

STORY VARIABLES NON-DIGITAL ACTIVITY MATERIAL

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These draft lesson plans, worksheets, worksheet solution guides, and review sheets are intended to instantiate activities developed as part of *Thinking Outside the Box: Integrating Dynamic Mathematics to Advance Computational Thinking for Diverse Student Populations*, a National Science Foundation's STEM+C/Core R&D Programs #1543062. These draft versions correspond to those used in classroom research February - March 2017. As drafts, no warrants are made about these materials' completeness or correctness.

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VELA LESSON #5

Story Variables (Non-Scratch) Lesson

What comes Before

Simple conditionals without variables (Scratch) lesson

What comes After

Cats and Ladders (Non Scratch) lesson

Summary

Students will collaboratively investigate a series of stories all containing *quantities that vary*. Through partner and group discussion, students will come up with a class definition of **'variable'** and practice identifying and naming variables meaningfully.

Desired Outcomes

Students will be able to . . .

- Define VARIABLES as quantities or things that change over time
- State that VARIABLES are common things we use in everyday description of changing situations
- Evaluate a name for a VARIABLE that will be accurate and descriptive even as the value changes, and not a single letter as many students wrongly tend to believe
- Identify a VARIABLE from a real world scenario with a name that does not change over time, and specify the value of the variable at a specific moment in time
- Analyze a VARIABLE's changing values to determine its specific types and expected ranges. Depending on the type of situation described by a variable, its values might be numbers, or names, or directions, or colors, or any other set of possible answers to the question

New Vocabulary Used/Introduced:

Variables	Values or quantities that change over time
Range of a variable	Possible values a variable can have
Variable Type	Numeric, Text, [Boolean (True/False) - not used in this lesson]

Hand out “Do Now” / Review Sheet for “Simple conditionals” before attendance to start the class (5-7 mins)

Prior Learning Connections:

If students have encountered the idea of VARIABLES previously, it is likely they have done so in a mathematics context, where VARIABLES are frequently thought of as “unknowns denoted by single letters” (e.g. $x + 1 = 3$) or as expressing universal relationships (e.g. $area = width \times height$). Here they meet VARIABLES in a *modeling context* more suitable for computer programming, where VARIABLES are used to represent specific (known) quantities or things that may change over time.

Overview of Tasks:

Hook/I Do	Student discussion guided by teacher finding commonality in stories
We Do	Pair discussions With Writing and discussing answers with the whole group
You Do	Option: Students create their own stories and practice isolating variables in each other’s stories; OR Students list 3-6 variables they can identify in a different “story” they watch as a YouTube video
Closing	Students do a quick verbal summary of the day’s learning

Assessments:

1. Mid lesson assessment: Listen to students identifying the variables and add the identified variables to a table during the whole class activity. Be sure to monitor pair talk during the discussion to identify misconceptions that can be understood by the whole group
2. End of lesson assessment: Each of the “You Do” activities offer opportunities to see student understanding. For Option 2: Observe a Popular Video Game activity, pay attention to work across the table even if you don’t understand the whole game yourself, you should see students be able to fill out the chart in a logical way (e.g. The grass in minecraft changes color based on the light; in the video the grass is normal, light, and dark green; the possible values are shades of green; I will call this variable `grass_greenness`). The upcoming Cats and Ladder’s lesson will provide more opportunities to practice variable naming.

Materials:

[Worksheets](#) (1 per student pair), Projector with Slide Deck and/or Stories written on white board, Table on variables (see below) should be drawn on chart paper and/or on whiteboard. If choosing the Popular Video Game option have a Projector with a “let’s play” video cued up (see the You Do activity)

Differentiation and Accommodations:

Mixed ability partnering will help, giving some concrete examples of one-on-one interactions during partner sharing for either You Do activity option.

English Language Learners:

Students should be paired with attention to their language abilities. Vocabulary around variable should be posted if needed. For the “You Do” activity students might be provided some vocabulary in a word bank either to come up with their own stories, or for whatever video game you choose to use for Option 2.

Procedure:

Hook:

Teacher: Let’s look at some different story fragments you might hear in different conversations. What do you think they have in common? (Projects story fragments Story 1-Story 4 on board.) These are the same prompts you have in front of you on your worksheet.

Let’s start by individually writing out what you think variables are on your worksheets. Don’t forget to write your names first.

“Then, with a partner discuss what all these stories have in common.”

Give students a few minutes and then call on a few students for responses. Try to find a student who recognizes that each is something said to you, maybe by a teacher, friend, or a parent. Ask “But what’s in common about the different things that are being said? You have three minutes!”

Teacher: “All right come back to eyes on me, let’s ask what a couple people came up with as something in common.” (Call on some different partner groups.)

After a few responses when you come to someone with the answer:
“they all have something that changes over time”

say “interesting...you noticed that all of these seem to be about some sort of situation—more than that, some sort of specific quantity—that *changes* over the course of what’s being said: the price of a pen, the temperature outside, the t-shirt sizes, the scores in a basketball game. If we think of the story as describing or taking place in some period of time, these quantities or things *change* over that period of time.”

If students cannot come up with this answer, explain what the stories have in common.

We Do

Teacher: “In computer programming, we call things like that “**variables**”—values or quantities that change over time. Any interactive program—any program that changes things when you use it—probably uses variables to keep track of change.

“Let’s see if we can identify what’s changing in each of the stories, and how it changes. What are its different values in this story, what are the different values it could be, and how could we give it a good, descriptive name?”

First I’m going to give you a couple minutes with your partner to find and write down what changes for each story on your worksheets. Then we’re going to come back together as a whole class and fill out a table together (empty) table:”

All students need not finish filling out the worksheet. Give students enough time so that all pairs can finish working on at least 2 stories.

Then, for each story, collect a number of names for the variable, hold votes or short discussions on which is the BEST name. Note that the name column might look very similar to the “what is changing” column, that is okay, but they need to practice for when naming variables is more abstract later in their programming. If the class has many disagreements have students discuss it in pairs to come up with the best answer. Ask “who can tell about a partner who changed our minds in our thinking pairs and how did they do it?” to get students to do some think alouds.

Pursue these teaching points as they come up in the class.

What are best naming practices? Use this list to guide your discussion. Cover as much of these as possible while keeping up momentum and an authentic discussion. Some of these concepts will come up as you move through the stories.

- Short—ideally one word or a short noun phrase (when writing in most programs words will need to be concatenated “TeacherName” or spaces will be an underscore “Teacher_Name” Scratch does allow for spaces in variable names).
- Identifiable for it’s story (you should be able to identify what story it is for)
- Isn’t confusable with other variables in the story
- Almost always nouns (speed rather than “how fast”)
- Fits in a sentence like “Right now the *variableName* is *variableValue*.” Right now, the *priceOfThePen* is \$3.00.
- Somehow suggests appropriate values (*temperature* = 45° is better than *howHot* = 45°)? When we say THE OUTSIDE TEMPERATURE IS 80°F, the VARIABLE is “temperature” -- because it answers the question “what is changing?” (“The OUTSIDE

TEMPERATURE is changing" not "80°F is changing.") And 60°F is the VALUE which the variable has at the given moment we heard about. So a single VARIABLE, when it changes, takes on new and different VALUES. Likewise, a single VALUE might be the same for multiple different variables. ('The OUTSIDE TEMPERATURE is 80°F AND the SWIMMING POOL TEMPERATURE is 80°F.'

Pay special attention to Story #4. There is a lot of complexity there students won't see at first. Is the "score" of a game one variable (like *Score = 45:15*) or two (*Home=45, Away=15*)? (Arguments both ways are legitimate, but treating it as two separate variables, with numeric values, might let you *compare* them and answer questions like *average score* or *highest score* for a single team more easily.) Ask students about what the score is at the beginning of the game, ask them what they know about the score in the middle game and what they think we should do with that information.

Concluding discussions

Teacher: "Let's write down everything we know about variables so far."

It might help to enlist a student helper to do the writing on the board, and another student to pick students with raised hands to share.

Try to capture as many of the following ideas as possible:

1. Variables are quantities that can change over a story or program.
2. A variable's value is its quantity at one specific time in the story or program.
3. At any given moment in time, a variable has a specific value—even if we don't always know what it is (e.g. *Our Score* at halftime!). (In fact, one of the main reasons we use *variables*—in stories and in computer programs—is so we can describe situations even when we don't know their exact values. "It's hotter out than yesterday" doesn't tell you *how how* "it" (the temperature variable) is, but instead tells you how its value *today* relates to whatever value it had yesterday.)
4. Likewise, a variable's *name* lets us talk about it even without knowing its value at a specific moment.
5. Variables don't have to be numbers, the way they are in math class. (e.g. Shirt size, *weather, etc.*)
6. The values of variables tend to be in a range or drawn from a set of reasonable possibilities. A t-shirt size will never be a negative number, our team's basketball score will never be ten million, or an adjective like "hairy," etc.

Proceed to answering review questions individually (2 options).

Review questions - (Teacher Chooses From 2 Options):

OPTION 1: Variables in student developed stories:

“Now each of you will come up with two stories involving some changing quantity of your own. You will need to think of a story where something changes over time (a variable), and mention some different changes. The story can be just a couple of sentences long, like the ones we’ve already done. First write down your stories on one piece of paper. Then, for each story, fill out a row in the table like the one we did with the stories given to you. You will have to identify what is changing in your story, a good name for the thing that is changing, some *specific* values the variable *actually* has in your story, and the range of possible values the variable *might* have.

When we are done we are going to swap our two story ideas with a neighbor and each fill out our table for the other person’s story too, not looking at how they filled out *their* table.”

After students finish filling out the table for their stories and their partner’s stories, have all teams explain why they disagreed or agreed on names for variables. Call out some student pairs to explain what their names were, and if they were different why they were different. Highlight that there might not always be only one right way to name a variable.

OPTION 2: Variables in video-game stories:

Provide students one of the links provided below or provide a new game link.

This option may be more difficult to assess if you are not as familiar with the video games. Some of the games have lots of different variables (see Minecraft), but note that students need to only choose 3. At this point correctly identifying a few variables and coming up with descriptive names and understanding possible values is more important than recognizing all the variables.

Find a link of a young person playing through a video game (These videos frequently are titled “Let’s play . . .”) Choose either a simple video game like Pac-Man or Donkey Kong, Tetris, or a more complex game your students are talking about, Minecraft and Clash of Clans are both very popular.

Complexity	Game Title	Example Variables	Suggested Link
Very Low	Tetris	Position, type of piece, Orientation, Score	http://tinyurl.com/jao4pne
Very Low	Pac-Man	Score, Level, Power Mode, Position, Orientation,	http://tinyurl.com/h3tugm2
Low	Super Mario	Lives, Level, Position,	http://tinyurl.com/zvyyao2

		Coins, Little/Big/Fire flower Mario	
Complex	Clash of Clans	Level, Elixir, Gold, Army members,	http://tinyurl.com/z6rd4kv
Very Complex	Minecraft	Food, Hearts, Stone, Wood, (many different other things)	http://tinyurl.com/z3uttkm

Teacher: “So let’s try to see if we can identify the variables in a game. I’m going to play a YouTube clip of a young person playing a popular video game. While you watch try and write down three different changing elements or quantities in the game, as a challenge see if you can get up to 6!. Think about how you might represent these changes with variables. For each type of change, think about how to describe what is changing, what a strong descriptive name for that changing variable might be, what it’s value could be or could *possibly* not be, and what *actual* values you see for it represented on the screen. We will see LOTS of different possible variables! For this assignment try and pick 3 that you notice.”

Watch the video while students are taking notes on the variables they notice. Hold a group discussion as students mention variables they noticed, and push kids to suggest items that they weren’t certain are variables or not. Pick one or two and decide as a class, what is a good name for the variable (example: score), what are the possible values for the variable (any number), and what values we saw (100 points).

Closing:

Have students pass back any evidence of learning (worksheets and review sheets) Call on some students to teach back to the class what they learned about variables today. Congratulate the students on their work and close class.

Names: _____ and _____

What do these stories have in common?

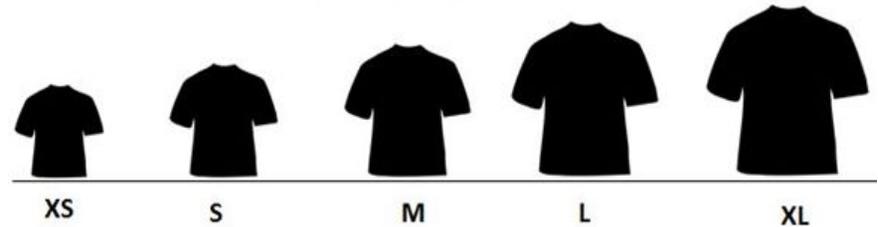
Story 1

“Excuse me --- last week I bought one of these pens here for \$1.50. Are you really telling me they now cost \$3?”



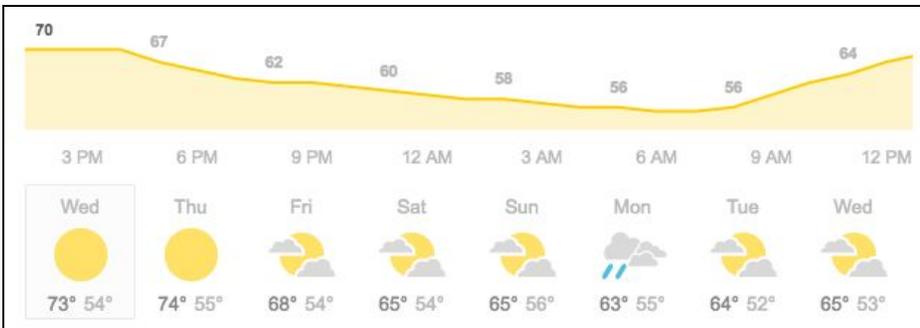
Story 2

“We sell t-shirts in all sizes - extra-small (XS), small (S), medium (M), large (L), and extra-large (XL)”



Story 3

“Here is the temperature forecast for the next few hours today and for the rest of the week.”



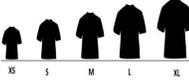
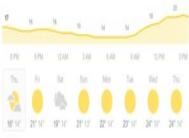
Story 4

“I watched the basketball game last night. At halftime we were tied, but in the end they beat us, 34-30.”



A variable is: _____

With a partner fill out the following table about variables in these stories

Story:	Describe a specific element or quantity in the story that is changing	What would be a good, meaningful name for the variable?	What are some of the <i>specific values</i> of the variable within the story?	How would you describe <i>all possible values</i> this variable might take?
<p>1</p> 				
<p>2</p> 				
<p>3</p> 				
<p>4</p> 				

Story Variables Worksheet solution

Here is an example of what the table for each of the 4 stories would look like when filled out. The last column are comments from the curriculum designer just for you, referencing particular teaching points you might want to emphasize about the different stories.

Story	What is changing	What is a good name for the variable	What are some of the values in the story	What are the possible values	Teaching points (for teacher reference)
#1	<i>Price of a Pen</i>	Pen price, cost, price, cost in dollars, dollar cost	\$1.50 (Last Week) \$3.00 (Now)	Any monetary number. But probably not more than a million dollars!	This one is the most straightforward, you might want to do this with students as an example. Point out that if the variable is "cost", we would not know if it meant the "cost" of a pen or the "cost" of a book, or something else.
#2	<i>How big the t-shirts are</i>	Size, Shirt size	XS, S, M, L, XL	Any valid size described using letters or numbers or a combination, like 8P or 10T	This shows that variables can contain non-numeric values. (In computer programming, values like the names in this story are often referred to as <i>text</i> , <i>character data</i> , <i>alphanumeric data</i> , or " <i>strings</i> ".)
#3	<i>Maximum and minimum temperature for different days of the week, Temperature for different times during</i>	Temperature, weather, Maximum temperature, minimum temperature	"17", "16", "15", "14", "21", etc. - values for temperature "Sunny", "Cloudy", "Partially cloudy" - values for weather	Any reasonable value for temperature, or any feasible weather conditions like "stormy", "snowy", "rainy", etc.	Students might just say that "day of the week" or "time of day" changes and that is a variable. That is correct, but also get them to think about temperature and also weather, if possible.

	<i>the day today</i>				
#4	<i>Our team's score and other team's score</i>	Team A score, Team B score Home Score, Opponent score	0,0 (at start of game) same scores (Home score =Opponent score) (at halftime) 34,30 (at end of game)	Scores can be positive whole numbers	We know that the scores start at 0 in basketball, even though it's not stated. Sometimes even if we don't know a variables exact value, we know its relationship to other variables, which we can describe using an <i>expression or equation</i> , such as <i>Our Score = Their Score</i> (when scores are "tied"). If we know those other variables values, we can then use the expression to compute our own value. Thus if <i>the scores are tied</i> and <i>Their Score = 15</i> then <i>Our Score = 15</i> too!

Name: _____

Story Variables Review - Variables in Student-Developed Stories

In box A and B

1. Come up with two stories about situations or things that changes over the course of the story--like the examples you read earlier.
2. Mention specific details of the situation in your story as it changes---specific values a variable might take over the course of the change.
3. After writing your stories, fill out the first two rows of your worksheet on the next page for your two stories.
4. Then, interchange your stories with your partner. Use your partner's stories to fill out the last two rows of your worksheet.

A) Your Story 1:	B) Your Story 2:
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Student-Developed Stories Part 2:

Story:	Describe a specific element or quantity in the story that is changing	What is a good name for the variable? (1-3 words)	What are some of the specific <i>values</i> of that variable within the story?	What are other the possible values it <i>might</i> take, in a similar story?
A) Your first story				
B) Your second story				
C) Your partner's first story				
D) Your Partner's second story				

Name: _____

Story Variables Review - Variables in video game stories

Click the video game link your teacher provides and watch the video.

As you watch the video game, come up with 3-6 variables you observe in the game. For each variable, identify a good name, what values the variables had in the game, and possible values (range) for the variable.

	Describe a specific element or quantity in the story that is changing	What is a good name for the variable? (1-3 words)	What are some of the specific <i>values</i> of that variable within the story?	What are other the possible values it <i>might</i> take, in a similar story?
1				
2				
3				
4 (optional)				
5 (optional)				
6 (optional)				