Disabled Ramps

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Integration

21st Century Theme: Environmental Literacy

Disciplinary Concepts	**Mathematics** Slope	**Science Education** Inclined Plan
	Technology GeoGebra	**Art** 3D modeling, Design

Prerequisite Knowledge

Learning Outcomes for Mathematics

- Students are able to determine the other quantity given one of two quantities with a known ratio.
- Students are able to express the relationship between two directly proportional quantities.
- Students are able to find the amount of a quantity that corresponds to a specified percentage, as well as calculate the entire quantity based on a given percentage.
- Students are able to perform calculations to increase or decrease a quantity by a certain percentage.

Learning Outcomes for Science Education

- Students are able to compare balanced and unbalanced forces by observing the motion states of objects.
- Students are able to explain that the work done physically has relationship with the applied force and the path taken.

Learning Outcomes for Information Technologies

- Students are able to visualize data using appropriate chart types.
- Students are able to create a table suitable for the purpose by recognizing the interface and features of the spreadsheet software.
- Students are able to divide a problem into sub-problems.
- Students are able to develop an original product for the solution of a specific problem

Learning Outcomes

Grade Level: 8th-grade
Activity duration: 10 lesson hours

Learning Outcomes for Mathematics

- Students are able to explain the concept of slope in a line using models and establish connections between linear equations, their graphs, and the slope.
  a) The teacher emphasizes the significance of both the sign and magnitude of the slope.
  b) The teacher does not solely focus on the sign; instead, s/he emphasizes the slope, which represents the ratio of vertical length to horizontal length in real-life modeling
  c) The teacher utilizes relevant information and communication technologies when needed.

Learning Outcomes for Science Education

- Students are able to explain the advantages of simple machines using examples.
- Students are able to design a device that incorporates simple machines to provide ease of work in daily life.

Learning Outcomes for Information technologies

- Students are able to present the solution proposal and approach created for a determined problem.
- Students are able to create model design.
- Students are able to develop an original design product for a specific purpose.

Real World Context

Problem Situation

In order to ensure the accessibility for the disabled people, the suitability of disabled ramps in shopping centers is of great importance. In this context, what should be the ideal slope, width and length of disabled ramps? In this way, it is aimed to determine the most suitable ramp design and to provide easier access to places such as stores and shopping centers for the disabled people.

Materials

Appendix1. Modelling and Construction Activity, Appendix 2. “How to calculate the slope?”, Appendix 3. “The discovery of sloped surfaces”, GeoGebra Activity, Worksheets, Tablet

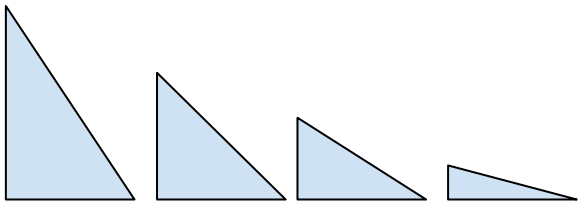
	Preparation for the lesson Answers will be sought to the following questions: ● Why is the suitability of disabled ramps important? ● Which factors affect the suitability of disabled ramps? ● What can be used to determine the suitability of disabled ramps? ● How can the most appropriate ramp design be determined? ● What tests or measurements can be used to assess the suitability of ramps? ● What are the legal requirements to consider when designing disabled ramps? ● Can different materials or design changes be made to improve the suitability of disabled ramps? ● How can STEAM skills be used to improve the suitability of disabled ramps?
	Resources www.youtube.com https://www.freepik.com/ www.geogebra.org
STEAM Activity	**Ask** The teacher asks questions to evaluate the students' prior knowledge and to prepare them for the lesson. The questions can be as follows: ● What is a Simple Machine? What advantages does it give us in our daily life? ● What are the simple machines used in daily life? ● Can we carry a heavy object more easily by using an inclined plane? Why? ● Why are inclined surfaces preferred in sports activities (such as skiing, snowboarding, canoeing)? ● How is walking or running on an inclined surface different from walking on a flat surface? ● Why do you think a handicap ramp should have an appropriate slope? The teacher starts the video (Inlined Plane) and helps the students discover the importance of Inclined Planes.
	Research In the first part of the research part of the lesson, students are asked to do the **Appendix 1. Modeling and Construction Activity** in order to explore the concepts of inclined plane and slope. Students are divided into groups of 3 or 4. They are given different materials (bamboo sticks, cardboard, boxes, wood, etc.) and glue. Students are asked to build models of inclined planes with different slopes. Students observe how the slopes change and how the motion is affected depending on the slope of the surface. After the students have explored the design of the inclined plane depending on its slope, the teacher explains the concepts of slope for the students. S/he distributes Appendix 2, titled "How to Calculate Slope", to them. This allows the students to learn that slope is determined by calculating as the change in the vertical distance relative to the change in the horizontal distance. After providing a mathematical explanation of slope, the students will watch a video titled "How To Calculate Slopes And Gradients?". In this video, the method for calculating the slope of an inclined plane is explained. Through this activity, students will discover how to calculate slopes of objects in the context of everyday life.
	Imagine The groups are given a worksheet named **Appendix 3. "The Discovery of Sloped Surfaces".** A field trip is organized either in the classroom or in the schoolyard to explore surfaces with various slopes. Students are encouraged to locate sloping paths, ramps, stairs, and other inclined areas. By allowing them to experience movement on different slopes, students will be able to discover how inclined planes are utilized in everyday life. Additionally, students will take photographs of the inclined planes they come across. Then, the students are assigned the activity related to slope and inclined planes, which was prepared using the GeoGebra application, as a group lesson (GeoGebra Activity). The instructions on how to use the activity in GeoGebra are explained to the students. Subsequently, the students are requested to upload the photographs of the inclined planes they captured during the exploration to GeoGebra and calculate the slopes of these planes. Additionally, students are instructed to interpret these inclined planes based on their slopes and engage in a class discussion about their findings. Discussion questions can be as follows: • Which slopes and inclined planes are most commonly found in everyday life? Why? • What effects does the slope of inclined planes have? What factors influence the slope of inclined planes? • Which inclined planes are easier to climb? Which inclined planes are more challenging? • Why are the slopes of inclined planes important? In which situations is a suitable slope necessary? • How do we calculate the slope of inclined planes? Which mathematical concepts do we employ when calculating slopes?

	• Which slopes are preferred for disabled ramps? Why do disabled individuals require ramps with appropriate slopes in their daily lives?
	Plan After determining the width, length, and height of the ideal slope for a handicapped ramp, students will design their own slope in 3D using GeoGebra (GGB). • Ask students to draw a curve representing the ramp design and adjust the slope of this curve. Instruct them to determine the characteristics of the ramp they designed in GeoGebra, considering factors such as width, length, and other relevant factors. • Ask students to analyze the slope of the ramp they designed and evaluate its usability based on the measurements they have identified. • Prompt students to consider whether the ramp they designed is suitable to meet the needs of people with disabilities and revise their designs if necessary. • Encourage the exchange of ideas by having students discuss their designs in class or small groups. • Motivate students to refine and optimize their designs by providing group discussions and feedback on presentations and sharing their work in class.
	Create The designs are saved as prototypes in an SVG format to be printed on a 3D printer. Students who wish to create physical models of their disabled ramps from the printer will be given 15 minutes to do so.
	Test The following criteria can be used to check the printed inclined plane. ● Size and Dimension Check: Compare the printed ramp with actual measurements and test whether the dimensions are in accordance with the design. Check features such as width, length, height and slope. ● Durability Test: Subject the ramp to a weight test. Place a high weight (e.g. books, weight plates) and check for deformation or breakage to verify that the handicap ramp is properly resistant to weight and pressure material. Anti- ● Slip Test: Conduct a non-slip test to assess the non-slip properties of the handicap ramp. For example, assess the risk of slipping by moving a toy car on it. ● Usability Test: Perform a usability test to assess that the handicap ramp is functional in real use scenarios. Test accessibility by using the ramp using a toy model.
	Improve Generate ideas for improvement based on the collected feedback and test results. Involve students in this process and encourage them to share their suggestions for enhancing specific areas of the design. Based on these improvement ideas, make the necessary modifications to the disabled ramp's design. Provide students with the opportunity to revise their designs and implement the suggested improvements.
Materials	Each group will receive one worksheet for the **Modeling and Construction Activity.** This activity aims to raise awareness about the factors that influence slope. Each student will be provided with one worksheet for the **How to Calculate Slope activity**. Through this activity, students will gain an understanding of the concept of slope and learn which variables are necessary for its calculation. Each group will receive one tablet for the **Exploring Inclined Planes activity**. Using the tablet, students will capture pictures of inclined planes in their classroom or school environment. They will then upload these photos to the GeoGebra Activity in GGB, where they will calculate the slopes of the inclined planes. Following this, students will engage in discussions about the practical utility of inclined planes based on their calculated slopes.
Test	*This part will be completed by the teacher after the lesson plan is implemented in the classroom.*
Improve	*This part will be completed by the teacher after the lesson plan is implemented in the classroom. This activity was developed for secondary school level. The activity can be applied at the secondary education level by considering the parabola subject in mathematics lesson, and the endurance subject in the science lesson.*

Appendix 1. Modeling and Construction Activity

Necessary Materials: Cardboard or thin board, Silicone or glue, scissors and bristle saw, toy car

Students are divided into classes of 3 or 4. Preparation questions given below are distributed to each group. Students are asked to answer questions about different inclined planes.

Preparation Questions		
		
	Pre-activity answers	**Post-activity answers**
Look at the two inclined planes. Describe what you notice about each plane?		
If you had to push something up on one of the inclined planes, on which inclined plane would it be easier to push something up? Why do you think so? How can you find out?		

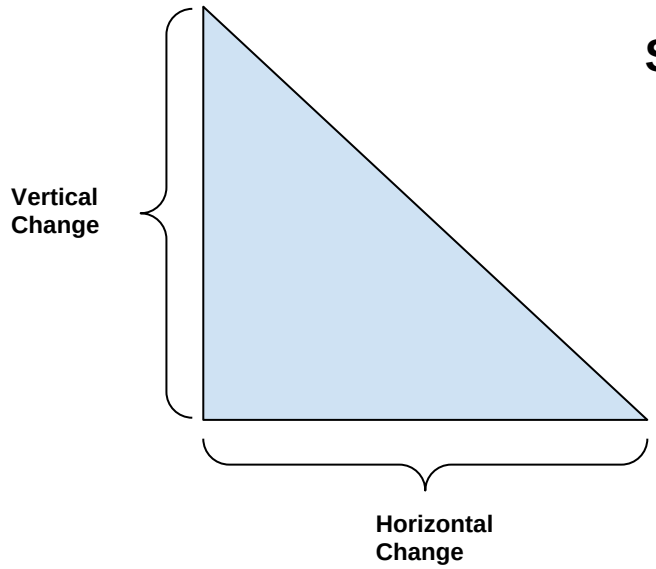
Materials are then distributed to each group to construct the inclined plane securely. Students are tasked with designing three different inclined planes, each with a unique slope. They will engage in discussions to determine whether it is easier or more difficult for a car to navigate each inclined plane.

During these discussions, it becomes evident that cars can easily navigate inclined planes with smaller slopes, while they face challenges when attempting to traverse inclined planes with steeper slopes.

Upon completing the activity, students are asked to revisit the initial preparatory questions they were given at the beginning of the activity. They are encouraged to identify any changes in their ideas and explain the reasons behind those changes. This process is then further discussed as a class.

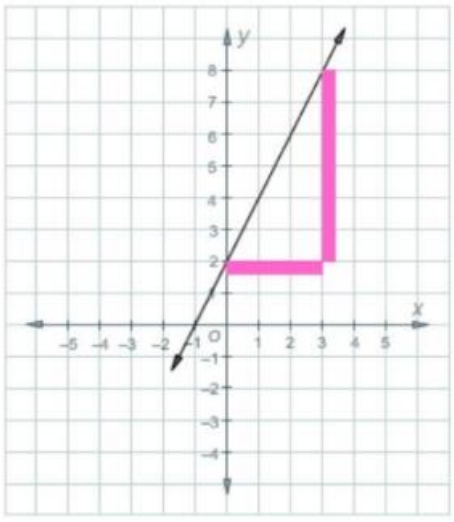
Appendix 2. How to Calculate Slope?

This activity aims to teach students how to calculate slope.

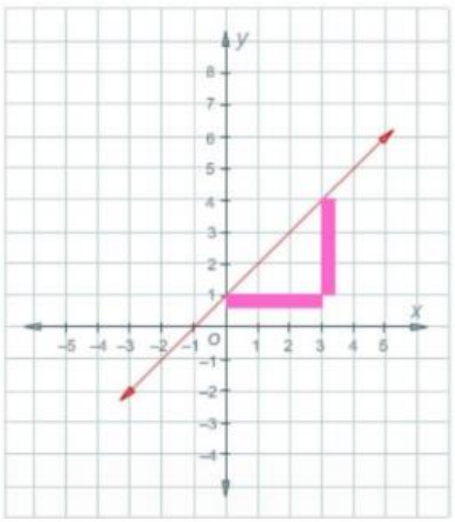


$$\text{Slope} = \frac{\text{Vertical Change}}{\text{Horizontal Change}}$$

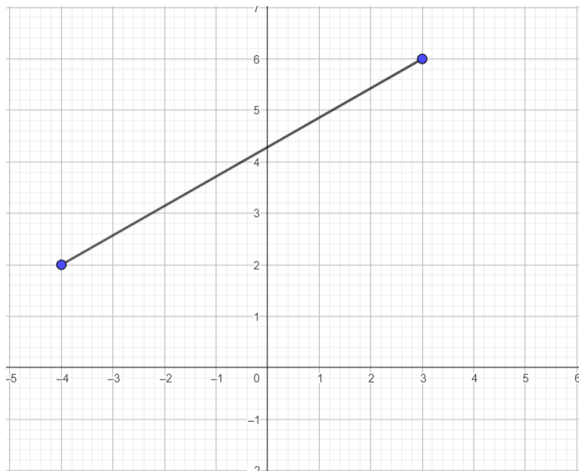
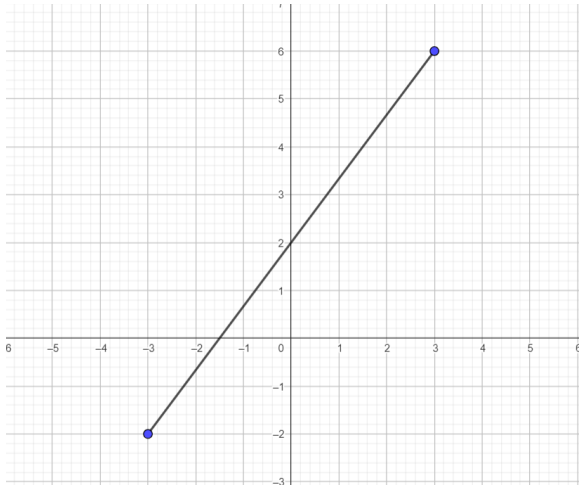
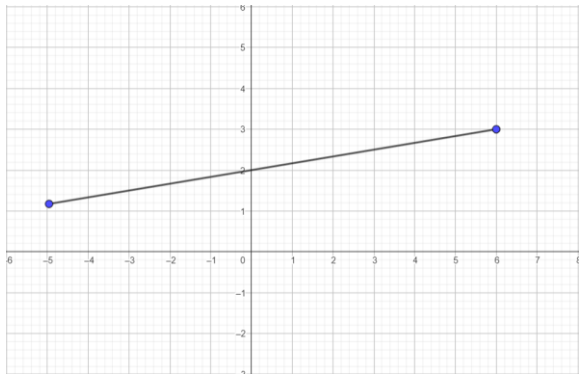
Example:



$$\frac{Vertical\ Chande}{Horizontal\ Change} = \frac{6\ Unit}{3\ Unit} = 2$$



$$\frac{Vertical\ Chande}{Horizontal\ Change} = \frac{3\ Unit}{3\ Unit} = 1$$

Slope	Slope	Interpretation of the slope
		
		
		

Appendix 3. "Exploration of Inclined Planes"

Necessary Materials: Tablets, worksheet

Students are divided into groups of 3 or 4. Each group is given a paper and a worksheet.

Students take photographs of the sloped planes they identify while traveling around the classroom and school.

- They first comment on the inclination of this inclined plane. Students are asked to find an answer to the following question. How do you think you would interpret the slope of this inclined plane (e.g. the slope of this inclined plane is large or the slope of this inclined plane is small)?
- Then comments are made about this inclined plane. Students are asked to find an answer to the following question. Do you think it would be easy to use this inclined plane to carry a load upwards? (e.g. If I want to take a load off, we can take it off easily or we may have difficulty taking a load off.

Name	**Comment about the slope**	**Comment on the inclined plane**
Stairs		