Support for Learning Mathematics Using the 5E Instructional Model

Steven Zaccardo
State University of New York (SUNY) Brockport

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Abstract

This curriculum project is designed to assist mathematics teachers in implementing the 5E Instructional Model into their lessons. The four consecutive lessons were taught in a special education algebra 1 setting and each lesson integrates the 5E method (engagement, exploration, explanation, elaboration, and evaluation) into graphing linear equations. Lesson 1 includes an introduction to finding points on a line. In lesson 2, students will take a deeper dive into the equation of a line and discover why a point is a solution to a linear equation. Lesson 3 moves onto slope and the many ways we can find slope when various information is given. Lesson 4 focuses on recalling information from the previous 3 lessons to incorporate what has been learned into the slope-intercept concept. In the end, this project engages students in learning linear equations using the 5E Instructional Model.
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Introduction

Although originally created for the secondary science classroom, the 5E method has been documented to support and improve student learning across many content areas. This curriculum project was developed to provide mathematics teachers with exemplar lessons for an 8-1-1 special education high school mathematics classroom. The 8-1-1 setting is eight students, one content teacher, and one special education teacher. It is typical for self-contained programs, designed to teach mathematics to students with special needs, to have small classes. Students disabilities often range from autism to PTSD resulting in severe social emotional difficulties. In many states, students with disabilities must take the end of course exam such as New York State’s Algebra 1 Regents Exam at the end of the year.

It can be challenging for teachers to prepare students with special needs for end of year exams because of the variety in cognitive ability and overall perception of Mathematics. Some students require more support than others and some students like learning mathematics more than others. The 5E instructional method provides a way for students to develop an in-depth understanding of concepts taught in Algebra 1 regardless of learning challenges. As with all curriculum plans, it requires discipline on the part of the teacher and the student to ensure that each of the 5E’s are a focal point in each lesson.

Providing perspectives on what the 5E method looks like in a special education mathematics setting can be useful for teachers in any setting. Each lesson will address how each of the 5E’s will be accounted for and what can be expected from students and teachers.
Literature Review

The 5E’s

The goal of mathematics instruction should be to maximize the learning potential for all students in the classroom. In the current landscape of mathematics, there is a consistent focus on cognitive psychology, constructivist-learning, and overall best practices to support all learners (Colclasure, 2020). The 5E Instructional Model encompasses such, and more specifically, it focuses on the interactive aspects of learning: engagement, exploration, explanation, elaboration, and evaluation, “Using this approach, students redefine, reorganize, elaborate, and change their initial concepts through self-reflection and interaction with their peers and their environment.” (Colclasure, 2020). Hassan (2019) provided how the parts of 5E relate to learning mathematics:

Engagement: The objectives of this first step of the 5E model are reaching students, getting their attention and guiding them to focus on a problem or a question. This step also stimulates their prior knowledge and helps relate what they have already learned to new concepts.

Exploration: In this phase of the 5E model, activities are introduced to provide students with materials and concepts in order to start to investigate the idea presented. They may discuss ideas with other students in groups and relate what they have already learned to this new idea. The teachers will know how much the students already know about the subject of the lesson.

Explanation: In this phase, teachers take an active role by introducing more detail in the form of terms, definitions and explanations for a specific subject or concept. Students begin to talk about their understanding and show the new skills they have learned.

Elaboration: In this phase, teachers use activities that are challenging but can be achieved by the students. The students increase their understanding and begin to sharpen the skills through these
learning experiences. They are encouraged to utilize what they have learned and apply it to a different but related concept.

**Evaluation:** This final phase is used to evaluate the final outcome. However, the 5E model is designed so that teachers can evaluate students’ progress throughout the process by using formative assessment.

**Cognitive Psychology**

Cognitive psychology in education focuses on the mental processes that contribute to learning. Memory, attention, and problem solving all effect how students acquire, process, and retain information. Tanner (2010) stressed the order in which instruction occurs is critical. That is precisely what this curriculum project focuses on. The 5E Instructional Model supports Tanner’s idea that what we do first, second, third and so on can have many ramifications (Tanner, 2010). By understanding the cognitive process, teachers can become more effective in optimizing student learning.

**Constructivist Theory**

Constructivist theory states that students construct their own knowledge through exploration. Prior to the development of this theory, traditional education models would provide students with the correct processes, answers, and supposed facts to be learned (Omotayo, 2017). A major part of this curriculum project is to engage students in the learning process. It emphasizes critical thinking where, instead of students receiving information, they are encouraged to construct their own knowledge through the exploration of topics and problem solving. According to Omotayo (2017), this approach not only helps students develop an in-depth understanding of mathematical concepts, but also helps promote lifelong learning.
Curriculum

Engage

Students will engage in a warm-up activity that calls upon their ability to substitute in an \( x \) value to figure out what the \( y \) value is for a given linear equation. Throughout the lesson, students will use this same idea of substitution to determine whether or not an ordered pair is a solution to an equation. Ideally, students will make the connection between the two.

Explore

Throughout the guided practice, teacher should pull up the graphs for certain lines on the smart board by using Desmos. Use this to show a visual of what it looks like when an ordered pair is a solution, and what it looks like when an ordered pair is not a solution.

Explain

Throughout the YOU DO portion of instruction, teacher will interrupt periodically to identify any common areas of difficulty. Ideally, teacher would explain and address any confusion that has come up throughout this portion of instruction and encourage students to answer each other’s questions.

Elaborate

After students voice their questions, comments and concerns, they will be allowed the rest of guided practice time to apply what they have learned. Students will be able to reinforce their newly developed skills and knowledge before they are given the exit ticket to be evaluated.

Evaluate

The exit ticket will be given to students as an informal assessment. Students and their work will be observed throughout the evaluation phase to see whether or not they have a sufficient understanding of the main concepts of the lesson. Common areas of difficulty and different methods of solving each problem will be noted.
FINDING POINTS ON A LINE

EDUCATION STANDARD(S)

- AI-A.REI.10 - Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane.

LEARNING TARGET(S)

1. Students will be able to evaluate the equation of a line to determine whether or not a given ordered pair is a solution.

MATERIALS NEEDED

1. Smart Board
2. Pencil
3. Calculator
4. Ruler
5. Finding Points on a Line Notes/Worksheet (Attached)

TIMELINE

a. Introduction/Warm-up (5 - 10 Minutes)
   
i. Reteach any common areas of difficulty from previous lesson assessment. Reinforce knowledge from previous lesson dedicated to graphing lines with a table. Have students complete the warm-up independently, then review on the board.

   1. Have students complete the warm-up independently, then review on the board.

   2. Ask 1 student to come up to the board and show how they figured out the y values on the table.

   3. Make connection between those points making up the given line and that those
points technically lie on the line for that given equation.

b. Explicit Instruction + Practice (20 – 30 Minutes)

i. I DO

1. I will go over the definition of the solution to a linear equation.

2. Demonstrate how to determine whether or not a given ordered pair is a solution to an equation (tie into warm-up).

ii. WE DO

1. Class will be asked to participate in helping me solve the next problem.

2. Ask students to identify which numbers get substituted where in the linear equation.

3. Emphasize the fact that each ordered pair is made up of an x and y AND the idea of substitution for the corresponding variables in the equation.

iii. YOU DO

1. Students will be tasked with completing 10 practice problems asking them whether a point lies on a line or whether a coordinate pair is a solution to a given equation.

2. Emphasize the fact that if a point lies on the line, it is a solution, and vice versa.

3. Encourage students to work with desk mates.

4. Monitor for any common areas of difficulty and go over with class sporadically.

c. Assessment (5 - 10 minutes)

i. Remind students to take their time and show work.

1. Hand out a 2 question “Exit Ticket” that asks students to identify solutions to given linear equations.

2. Encourage students to call me over to ask clarifying questions if anything appears confusing.

3. Once all students are finished, collect papers and grade for conceptual understanding and procedural fluency.
DIFFERENTIATION

- Students will be allowed to circle one question on the assessment that they were not confident in answering. If answered incorrectly, students will be given a chance to try again for half credit.

REVIEW/DATA COLLECTION

- Assess what specific questions were most difficult among students to reteach at the beginning of next class.
- Assess where in each question students found the most difficulty.
- Document data broken down into conceptual understanding and procedural fluency scores.
LESSON MATERIALS

Warm-Up

Complete the table below for the linear equation: \( y = 3x - 2 \)

<table>
<thead>
<tr>
<th>( x )</th>
<th>( y )</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Does the point lie on the line?

- A point lies on a line if it is a ________________________ to the equation.
- To check, plug in the ordered pair and see if you get a true statement.

I DO

Is the point (2,5) a solution to the equation \( y = 3x - 1 \)

WE DO

Does the point (4,1) lie on the line \( y = 3x + 1 \)
YOU DO

1.) Does the point (3,1) lie on the line $y = x - 3$

2.) Is (5,7) a solution to the equation $y = -3x + 22$

3.) Does the point (-4,-8) lie on the line $y = -2x$

4.) Is (-1,8) a solution to the equation $y = 2x + 11$

5.) Does the point (12, 60) lie on the line $y = 7x - 18$

6.) Is (2,0) a solution to the equation $y = 4x - 8$

7.) Does the point (-3,10) lie on the line $y = -5x + 10$

8.) Is (5, -2) a solution to the equation $y = x - 7$

9.) Is (7,9) a solution to the equation $y = 5x - 26$
10.) Does the point (0,12) lie on the line $y = 8x - 11$

Exit Ticket

1) Is (2, -3) on the line $3x - 2y = 12$?

2) Which point is not on the line $4y - 3x = 7$? (3, 3) or (-1, 1)
Engage

Students will engage in a warm-up activity that calls upon their ability to solve for \( y \) in a two-variable equation. This is a skill that has been addressed in earlier units, so the teacher will be calling upon this knowledge at the beginning of the lesson, and throughout the lesson to help students make the connection between solving the two variable equation and graphing it.

Explore

With the guided practice requiring the students to find slope in 4 different ways, the students will be able to explore the differences between each strategy. Not only that, students will be able to find out what strategies work best for them, and which strategies they think they need the most practice with.

Explain

Throughout each portion of independent practice, the teacher will be going over one strategy fully before moving onto the other. At that time, students will be asked what they had trouble with. Students will also be able to voice what strategies and procedures worked best for them for each strategy.

Elaborate

Ideally, students will hear strategies or thought processes that they may not have thought of before. Students will make note of these strategies shared by the teacher and other students to either confirm that they are finding slope for each strategy in the way that works best for them, or if there is a different strategy that they now prefer.

Evaluate

The exit ticket will be given to students as an informal assessment. The teacher will record what strategies students thought they did best with and which ones they felt least comfortable with. The teacher will then compare that to how students scored actually scored on each strategy for finding slope. Students will be able to evaluate how well they scored on each strategy against how they thought they would score on each one. This will allow the teacher and student to discuss together which strategies they would like to review next class.
LINES AND SLOPES

EDUCATION STANDARD(S)

- AI-A.REI.10 - Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane.

- AI-A.REI.11.ii - Find the solutions approximately using technology to graph the functions or make tables of values

- AI-F.LE.2.iii - Construct a linear or exponential function symbolically given: two input-output pairs (include reading these from a table).

- NY-8.EE.5 - Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways.

LEARNING TARGET(S)

1. Students will be able to solve a linear equation for y in order to find values for y in a table.

2. Students will be able to calculate the slope of a line graphically or algebraically from a table or the equation itself.

MATERIALS NEEDED

1. Smart Board

2. Pencil

3. Calculator

4. Ruler

5. Lines and Slopes Notes/Worksheet (Attached)

TIMELINE

a. Introduction/Warm-up (5 - 10 Minutes)
i. Reteach any common areas of difficulty from previous lesson assessment. Reinforce the concept of substituting values in for x and y, and the procedure of solving for the missing variable.

1. Have students complete the warm-up independently, then review on the board.
2. Make sure to emphasize students choosing their own x values.
3. Demonstrate solving for y first, and then plugging in chosen x values to calculate the value for y at a chosen x.
4. Emphasis on 3 points making a line. Remind students to draw line with straight edge and label.

b. Explicit Instruction + Practice (20 – 30 Minutes)

i. Notes

1. Fill out the top section of page 2 of Lines and Slopes worksheet, while encouraging student to identify what they already know about slope.
   a. Explain how you can find slope graphically, in a table, algebraically, or from an equation while showing examples.

ii. Guided Practice

1. Demonstrate the first question for the section where students are asked so find slope graphically. Emphasis on RISE OVER RUN.
2. Have students complete the remaining questions for finding slope graphically.
3. Go over the rest of the questions on the board and point out any common areas of difficulty for students.
4. Demonstrate the first question for the section where students are asked so find slope from a table. Emphasize change in Y over change in X.
5. Have students complete the remaining questions for finding slope from a table.
6. Go over the rest of the questions on the board and point out any common areas of difficulty for students.
7. Demonstrate the first question for the section where students are asked so find slope algebraically. Emphasize change in Y over change in X.
8. Have students complete the remaining questions for finding slope algebraically.

9. Go over the rest of the questions on the board and point out any common areas of difficulty for students.

10. Demonstrate the first question for the section where students are asked to find slope from an equation.

11. Have students complete the remaining questions for finding slope from an equation.

12. Go over the rest of the questions on the board and point out any common areas of difficulty for students.

c. Assessment (5 - 10 minutes)

1. Remind students to take their time and show work.

   1. Hand out a 4 question “Exit Ticket” that asks students to find the slope of a line. Each question will require a different strategy (Graphically, Algebraically, From a table, and from an equation).

   2. Tell students to circle the strategy that is most difficult for them and star the strategy that they are most comfortable with.

   3. Encourage students to call me over to ask clarifying questions if anything appears confusing.

   4. Once all students are finished, collect papers and grade for conceptual understanding and procedural fluency.

DIFFERENTIATION

- Students will be allowed to identify which strategy is the most difficult for them on the assessment. They will not be told, but that question will not be graded on the assessment.

REVIEW/DATA COLLECTION

- Assess what specific questions were most difficult among students to reteach at the beginning of next class.
- Assess where in each question students found the most difficulty.
- Document data broken down into conceptual understanding and procedural fluency scores.
Day 2  Lines and Slope

Warm Up: Solve for y, make a table and graph the line.

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

<table>
<thead>
<tr>
<th>(x)</th>
<th>(y)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2) \(x = 3\)

<table>
<thead>
<tr>
<th>(x)</th>
<th>(y)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3) \(y = -3\)

<table>
<thead>
<tr>
<th>(x)</th>
<th>(y)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Slope = \[\frac{\text{change in } y}{\text{change in } x}\] = \[a\] = \[b\] = \[c\] = \[d\] = \(m\)

You can find slope:
1) graphically – ____________________________
2) in a table – ____________________________
3) algebraically – ____________________________
4) from the equation – ____________________________

Graphically: Find the slope of each of the lines.

A)
B)
C)
D)
E)
F)

From a table: Find the slope of each linear relation.

<table>
<thead>
<tr>
<th>(ex 1)</th>
<th>(ex 2)</th>
<th>(ex 3)</th>
<th>(ex 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(x)</td>
<td>(y)</td>
<td>(x)</td>
<td>(y)</td>
</tr>
<tr>
<td>4</td>
<td>17</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>26</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>35</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>44</td>
<td>2</td>
<td>9</td>
</tr>
</tbody>
</table>
Algebraically: Find the slope of the line passing through the given two points.

ex 1) (3, 4) and (−2, 1)  
ex 2) (−3, −4) and (−5, 6)

ex 3) (3, 5) and (3, −1)  
ex 4) (5, 3) and (1, 3)

From the equation: Find the slope of each line.

1) \( y = 3x - 2 \)  
2) \( -2x - 5y = 10 \)

3) \( x = 3 \)  
4) \( y = 2 \)
Algebra I
Lines and Slope

Find the slope of a line 4 different ways. Then, circle the question that was most difficult for you, and star the question that was most easy.

1.) Algebraically: Find the slope of this line.
   
   A line passing through (5, 1) and (4, 5).

2.) Graphically: Find the slope of this line.

3.) From a Table: Find the slope of this line.

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
</tr>
</tbody>
</table>

4.) From the equation: Find the slope of this line.

   A line with the equation $4x - 3y = 12$
Engage

Students will engage in a warm-up activity that calls upon their previously developed knowledge of slope and y-intercept. This skill was addressed in the previous lesson and students will be making connections to this knowledge throughout this lesson. These are two concepts that students have comfort with and will allow for a seamless introduction to slope-intercept form.

Explore

In the first part of guided practice, students will be allowed to explore the newly learned equation \( y = mx + b \). Students will be able to explore the different appearances of slope-intercept form for varying slopes and y-intercepts. Students will be able to explore what works best for them as far as substituting slope and y-intercept into the equation.

Explain

Throughout both sections of independent practice, the teacher should be asking students to explain what areas they are struggling with. The teacher should encourage other students to identify strategies that work best for them and share them while going over practice problems as a class.

Elaborate

During the guided practice, students are going to be tasked with solving a multi-variable equation in order to get it into slope-intercept form. In this section, students are elaborating on their previous knowledge of solving multi-variable equations when they put the given equations into slope-intercept form and then identifying what the slope and y-intercept of the line are.

Evaluate

Students will be assessed based on whether they can identify the slope and y-intercept when given an equation in slope intercept form, and whether they can write an equation in slope-intercept form when given the slope and y-intercept. The concept check will be given as an informal assessment will allow the student and teacher to evaluate student levels of understanding and fluency.
SLOPE INTERCEPT FORM

EDUCATION STANDARD(S)

- AI-F.IF.7.a – Graph linear, quadratic, and exponential functions and show key features.
- AI-S.ID.7 – Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.

LEARNING TARGET(S)

3. Students will be able to graph a linear equation in slope-intercept form.
4. Students will be able model and interpret a linear equation given the constraints of the problem (including the parameters of slope and y-intercept).

MATERIALS NEEDED

6. Smart Board/White Board/Black Board
7. Pencil
8. Calculator
9. Ruler
10. Slope-Intercept Form of a Line Notes (Attached)

TIMELINE

d. Introduction/Warm-up (5 - 10 Minutes)
   i. Reinforce knowledge of slope and y-intercept. Emphasize the different ways that we can be asked to find slope.
      1. Talk through questions 1 and 2 with students.
      2. Have students complete the table and graph for the given equation
independently.

3. Ask students to identify the slope (graphically) and the y-intercept.

4. Draw connection between the given equation and the identified slope and y-intercept.

e. Explicit Instruction + Practice (20 – 30 Minutes)

   i. Have students go onto the next page and attempt to write the equation of the line with the given slope and y-intercept (questions 1-3).

      1. Teacher should allow students to explore the newly learned concept.
      2. After students have completed the 3 questions, teacher should go over them on the board and answer any questions that students might have.

   ii. Introduce the next section which calls for equations to be put into slope-intercept form. Students will then identify the slope and y-intercept.

      1. Teacher should point out that the first 3 problems are already in slope intercept form.
      2. Students will complete the first 3 problems independently.
      3. Teacher will go over the first 3 questions and then introduce the following questions that require students to call upon their knowledge of solving multi-variable equations.
      4. Emphasize that students will need to solve for y in order to get an equation that is in slope-intercept form.
      5. Student will complete the rest of the table independently as teacher monitors for conceptual understanding and procedural fluency.
      6. Teacher will go over the remaining problems on the board while relying on input from students.

f. Assessment (10 - 15 minutes)

   i. Remind students to take their time and show work.

      1. Hand out a 3 question “Concept Check” that reinforces knowledge taught throughout this lesson.
2. Once all students are finished, collect papers and grade for conceptual understanding and procedural fluency.

REVIEW/DATA COLLECTION

- Assess what specific questions were most difficult among students to reteach at the beginning of next class.
- Assess where in each question students found the most difficulty.
- Document data broken down into conceptual understanding and procedural fluency scores.
Day 3  Slope-Intercept Form of a Line

1) What do you know about slope?

2) What do you know about y intercept of a line?

3) Create a table for the following equation and then graph it.

\[ y = 2x - 6 \]

What is the slope?
y-intercept?
Write the equation of the line with the given slope and y-intercept:

1.) slope = -2  
y-intercept = 4

2.) slope = \( \frac{1}{2} \)  
y-intercept = -3

3.) slope = 4/5  
y-intercept = 0

Put each of the following equations into slope-intercept form. Then, identify the slope and y-intercept of the line.

<table>
<thead>
<tr>
<th>Equation</th>
<th>Slope-Intercept Form</th>
<th>Slope</th>
<th>y-intercept</th>
</tr>
</thead>
<tbody>
<tr>
<td>( y = -x + 2 )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( y = \frac{x+3}{2} )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( y = -4 )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( 2x - 4y = 16 )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( 3x + y = 2 )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( 5x - 10y = -20 )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( 4x - y = 3 )</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Algebra 1
Concept Check

1) Given the equation: \( 8x + 4y = 16 \)
   
a. Solve the equation for \( y \).

b. Complete the table below with the linear equation given above.

c. Graph the linear equation from above on the axis below.

<table>
<thead>
<tr>
<th>( x )</th>
<th>( y )</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

2. Write an equation of a line that has a slope of -4 and a \( y \)-intercept of 2.

3. Find the slope of a line passing through the points (0, 2) and (6, 5). Show work.
Validity

I have taught these lessons to students using the 5E Model. Needless to say, no lesson is perfect but my students showed growth from one day to the next throughout these lessons. For those considering teaching these lessons, teachers should not be discouraged if students perform poorly on the first assessment. I was very nervous after lesson 1 because of how poorly students performed. With that said, I was pleasantly surprised that students began to perform better in the following assessments. It showed me that although they were not able to independently and efficiently identify solutions of a line, they were still able to pick up other skills that were necessary in succeeding in the rest of the linear equation’s unit.

Conclusion

Utilizing the 5E Method of Instruction requires consistency from the teacher that will trickle down to the students. With this curriculum project, it is crucial that the instructor leads the students to and through each of the 5E’s. With that, it is also imperative that teachers utilize a curriculum path that makes sense to incorporate with the 5E Method. To do that, teachers must use curriculum that build from one lesson onto the next by calling on prior knowledge. When this happens, there is a significantly higher possibility that students are able to truly understand and learn new concepts. We see this happen by the end of the final assessment where students demonstrate their growth from the first learning target, to the last one. Hopefully, this curriculum project not only encourages other teachers to utilize the 5E method, but also serves as an outline for teachers to modify for their specific content area.
References


Appendix

Lesson 1

Warm-Up

Complete the table below for the linear equation: y = 3x - 2

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1</td>
<td>-5</td>
</tr>
<tr>
<td>0</td>
<td>-2</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Does the point lie on the line?

- A point lies on a line if it is a **SOLUTION** to the equation.
- To check, plug in the ordered pair and see if you get a true statement.

I DO

Is the point (2,5) a solution to the equation y = 3x - 1

\[
5 = 3(2) - 1
\]
\[
5 = 6 - 1
\]
\[
5 = 5 \text{ TRUE}
\]

SOLUTION

WE DO

Does the point (4,1) lie on the line y = 3x + 1

\[
1 = 3(4) + 1
\]
\[
1 = 12 + 1
\]
\[
1 = 13 \text{ FALSE}
\]

NOT A SOLUTION
YOU DO

1.) Does the point (3,1) lie on the line $y = x - 3$

NOT A SOLUTION

2.) Is (5,7) a solution to the equation $y = -3x + 22$

SOLUTION

3.) Does the point (-4,-8) lie on the line $y = -2x$

NOT A SOLUTION

4.) Is (-1,8) a solution to the equation $y = 2x + 11$

NOT A SOLUTION

5.) Does the point (12, 60) lie on the line $y = 7x - 18$

NOT A SOLUTION

6.) Is (2,0) a solution to the equation $y = 4x - 8$

SOLUTION

7.) Does the point (-3,10) lie on the line $y = -5x + 10$

NOT A SOLUTION

8.) Is (5, -2) a solution to the equation $y = x - 7$

SOLUTION

9.) Is (7,9) a solution to the equation $y = 5x - 26$

SOLUTION
10.) Does the point (0,12) lie on the line $y = 8x - 11$

NOT A SOLUTION

Exit Ticket

1) Is (2, -3) on the line $3x - 2y = 12$?

SOLUTION

2) Which point is not on the line $4y - 3x = 7$? (3, 3) or (-1, 1)

$4(3) - 3(3) = 7$
$12 - 9 = 7$
$3 = 7$ FALSE
NOT A SOLUTION

$4(1) - 3(-1) = 7$
$4 + 3 = 7$
$7 = 7$ TRUE
SOLUTION
Day 2  Lines and Slope

Warm Up: Solve for $y$, make a table and graph the line.

1) $3x - y = 2$

\[
-3x - 3x
\]

\[
\frac{-y}{-1} = \frac{-3x + 2}{-1}
\]

\[
y = 3x - 2
\]

<table>
<thead>
<tr>
<th>$x$</th>
<th>$y$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-2</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>

2) $x = 3$

$x$'s must be 3

<table>
<thead>
<tr>
<th>$x$</th>
<th>$y$</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

3) $y = -3$

$y$'s must be -3

<table>
<thead>
<tr>
<th>$x$</th>
<th>$y$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-3</td>
</tr>
<tr>
<td>2</td>
<td>-3</td>
</tr>
<tr>
<td>3</td>
<td>-3</td>
</tr>
</tbody>
</table>
Slope = \frac{\text{Average Rate}}{\text{of Change}} = \frac{\Delta y}{\Delta x} = \frac{y_2 - y_1}{x_2 - x_1} = \text{Rise} = m

You can find slope:
1) graphically – \frac{\text{Rise}}{\text{Run}}
2) in a table – \frac{\Delta y}{\Delta x}
3) algebraically – \frac{y_2 - y_1}{x_2 - x_1}
4) from the equation – M \to y = mx + b

Graphically: Find the slope of each of the lines.

A) \frac{3}{2}
B) \frac{0}{2} = 0
C) -\frac{1}{2}
D) \frac{4}{1} = 4
E) \frac{2}{0} = \text{undefined}
F) -\frac{4}{2} = -\frac{3}{1} = -2

From a table: Find the slope of each linear relation.

(ex 1) Find the slope of each linear relation.
<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>17</td>
</tr>
<tr>
<td>5</td>
<td>26</td>
</tr>
<tr>
<td>6</td>
<td>35</td>
</tr>
<tr>
<td>7</td>
<td>44</td>
</tr>
</tbody>
</table>

\frac{9}{1} = 9

(ex 2) Find the slope of each linear relation.
<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>9</td>
</tr>
</tbody>
</table>

\frac{3}{0} = \text{undefined}
\frac{-5}{-2} = 1

(ex 3) Find the slope of each linear relation.
<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>14</td>
<td>-1</td>
</tr>
</tbody>
</table>

\frac{0}{1} = 0
Algebraically: Find the slope of the line passing through the given two points.

ex 1) $(3, 4)$ and $(-2, 1)$

\[
\frac{y_2 - y_1}{x_2 - x_1} = \frac{4 - 1}{3 - (-2)} = \frac{3}{5}
\]

ex 2) $(-3, -4)$ and $(-5, 6)$

\[
\frac{y_2 - y_1}{x_2 - x_1} = \frac{6 + 4}{-5 + 3} = \frac{10}{-2} = -5
\]

ex 3) $(3, 5)$ and $(3, -1)$

\[
\frac{y_2 - y_1}{x_2 - x_1} = \frac{-1 - 5}{3 - 3} = \frac{-6}{0} = \text{undefined}
\]

ex 4) $(5, 3)$ and $(1, 3)$

\[
\frac{y_2 - y_1}{x_2 - x_1} = \frac{3 - 3}{1 - 5} = \frac{0}{-4} = 0
\]

From the equation: Find the slope of each line.

1) $y = 3x - 2$

$m = 3$

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

\[
-5y = 2x + 10
\]

\[
\frac{-5y}{-5} = \frac{2x + 10}{-5}
\]

\[
y = \frac{-2}{5}x - 2
\]

3) $x = 3$

undefined

4) $y = 2$

$m = 0$
Find the slope of a line 4 different ways. Then, circle the question that was most difficult for you, and star the question that was most easy.

1.) Algebraically: Find the slope of this line.

A line passing through (5, 1) and (4, 5).

\[ m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{5 - 1}{4 - 5} = \frac{4}{-1} = -4 \]

2.) Graphically: Find the slope of this line.

\[ m = \frac{\text{rise}}{\text{run}} = \frac{-3}{4} \]

3.) From a Table: Find the slope of this line.

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
</tr>
</tbody>
</table>

\[ m = \frac{\Delta y}{\Delta x} = \frac{3}{2} \]

4.) From the equation: Find the slope of this line.

A line with the equation \(4x - 3y = 12\)

\[ \frac{-4x}{-3} + \frac{-3y}{-3} = \frac{12}{-3} \]

\[ y = \frac{4}{3}x - 4 \]

\[ m = \frac{4}{3} \]
Day 3  Slope-Intercept Form of a Line

1) What do you know about slope?
   
   Steepness of a line
   can be + or -

2) What do you know about y intercept of a line?
   
   where a line crosses the y-axis

3) Create a table for the following equation and then graph it.

   \[ y = 2x - 6 \]

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-6</td>
</tr>
<tr>
<td>1</td>
<td>-4</td>
</tr>
<tr>
<td>2</td>
<td>-2</td>
</tr>
</tbody>
</table>

   2(0) - 6 = -6
   2(1) - 6 = -4
   2(2) - 6 = -2

   What is the slope?  
   2

   y-intercept?  
   -6

Slope-intercept form of a line

\[ y = mx + b \]

slope  
\[ y = -6 \]
Write the equation of the line with the given slope and y-intercept:

1.) slope = -2  
y-intercept = 4
   \[ y = -2x + 4 \]

2.) slope = ½
   y-intercept = -3
   \[ y = \frac{1}{2}x - 3 \]

3.) slope = 4/5
   y-intercept = 0
   \[ y = \frac{4}{5}x \]

Put each of the following equations into slope-intercept form. Then, identify the slope and y-intercept of the line.

<table>
<thead>
<tr>
<th>Equation</th>
<th>Slope-Intercept Form</th>
<th>Slope</th>
<th>y-intercept</th>
</tr>
</thead>
<tbody>
<tr>
<td>( y = -x + 2 )</td>
<td>( y = -x + 2 )</td>
<td>-1</td>
<td>2</td>
</tr>
<tr>
<td>( y = \frac{x+3}{2} )</td>
<td>( y = \frac{1}{2}x + \frac{3}{2} )</td>
<td>( \frac{1}{2} )</td>
<td>( \frac{3}{2} )</td>
</tr>
<tr>
<td>( y = -4 )</td>
<td>( y = -4 )</td>
<td>0</td>
<td>-4</td>
</tr>
<tr>
<td>( 2x - 4y = 16 )</td>
<td>( y = \frac{1}{2}x - 4 )</td>
<td>( \frac{1}{2} )</td>
<td>-4</td>
</tr>
<tr>
<td>( 3x + y = 2 )</td>
<td>( y = -3x + 2 )</td>
<td>-3</td>
<td>2</td>
</tr>
<tr>
<td>( 5x - 10y = -20 )</td>
<td>( y = \frac{5}{10}x + \frac{2}{5} )</td>
<td>( \frac{1}{2} )</td>
<td>2</td>
</tr>
<tr>
<td>( 4x - y = 3 )</td>
<td>( y = 4x - 3 )</td>
<td>4</td>
<td>-3</td>
</tr>
</tbody>
</table>
1) Given the equation: \(8x + 4y = 16\)
   a. Solve the equation for \(y\).
      \[
      \begin{align*}
      8x + 4y &= 16 \\
      4y &= -8x + 16 \\
      y &= -2x + 4
      \end{align*}
      \]
   b. Complete the table below with the linear equation given above.
      | \(x\) | \(y\) |
      |---|---|
      | -1 | 6  |
      | 0  | 4  |
      | 1  | 2  |
   c. Graph the linear equation from above on the axis below.

2. Write an equation of a line that has a slope of -4 and a \(y\)-intercept of 2.
   \[
   y = -4x + 2
   \]

3. Find the slope of a line passing through the points \((0, 2)\) and \((6, 5)\). Show work.
   \[
   m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{3 - 2}{6 - 0} = \frac{1}{2}
   \]