Ramp It Up

I. UNIT OVERVIEW & PURPOSE:

The purpose of this unit is to get students familiar with how rate of change is associated with slopes and how that rate of change is used to build ramps designed for wheelchair accessibility.

II. UNIT AUTHOR:

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III. COURSE:

Mathematical Modeling: Capstone Course

IV. CONTENT STRAND:

Algebra

V. OBJECTIVES:

Students will explore and investigate what is necessary to build a ramp that will satisfy the American Disabilities Act for wheelchair accessibility and explore the GeoGebra website regarding linear equations.

VI. MATHEMATICS PERFORMANCE EXPECTATION(s):

MPE. 1 The student will solve practical problems involving rational numbers (including numbers in scientific notation), percent, ratios, and proportions.

MPE. 3. The student will use pictorial representations, including computer software, constructions, and coordinate methods, to solve problems involving symmetry and transformation. This will include

a) investigating and using formulas for finding distance, midpoint, and slope;

MPE. 5. The student will solve real-world problems involving right triangles by using the Pythagorean Theorem and its converse, properties of special right triangles, and right triangle trigonometry.

MPE.19 The student will graph linear equations and linear inequalities in two variables, including

a) Determining the slope of a line when given an equation of the line, the graph of the line, or two points on the line. Slope will be described as rate of change and will be positive, negative, zero, or undefined.

VII. CONTENT:

Lesson 1 will involve having the students find examples of slopes or rates of change and convert them into tables, graphs, and equations using the real world examples.

Lesson 2 will involve students actually gathering information regarding the requirements for wheelchair ramps for the disabled, investigating if ramps actually meet those requirements and problem solving about how to adjust measurements or identify measurements necessary to build the ramps.

Lesson 3 will involve students exploring the GeoGebra website and creating a sample screen for finding slopes.

VIII. REFERENCE/RESOURCE MATERIALS:

Students will need to have access to the internet for research, access to digital cameras for slope investigation, and GeoGebra installed on student computers.

IX. PRIMARY ASSESSMENT STRATEGIES:

Students will be assessed based on research data, computation of individual works, observation of work habits and overall project completion.

X. EVALUATION CRITERIA:

Grading rubric is included with each lesson.

XI. INSTRUCTIONAL TIME:

Lesson 1: Two 90 minute class periods
Lesson 2: one 90 minute class period
Lesson 3: one 90 minute class period

Exploring Various Rates of Change or Slope

Strand Algebra

Mathematical Objective

The student will explore the various rates of change for existing structures within or around a building to see how these measurements are related to linear equations through the use of tables, graphs and equations.

Mathematics Performance Expectation(s)

MPE. 1 The student will solve practical problems involving rational numbers (including numbers in scientific notation), percent, ratios, and proportions.

MPE. 5. The student will solve real-world problems involving right triangles by using the Pythagorean Theorem and its converse, properties of special right triangles, and right triangle trigonometry.

MPE.19 The student will graph linear equations and linear inequalities in two variables, including

a) determining the slope of a line when given an equation of the line, the graph of the line, or two points on the line. Slope will be described as rate of change and will be positive, negative, zero, or undefined

Related SOL

A.6 The student will graph linear equations and linear inequalities in two variables, including

a) determining the slope of a line when given an equation of the line, the graph of the line, or two points on the line. Slope will be described as rate of change and will be positive, negative, zero, or undefined and
b) writing the equation of a line when given the graph of the line, two points on the line, or the slope and a point on the line.

NCTM Standards

- represent, analyze, and generalize a variety of patterns with tables, graphs, words, and, when possible, symbolic rules;
- relate and compare different forms of representation for a relationship;

- explore relationships between symbolic expressions and graphs of lines, paying particular attention to the meaning of intercept and slope;
- use symbolic algebra to represent situations and to solve problems, especially those that involve linear relationships.

Materials/Resources (per group)

- tape measure
- grid paper to create graphs
- digital cameras
- poster creating material such as construction paper, glue, scissors.
- if possible access to a computer

Assumption of Prior Knowledge

- Student must have an understanding of what slope is and how to find it.
- Student must also be able to take accurate measurements with a measuring tool.
- Student should have understanding of how to use a digital camera
- If using Excel for data, students need to have an understanding of how to create formulas in the program.

Introduction: Setting Up the Mathematical Task

This activity is designed to expose students to real-life situations that involve slope or rates of change. By exploring ideas found around the school grounds, students should see how length and height measurements relate to the rise over run of various slopes. In addition, students should also realize how different measurements are related to the same slope.

Duration: Depending on the technology available and available resources, this project will take two 90 minute classes or one week for 45-50 minute classes.

To introduce the activity, have students brainstorm on the meaning of slope or rates of change and then as a class have students share meanings and discuss valid and invalid responses. (Incorporate technology by having students type answers using a real time writing site http://ietherpad.com.) 10 minutes

Student Exploration 1:

Small Group Work

1. Place students into small groups of no more than 3 students.
2. Have students explore the school grounds for examples of slopes and rates of change. Examples might include the cinderblocks on the wall to represent rise over run; it could be ramps or stairs; it could be windows placed in a horizontal fashion, etc. Each group needs to find at least one sample for each type of slope possible

(positive, negative, undefined and zero) and take a picture of each representation. (*Depending on the size and layout of your school, you may have to specify the location they may explore. In addition, you may have to take into consideration the class size and request help from additional teachers, parent volunteers, or aids for supervision purposes.)*

3. Using the tape measure, students should measure two horizontal lengths and two vertical lengths for each sample they have found and record the information on grid paper that represents a sketch of the slope or rate of change they are trying to represent. *For example, if a group is measuring a set of stairs, measure the horizontal and vertical measurements for two steps. If one is measuring a ramp, take one horizontal measurement to a point and then the vertical measurement that corresponds and then repeat the horizontal measurement, only make it shorter or longer and find the corresponding measurement.*

   Allow about 30 minutes for exploration and gathering of data.

4. Upon return to the classroom *(or next day due to class time),* students should create a table to represent vertical and horizontal changes for each sample and then extend the table to include other measurements that could apply to the sample. (Table may be created using Excel program in a computer). 15 minutes (less if using Excel and students know how to create formulas)

   a. Stress to students when making the table, you are using measurements that will create the same slope for the samples they found.
   b. If students get stuck with the stairs or cinderblock situations, point out how similar triangles are involved to help them visualize the same type slope.

5. Once the tables are created, have students draw scatterplots on grid paper that are associated with the table produced for each sample (Graphs may be created using Excel or the graphing calculator) and write the equation associated with measurements of each sample. 30 minutes by paper, 15 minutes if done on Excel.

6. Have students create a poster type presentation *(possibly using Powerpoint, Movie maker or the site http://www.edu.glogster.com (free for up to 50 students))* to describe the slopes and characteristics of samples. Each poster must contain a picture, describe where the sample is located, and list the table, graph, and equation associated with each sample. 45 minutes (allowing time for instruction on how to create posters on computer)

Whole Class Sharing/Discussion

7. Upon completion have each group present their findings by describing where the pictures are located and telling about one new thing the group learned that they did not know before they started the project. (Giving each group about 5 minutes to speak means you would need a 50 minute class period to go through 10 groups of 3)

Teacher Actions

- While students are gathering information, teacher should make sure students are measuring correctly and getting two measurements for each type of sample.
- During table creation, make sure students are extending tables with correct measurements. If not, discuss proportionality or triangle similarity with them.
- If using Excel, make sure students place labels on tables and graphs.
- While groups are presenting, take note of the new knowledge gained during this activity.

Monitoring Student Responses

- Students should be able to extend tables based on patterns of measurements gathered through proportionality or similar triangles.
- Scatterplots should be creating points that are linear
- The equation found should be the line of fit for the scatterplot as well as produce the numbers in the table.

Assessment

Students will be assessed through observation, information contained in the poster, as well as information presented to the class.

Grading Rubric

Poster

Photos (Min: 4)	8 points
Tables (Min: 4)	16 points (4 points per table)
Graphs (Min: 4)	8 points
Equations (Min: 4)	8 points
Presentation	10 points
Total	50 points

Strategies for Differentiation

Schools without the appropriate technology could have the students explore the grounds, but give a brief description of the slope found instead of taking a picture. (Possibly get permission for the students to use their own camera device). Students could also cut out examples of slopes from magazines. The posters could be created using construction paper and grid paper.

Incorporating the knowledge of similar triangle measurements and/proportions should help those that have difficulty understanding how to get additional measurements.

An extension to the activity could be to discuss how the slopes and measurements are related to a right triangle.

What is in a Ramp?

Strand Algebra

Mathematical Objective

The student will use the knowledge of slopes and Pythagorean Theorem to find the lengths of various size ramps and convert them to meet Disabilities Act regulations.

Mathematics Performance Expectation

MPE. 1 The student will solve practical problems involving rational numbers (including numbers in scientific notation), percent, ratios, and proportions.

MPE. 3. The student will use pictorial representations, including computer software, constructions, and coordinate methods, to solve problems involving symmetry and transformation. This will include

a) investigating and using formulas for finding distance, midpoint, and slope;

MPE. 5. The student will solve real-world problems involving right triangles by using the Pythagorean Theorem and its converse, properties of special right triangles, and right triangle trigonometry.

MPE.19 The student will graph linear equations and linear inequalities in two variables, including

a) determining the slope of a line when given an equation of the line, the graph of the line, or two points on the line. Slope will be described as rate of change and will be positive, negative, zero, or undefined

NCTM Standards:

- represent, analyze, and generalize a variety of patterns with tables, graphs, words, and, when possible, symbolic rules;
- relate and compare different forms of representation for a relationship;
- explore relationships between symbolic expressions and graphs of lines, paying particular attention to the meaning of intercept and slope;
- use symbolic algebra to represent situations and to solve problems, especially those that involve linear relationships;

SOL A.6 The student will graph linear equations and linear inequalities in two variables, including

a) determining the slope of a line when given an equation of the line, the graph of the line, or two points on the line. Slope will be described as rate of change and will be positive, negative, zero, or undefined.

A.3 The student will express the square roots and cube roots of whole numbers and the square root of a monomial algebraic expression in simplest radical form.

Materials/Resource

- internet access
- word document
- grid paper

Assumption of Prior Knowledge

The student must have an understanding of how to find slope as well as the use of the Pythagorean Theorem. In addition**,** it is understood that students know how to navigate a search engine on the internet as well as create and save a word document.

Introduction: Setting Up the Mathematical Task

The purpose of this activity is to relate ramps with slope and how lengths are used to create ramps of specific ratios. To complete both explorations in this activity it will take approximately 75 minutes.

Student Exploration 1

Duration: 30 minutes
(See "Ramp It Up" worksheet #1)

Individual Work

1. Have students use the internet to Google the public regulation size of ramps for personal and public use. Especially have them look for the regulations specified for disabled citizens. *(Disability act states 12ft length for every 1 ft height; personal use should be about 16:1 ratio)*

2. Based on the information discovered, have students explain the meanings of the ratios in terms of the ramp. Make sure to have them explain how positive and negative slopes would be used in this fashion. Have them explain the meaning of undefined slopes and zero slopes in the world of ramps.

3. Either have students email you and attach the document or print out the document and turn in results.

Ramp It Up
Student Exploration #1

1. Open up a word document and then save the blank document using the following name: RampItUp_firstinitialLastName.doc (Ex. RampItUp_LJones)

2. Using the internet, research what a safe ratio for wheelchair type ramps should be for personal use. Place the answer into your word document specifying what the ratio is and what that means in terms of the ramp. Please identify the source location. *(You may copy and paste the site into your word document) Save your work.*

3. Locate an article that identifies what the American Disability Act states the ramp ratio must be for public use. Place the answer into your word document specifying what the ratio is and what that means in terms of the ramp. Please identify the source location. *(You may copy and paste the site into your word document) Save your work.*

4. In your word document, explain how a ramp with a slope of zero could be used. If you use the internet to locate an answer, be sure to site the location into your word document.

5. In your word document, explain why ramps with undefined slopes cannot be used. Explain where undefined slopes can be helpful in the aiding of certain ramps. If necessary, identify sites used.

6. Email or Print out document and turn into teacher

Extensions and Connections

An extension to student exploration #1 could be to have a wheelchair available along with ramp boards set to various heights to allow students to experience what it is like to maneuver a wheelchair up a ramp.

Student Exploration 2

The purpose of this portion of the activity is to identify what the lengths of ramps have to be in order to meet standards for ramp ratios. Students will identify which measurements are unreasonable and discuss how adjustments can be made to meet standards.

Duration: 45 minutes
(See "Ramp It Up" worksheet #2 after lesson)

Individual Work

1. Once the ratios for the ramps have been found, have students create a scaled right triangle on a piece of grid paper for each ratio (personal and disabilities act). Once

created, have students calculate the length the ramp portion (hypotenuse) for such ratios to be met and identify what the measurement represents.

2. Using various teacher created measurements, have students identify which measurements meet the ratio codes for personal and disability ramps.

3. For the ratios in the table that did not meet standards, ask students to keep the vertical lengths the same and adjust all the horizontal lengths so they meet the regulations of the Disability Act and then calculate the length of the ramp portion for each measurement in the table and the corrected lengths for non standard ratios.

4. Have students identify the lengths that are unreasonable and explain how to accommodate for extreme measurements.

Whole Class Sharing/Discussion

5. Discuss findings and explanations of ramp adjustments.

Ramp It Up
Student Exploration #2

1. Using grid paper, create two scaled right triangles (one for each ratio) that follow the ratios.

2. Find the length of the hypotenuse of each triangle. What does this measurement represent on our ramps?

3. Identify which of the following rates will meet the 12:1 or 16:1 ratios (some may not meet either)

Horizontal length	Vertical height	Which ratio does it meet?
48 ft	3 ft	
24 ft	2 ft	
8 ft	16 ft	
3 ft	4 ft	
8 ft	6 inches	

4. For the measurements in the above table that do not meet an appropriate ratio, keep the vertical height and find the horizontal measurement to meet the disability act standard.

5. Calculate the ramp lengths necessary for all measurements in the table (use the corrected horizontal lengths for the non standard ratios)

6. Identify the measurements that seem unreasonable and explain why they are unreasonable. Identify ways the contractors must adjust the lengths in order to meet standards.

7. Turn in all calculations and explanations into teacher

Student/Teacher Actions:

- Check for student understanding of 12:1 or 16:1 ratio of ramps (for every horizontal 12ft length there needs to be a 1 ft rise) and how the negative slope would be described for a ramp that needs to be inclining from the left side
- Have students identify where horizontal (zero) slopes would come into play with (chair lifts into vans, platforms for extremely long ramps) and why undefined slope ramps cannot exist. They can be helpful in aiding a ramp such as the chair lift.
- When creating triangles, make sure students are drawing the triangles correctly.
- When students are calculating the length of the hypotenuse, make sure students are doing calculations correctly.

Assessment

Students will be graded based on responses to research questions and calculations of ramp measurements.

Grading rubric

Worksheet #1		
Created word document	2 points	
Cited work	3 points	
Correct ratios found	5 points	
Explanations	10 points each	(20 total)
Total	30 points	
Worksheet #2		
Scaled drawings	5 points each	(10 total)
Ramp length calculations	5 points each	(10 total)
Table completed	2 points each	(10 total)
Adjustments	5 each	(10 total)
Table ramp lengths	5 each	(25 total)
Explanation	5 each	
Total	70 points	

Strategies for Differentiation

- Teachers could have specific websites ready for students to explore
- Those without internet or computer access through school could provide an article that details the information students need to make calculations.
- Students could be paired in such a manner that their levels of understanding could compliment each student.

GeoGebra Exploration

Strand Algebra

Mathematical Objective

The student will become familiar with the GeoGebra software by visiting pre-created activities, working with a direction guided activity, and attempting to create their very own GeoGebra site about slopes.

NCTM Standards:

- represent, analyze, and generalize a variety of patterns with tables, graphs, words, and, when possible, symbolic rules;
- relate and compare different forms of representation for a relationship;
- explore relationships between symbolic expressions and graphs of lines, paying particular attention to the meaning of intercept and slope;
- use symbolic algebra to represent situations and to solve problems, especially those that involve linear relationships;

Mathematics Performance Expectation

MPE.19 The student will graph linear equations and linear inequalities in two variables, including

a) determining the slope of a line when given an equation of the line, the graph of the line, or two points on the line. Slope will be described as rate of change and will be positive, negative, zero, or undefined

SOL A.6 The student will graph linear equations and linear inequalities in two variables, including

a) determining the slope of a line when given an equation of the line, the graph of the line, or two points on the line. Slope will be described as rate of change and will be positive, negative, zero, or undefined

Materials/Resources

Internet access with GeoGebra software installed on computers. (This software is free, but will need to downloaded on all computers prior to class, especially if permission is required.)

Assumption of Prior Knowledge

The student should have previous knowledge of finding slopes.

Introduction: Setting Up the Mathematical Task

The purpose of this activity is to expose students to the GeoGebra website and expose them to an alternative site that will allow them to seek additional access to material of a difficult nature.

As an introduction to what the students will be doing have the students explore GeoGebra software by asking them to visit the GeoGebra Wiki: http://www.geogebra.org/en/wiki/index.php/English

Discuss what students are finding and ask some students to share what they find interesting.

Student Exploration 1

Duration: 45 minutes

Individual Work

1. Students should check out at least three of the pre-created sites on linear equations (http://www.geogebra.org/en/wiki/index.php/Linear_Equations) and prepare a journal entry presentation that
    a. describes what each site asked them to do,
    b. rate the site on how easy it was to work and understand, and
    c. describe three things he/she liked about the site and three things he/she did not like about the site they visited.

2. Upon completion of journal entries, have students share their findings and then turn in work.

Student Exploration 2

Duration: 45 minutes

Individual Work

1. To get students familiar with some of the icons available in the GeoGebra software regarding linear equations, have the students complete the following steps using GeoGebra.

    Step 1: Click on the drawing lines with two points icon and place two points on the grid wherever you desire.
    Step 2: Click on the arrow icon, then click on one of your points

and move the point to watch the line move.

Step 3: Click on the angle measurement icon arrow (tiny arrow in lower right corner and change to slope icon

Step 4: Click any where on your line
and a slope measurement will appear.

Step 5: Click on either point A or point B and move it.
Watch the slope measurement change as you move the point.

3. Give the students the opportunity to try and create their own instructional site. Be sure to demonstrate how they can incorporate a textbox with instructions inside the site.

4. Students need to save their creation into an appropriate folder or on a jump drive for the teacher to access.

Student/Teacher Actions

- Monitor student actions and assist where necessary.
- Journal entries should be written on paper to avoid toggling back and forth between programs.

Assessment

Students will be graded on completion of journal entries and geogebra creation.

Grading Rubric

Journal Entries		
Description of site	5 points each (15 total)	
Rate on ease of use	5 points	
Likes/Dislikes	5 points	
Total		25 points
GeoGebra Creation		
Created one	20 points	
Works as directed	5 points	
Total		25 points

Strategies for Differentiation

- One could make this a group project so students could assist each other in the creation phase
- Teacher could have specific GeoGebra sites for students to explore to save time
- Since GeoGebra is free, offer an opportunity for students to work on an assignment at home using the software