DESIGNED BY KEVIN PAQUETTE

The Meaning of Slope

A TECHNOLOGY INTEGRATED LESSON
PLAN FOR GRADE 9 MATHEMATICS

Increasing function **Decreasing function** **Constant function**

(a) (b) (c)
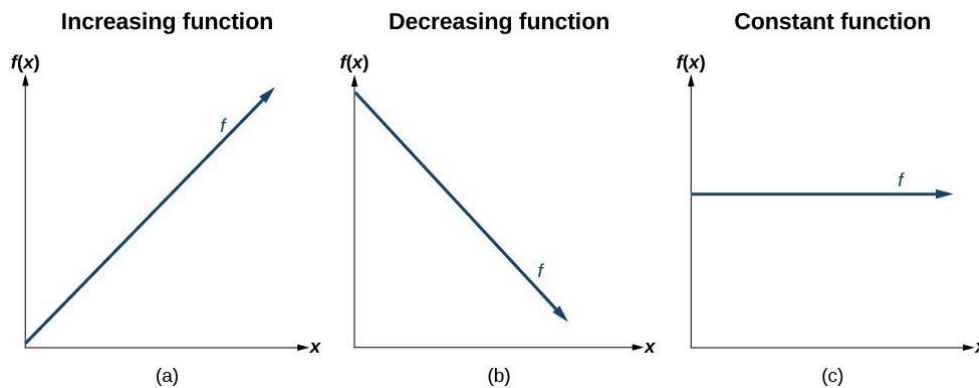
| Summary | Objectives | Specific Details | Procedures | Technology Integration |
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Lesson Summary:

This is an introductory lesson on the slope of a line. Students will be introduced to the equation $a = \frac{y_2 - y_1}{x_2 - x_1}$ and understand the meaning of positive vs. negative slope, and the relative slopes of parallel and perpendicular lines. Desmos will be used to help students visualize and practice these concepts.

Learning Goal: (Content Standard, taken from the QEP)

B. Straight lines and half-planes

    1. Uses the concept of change to

        c. calculate and interpret a slope → Student constructs knowledge with teacher guidance

Objectives:

By the end of the lesson, students will be able to:

- Understand the effect slope has on a line (e.g. how steep the line is) using Desmos with little to no errors by the end of the second class

- Determine the slope of a line correctly with 85% accuracy using the formula $a = \frac{y_2 - y_1}{x_2 - x_1}$ by the end of the first class

- Determine if lines are coincident (if they are, are they perpendicular?) or not (with respect to each other, or a given line) using only the slope of the lines and the relationship that lines are perpendicular if their slopes are the negative reciprocals of each other with 85% accuracy

Specific Details:

This lesson should be expected to take between 120 and 150 minutes (between 2 and 3 classes depending on the length). It will be based on individual work however there will be opportunities for students to work in pairs.

Instructional Procedures:

In grade 8, students are briefly introduced to the concept rate of change and linear functions but do not use those terms; they are given a table of values and asked to find the rule. The lesson will begin with a short discussion about what they saw last year along with 4 examples (maybe more if the class does not seem to remember). The first two will have only tables of values, the third will have a table of values and its associated graph (Desmos will be used here), and the last will have only a graph. This will serve as a pre-assessment to see where the students are at in terms of prior knowledge and readiness to move on to the main content of the lesson. The last example will involve something that students can relate to. For example, "if someone offers you

a phone for free and says that this line represents how much you will have to pay, how much would you be charged every month?".

Using this last example, the terms "rate of change" and "slope" will be introduced to students as a measure of how steep a given line is. The teacher will ask questions such as "how might you determine how much you pay each month" or "how would you figure out how much they want you to pay the fourth month" to encourage students to come to the formula $a = \frac{y_2 - y_1}{x_2 - x_1}$ by themselves as a class (i.e. without the teacher just giving them the formula). A second example will be presented without any context where students are simply asked to find the slope of a line, but the teacher will not allow them to simply plug in the formula. This will allow them to find the mathematical reasoning for why the formula is what it is.

If students seem to be getting the hang of how to find the slope of a line, then they will receive a worksheet to do either individually or in pairs (depending on their individual preference) for the rest of the class (50 minute class) or for about 20 minutes (75 minute class). If students need more explanation and examples, the worksheet will wait to be assigned later in the class and time will be allotted next class (50 minute class) or should be completed in class (75 minute class). Students will be asked to experiment with Desmos at home to see the effect that slope has on a line (see Technology Integration)

(For the rest of the lesson, I will not explain when each part should/will happen as I did because it will depend on when the worksheet was given, how comfortable students are with the material so far, and how long the class is.)

Through the use examples (purely mathematical at first, then with context), once again, the class will come to the conclusion that lines are perpendicular if their slopes are the negative reciprocal of each other (i.e. $a_1 = -1/a_2$) and that lines can intersect but not be perpendicular. If technology is readily available in the classroom (Chromebooks, etc.), students will be asked to do the rolling ball activity on Desmos, otherwise they will do it at home. The rest of the time will be dedicated to practicing this concept. Students can use this time to ask for help if there is something they do not understand before they move on the next topic, being initial values (linear functions that do not pass through the origin). After the last class, students will be assigned an online quiz (Google Form) to do to ensure their understanding and readiness to proceed.

Technology Integration:

The main technology that will be used in this lesson is Desmos, an open source platform online that allows users to plot many different 2-dimensional graphs. Students will be given the generic formula $y = ax$ and asked to experiment with different a values. The teacher will also use this software to go over the activity at the end of the lesson and to help students clarify their misunderstandings if they have questions or are unsure about something.

There are three major domains of Desmos that this lesson will make use of:

1) https://www.desmos.com/calculator

   This is the most basic one, allowing users to graph whatever they want and include parameters for which they can vary either manually or automatically. This is the site that the teacher will use to answer students' questions throughout the lesson and to sum everything up at the end. Users can preload various functions and choose which ones are visible by clicking on the circles on the left-hand side of the function. "Projector mode" also allows for the only the graph to be projected so that students cannot see the equation of the function.

   For example, https://www.desmos.com/calculator/mndqybjagm

2) https://student.desmos.com/

3) https://teacher.desmos.com/

   2) and 3) go together as a "teacher creates activity, students do activity" type interface. The teacher first creates a class code which students can then input at https://student.desmos.com/ to access the teacher's activity. This lesson will make use of a rolling ball activity. Each level starts with a given line (and its equation) with a ball above it and a star somewhere on the graph. Students must alter the equation to collect the star by having the ball roll over it. While the activity allows teachers to have students alter either slope, initial value, or both, it will be restricted to just slope for now. Students will revisit this activity after being introduced to the concept of initial value when they will have to consider which parameters they must alter.

   The teacher can see what students answer so this is a good formative assessment and will show the teacher if they must spend more time going over the material or if they should provide extra help to certain students.

(https://teacher.desmos.com/activitybuilder/custom/566b31734e38e1e21a10aac8, note that only certain questions would be assigned to students)

The other technology that is important for this lesson is Google Forms which will be used at the end of the lesson as a summative assessment. This is explained more below (Evaluation).

Learning Outcomes:

By the end of the lesson, students will be able to analyze linear functions based on their slopes to determine 1) how steep a line is, and 2) if two lines are coincident (if they are, are they perpendicular to each other?).

Evaluation:

As was explained above (Instructional Procedures), there will be a formative pre-assessment at the beginning of the lesson to see how comfortable students are with the pre-requisite material. After the final class, students will be assigned a short Google Form to do at home as a quiz to see if they understand the material. This is, of course, in addition to the ongoing formative assessment throughout the lesson. For the purpose of demonstration, this quiz allows you to repeat it however many times you want and you get a grade immediately; the quiz that will be used for the actual lesson will not give the student a grade as soon as they finish and can only be completed once by each student (they will need to log in, many schools give their students Google accounts). While there is nothing preventing them from working together to receive the same grade (although it is highly recommended that they don't work together), this will prevent students from being able to keep track of their friends' answers and get 100% without doing any thinking.

(https://goo.gl/forms/Hpjz3e51eyCFOqw42)