to graph equations with/without the graphing calculator and identify the $x - \& y -$intercepts on the graph and on graphing calculator.

Guided Practice
Practice sheets will be given on one day where the students will not be allowed to use the graphing calculators, and on another day, they will be allowed to use the graphing calculator. They will be given instructions on how to find the intercepts using the graphing calculator. Use cooperative learning techniques with these activities sheets because students will retain the skills which you want them to learn well.

Assessments

Administer another assessment to see if there is any growth. When you achieve about 85% of your students passing with above 80%, you can go on to the next lesson.

Duration

You will be on lesson 2 for about 2-3 weeks. It depends how weak your students are in their skills and after you assess them. It really depends how you feel as their instructor, if they can go on to next lesson or not.
Pre-Assessment on Graphing with Intercepts

Graph the following equations and label the $x$ – & $y$ – intercepts.

1) $x - y = 8$

2) $x - y = -5$

3) $2x - 6y = -12$

4) $4x + 5y = 20$

5) $-3x - 6y = -6$

6) $4y = 2y + 8$

7) $-9x - 2y = 18$

8) $4y = 12x - 2$

9) $2x = -7y + 14$

10) $x - 2y = -16$

Define the following algebra concepts using diagrams, pictures, and labels, if necessary.

1) Equation
2) Function

3) X-intercept

4) Y-intercept

5) Ordered pairs

6) Graphing equation (Describe the procedures how to graph equation)

7) Value table

8) Point

9) Expression

10) Line
Identifying Intercepts

Label the $x$ – and $y$ – intercepts as ordered pairs using the coordinates shown in each of the following graphs of linear equations. Assume the scale is 1 unit on each axis.
Graphing using Intercepts

Identify the $x$- and $y$-intercepts for each equation. Then, graph the equations, labeling the intercepts.

1) $y = 2x - 1$

2) $y = 10x - 20$

3) $3x - 4y = 12$

4) $6x + 2y = 8$

5) $3y = 9x - 6$

6) $-4y = 2x - 4$

7) $5x = -2y + 10$

8) $x = y - 9$

9) $3x - 2y = 24$

10) $6x - 8y = 24$
Post Assessment on Graphing with Intercepts

Graph the following equations and label the x – and y - intercepts.

1) $2x + y = 5$

2) $x + 4y = 10$

3) $x - y = -3$

4) $4x + 6y = 8$

5) $2x + 5y = 10$

6) $x - y = 0$

7) $3x + 2y = 9$

8) $3x + y = -1$

9) $2x - 3y = 6$

10) $6x - 3y + 12$
Lesson 3: Slopes of Lines

*Constant Rate of Change and the Slope Formula*

This lesson introduces students to the slope formula through a focused set of examples emphasizing lines with positive, negative, and zero slope.
Teacher Notes for Lesson 3

Pre-Assessment

This assessment can be administered to see how much information your student had acquired from previous school years.

Activity

Part I: Determining Slope from a Graph

Cooperative Activity
Your students can be paired into groups of two. Hand out the activity sheet, “Slope of the Line”. Give the students instructions on what you want them to do for the activity. Using the slope formula, they need to use two points from their graph in the activity sheet. After about 20 minutes, each group will have a chosen speaker to answer your questions concerning finding the slope from five problems.

Part II: Finding the Slope-Intercept Form

Technology Usage
Each student should be able to find the slope by using the two given points (ordered pairs or x-& y-intercepts), using the slope formula, and the rise and run method; therefore, they will be given a pretest on finding the slope and slope–intercept form without using the graphing calculator and one using the graphing calculator. If needed, the teacher will reteach these skills and reassess the students.

Guided Practice
Practice sheets will be given on one day where the students will not be allowed to use the calculator, and the other day, they will be allowed to use the graphing calculator. Use cooperative learning techniques with these activities sheets because students will retain the skills which you want them to learn better.

Assessments

Administer another assessment to see if there is any growth, when you achieve about 85% of your students passing with above 80%, you can go on to the next lesson.

Duration

You will be on lesson 3 for about 3-4 weeks. It depends how weak your students are in their skills and after you assess them. It really depends how you feel as their instructor if they can go on to next lesson or not.
Pre-Assessment on Slope & Slope-Intercept Form

A. Find the slope. Use the slope formula using the following ordered pairs.

1) \((-2,3)\) and \((4,-1)\)

2) \((1,-1)\) and \((2,3)\)

3) \((3,0)\) and \((0,-3)\)

4) \((2,4)\) and \((2,5)\)

5) \((-1,1)\) and \((3,1)\)

B. Find the slope–intercept form of each line joining the ordered pairs in tasks 1) and 2) of the previous problem.
Pre-Assessment on Slope & Slope-Intercept Form

A. Find the slope. Use the slope formula using the following ordered pairs.

1) (5,0) and (0,5)
2) (1,5) and (6,10)
3) (3,2) and (2,3)
4) (-1,2) and (1,-2)
5) (-2,0)(0,-6)

B. Find the slope–intercept form of each line joining the ordered pairs in tasks 1) and 2) in the previous problem.
Identifying Slope from a Graph

Use the rise over run method to find the slope in each graph. Assume the scale is 1 unit on each axis.
Slope-Intercept Form from Two Points

Given the following sets of ordered pairs, use the slope formula to find the slope and slope-intercept form of the lines joining each pair of points.

1) (0, -3) and (3, 0)

2) (1, 2) and (2, 1)

3) (3, 4) and (6, 3)

4) (2, 1) and (2, 4)

5) (4, 3) and (8, 5)

6) (8, 5) and (12, 10)

7) (2, 3) and (4, 9)

8) (2, 4) and (6, 3)

9) (1, 10) and (3, 11)

10) (1, 5) and (2, 1)
Lesson 4: More Forms of Linear Equations

The Standard Form & Slope-Intercept Form for a Line

This lesson helps students understand linear relationships using the standard and slope-intercept forms of a line, graphs, and real world situations.
Teacher Notes for Lesson 4

Pre-Assessment

This assessment can be administered to see how much information your student had acquired from previous school years.

Activity

Part I: Switching between Standard Form & Slope-intercept Form

Cooperative Activity
Students can be in groups of 4. Hand out the activity sheet, “Standard form equation”. Teacher should model to students how to change standard form to slope-intercept form without/with using graphing calculator. This technique is important because if they are given standard form, they would have to change this form to slope-intercept in order to use the graphing calculator. After about 15 minutes, each group will have a chosen speaker to answer questions concerning changing the standard form to slope-intercept form.

In another cooperative session, students will be put in groups of two. Hand out the activity sheet, “Real world situations”. Students will work with word problems which are solved by using linear relationships and graphing.

Part II: Finding the Equation of a Line

Technology Usage
Each student should be able to find the equation of line in the activity sheet, “Slope–intercept forms” using the x- & y-intercepts. Therefore, they will be given a pretest on finding the equation of line and change the standard form to slope-intercept form with/without using the graphing calculator. If needed, the teacher will re teach these skills and reassess the students.

Guided Practice
Practice sheets will be given on one day where the students will not be allowed to use the calculator, and the other day, they will be allowed to use the graphing calculator. Use cooperative learning techniques with these activities sheets because students will retain the skills which you want them to learn better.

Assessments

Administer another assessment to see if there is any growth. When you achieve about 85% of your students passing with above 80%, you can go on to the next lesson.
Duration

You will be on lesson 4 for about 2-3 weeks. It depends how weak your students are in their skills and after you assess them. It really depends how you feel as their instructor, if they can go on to next lesson or not.
Pre-Assessment on Standard Form

A. Identify the x-intercept, y-intercept, and slope of each of the following equations. Then, write each equation in slope-intercept form.

1) \(2x - 3y = 12\)

2) \(-4x + 5y = 20\)

3) \(x = y + 8\)

4) \(3y = 4x - 12\)

5) \(15x - 5y = 15\)

B. Rewrite the following equations in slope-intercept form. Then, using a graphing calculator, graph the equations and write a table of values.

1) \(2x + 3y = 6\)

2) \(-5x - 2y = 10\)

3) \(3x - 6y = 18\)

4) \(x - y = -1\)

5) \(11x + 12 = 121\)
Using Slope-Intercept Form

Identify the x-intercept, y-intercept, and slope of each of the following equations. Then, write each equation in slope-intercept form.

1) \(-x - y = 4\)

2) \(2y = 6x + 14\)

3) \(-10y = 20x - 100\)

4) \(15x + 30y = -60\)

5) \(4y = 12x - 1\)
Standard Form

Rewrite the following equations in slope-intercept form. Then, using a graphing calculator, graph the equations and write a table of values.

1) \(2x + 3y = 6\)

2) \(-5x - 2y = 10\)

3) \(3x - 6y = 18\)

4) \(x - y = -1\)

5) \(11x + 12 = 121\)

6) \(x + y = 5\)

7) \(-3x + 8y = 24\)

8) \(12x - 10y = 120\)

9) \(-4x = 2y - 8\)

10) \(2y = -6x - 12\)
Modeling the Real World with Linear Relationships

Show your work for each word problem and explain the independent variable and dependent variable.

1) The admission fee at a small fair is $1.50 for children and $4.00 for adults. On a certain day, 2200 people enter the fair and $5050 is collected. How many children and how many adults attended.

2) 2000 tickets were sold in an exhibition on Saturday. the cost of a ticket for an adult is 44.00 and for a child is $2. The total amount collected on Saturday was $6400. Find the number of adult tickets and child tickets sold on Saturday.

3) John bought 5 apples and 10 oranges for $4. Ben bought 3 apples and 9 oranges for $3. The shop keeper strictly told that there will not be any discounts. What is the cost of an apple and an orange?
Lesson 5. Multiple Representations of Lines

This final lesson synthesizes the multiple ways of representing linear relationships using a partially completed arrangement of linear relationships expressed in various ways.
Teacher Notes for Lesson 5

Pre-Assessment

To get a sense for how well your students understand the many representations for linear equations, you can have them complete the Walbey Table or List for two or three linear equations as a pre-assessment.

Activity

Part I: Walbey's Table

Cooperative Activity
Students can be in groups of 2. Hand out the activity sheet, “The Walbey’s Table”. Teachers will model how to fill in the Walbey’s Table. Give the student only two different problems and instructions what you wanted them to do. After about 15 minutes, each group will have a chosen speaker and an assistant to answer your questions concerning filling The Walbey’s Table.

Part II: Walbey’s List

Technology Usage
Each student should be able to fill in the Walbey’s Table /List. Therefore, they will be given a pretest on the Walbey’s Table/List. If needed the teacher will re-teach these skills and reassess the students, using the Walbey Table/ list.

Part III: Linear function Web

Guided Practice
Practice sheets including the Linear Function Web sheet will be given on one day where the students will not be allowed to use the calculator, and the other day, they will be allowed to use the graphing calculator. Use cooperative learning techniques with these activities sheets because students will retain the skills which you want them to learn better.

Assessments

Administer another assessment to see if there is any growth. When you achieve about 85% of your students passing with above 80%, you can go on to the next lesson.
Duration

You will be on lesson 5 for about 4-5 weeks. It depends how weak your students are in their skills and after you assess them. It really depends how you feel as their instructor if they can go on to another skill or not.
### Walbey’s Table

<table>
<thead>
<tr>
<th>Slope (m)</th>
<th>Type of Slope (positive, negative, 0, undefined)</th>
<th>(x)-intercept ((x, 0))</th>
<th>(y)-intercept ((0, b))</th>
<th>Standard Form (Ax + By = C)</th>
<th>Slope-intercept Form (Y = mx + b)</th>
<th>Point-slope form (y - y_1 = m(x - x_1))</th>
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<td>Point-slope form $y - y_1 = m(x - x_1)$</td>
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<tr>
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<tr>
<td>Slope-intercept form_________</td>
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<tr>
<td>Point-slope form_________</td>
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<tr>
<td>Graph (on a grid).</td>
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<th>C</th>
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<tbody>
<tr>
<td>Slope _________</td>
<td>Slope _________</td>
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<tr>
<td>Type of slope_________</td>
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<tr>
<td>x-intercept_________</td>
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</tr>
</tbody>
</table>
Linear Function Web

Slope-intercept form

Slope \( m = \)

Parallel Line \( m = \)

Perpendicular Line \( m = \)

\( y \)-intercept \( b = (\ ,\ ) \)

\( x \)-intercept \( (\ ,\ ) \)

\((\ ,\ y)\) \(\ y = \)

\((x,\ )\) \(x = \)

Graph

Parent function

\((\ ,\ )\) \(y = \)

\((\ ,\ )\) \(x = \)