**Wasted Water?**

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| In this lesson, students develop an understanding of the concept of graphing data over time on a line graph, by measuring (at multiple times) the amount of water being poured. They work collaboratively in teams, with roles for accountability, as they practice protocols for a productive mathematics classroom culture. |

**NC Mathematics Standard(s):**

**Measurement and Data**

NC.5.MD.2 Represent and interpret data.

• Collect data by asking a question that yields data that changes over time.

• Make and interpret a representation of data using a line graph.

• Determine whether a survey question will yield categorical or numerical data, or data that changes over time.

**Standards for Mathematical Practice:**

* Math Practice 2 Reason abstractly and quantitatively
  + Students will be collecting data around an interesting question. They then represent the data gathered to the meaning of the representations in a line graph. Students also study the data of other line graphs and attend to the meaning of the data represented in them.
* Math Practice 3 Construct viable arguments and critique the reasoning of others
  + Students analyze data as teams and make conjectures from the findings of their data. They compare their data to the data of other teams and compare their reasoning to the reasoning of other teams, as it relates to the data each team collected.
* Math Practice 6 Attend to Precision
  + Students carefully measure the height of the water over time, using a ruler and accurately specifying the unit of measurement. Students also label the axis of the line graph to clarify the meaning of each data point.

**Student Outcomes:**

* I can use a line graph to graph data collected over time.
* I can participate on my team by completing my role.

**Math Language:**

**What words or phrases do I expect students to talk about during this lesson?**

Students will be using vocabulary from third and fourth grade such as*: data, graphs, categories, frequency table, scaled picture graph, bar graph, axes, survey, line plot, title.* New vocabulary words that will be conceptualized and then used in this lesson are: *data that changes over time*, *line graph, points, coordinates, team roles, reflection.*

**Materials:**

* For each student team of 4:
  + 2 liters of water
  + empty container (large enough to hold 2 liters of water)
  + Measuring container with milliliters (Beaker or Measuring Container)
  + team recording sheet
  + graph paper
  + paper towels (just in case)

**Advance Preparation**:

* Print team recording sheets
* Set up 2 liters of water, 1 measuring container, and 1 empty container for each team of 4 students
* Provide graph paper for use with exit ticket

**Directions:**

***ENGAGE/LAUNCH: (5-7 minutes)***

*Build Upon Prior Knowledge*

* Say: In previous grades, you have collected data by conducting surveys and you have organized that data in bar graphs, line plots, and picture graphs. *(Consider including images of those types of graphs as a review.)* Today we’re going to explore a new way to organize data that we collect: the line graph. A line graph is used to organize data that changes over time. To do this, we need to collect some data that changes over time. Today, we’re going to collect data on how much water pours out over a certain amount of time.
* Say: Sometimes, in math class we talk as partners and share ideas. When you talk with a partner, it is important that you look at your partner. That shows respect and shows that you are listening. While your partner is talking, it is also important for you to actively listen. Actively listening means that you are hearing what your partner says and are connecting their thoughts to your thoughts. Then, when your partner pauses, you can share in the conversation by making connections between your ideas and their ideas. Sometimes, you and your partner might disagree. It is important that you disagree politely, because everyone’s thoughts are important.
* Say: Turn and ask your partner these questions:
  + “Do you brush your teeth every morning?
  + When you are brushing your teeth, do you turn the water off?
  + How much water do you think is wasted by not turning off the water?
* Show one of these videos if you wish:

<https://www.youtube.com/watch?v=pr3-I68c-GE&feature=youtu.be> (length of video :36)

<https://video.nationalgeographic.com/video/green-guide-howdini/conserve-water-greenguide> (length of video is 3:21)

<https://www.youtube.com/watch?v=B4ZR53n0D8I> (length of video is 2:52)

<https://www.youtube.com/watch?v=hLcKn1M5fRQ> (length of video is 2:01)

***EXPLORE:***

**Activity 1: Wasted Water? (Collecting Data) - 15 minutes**

*Introduce the Task*

* Say: Today, we’re going to investigate how fast water pours out over 1 minute, and keep track of that data over time. In order to see how much water is being poured out over time, we will need to measure how much water has poured out every ten seconds. Ask: How many trials will we need to do if each trial is 10 seconds and we need data for one minute? (Since there are 60 seconds in a minute, we will need to do 6 trials or rounds)
* Say: Since we don’t want to waste water, we will use the water from our experiment to water plants and flowers in our schoolyard at the end of the lesson!
* Say: In our math community, it is important that we work together, so we can share ideas and learn from one another. When working as a team, it is important that everyone completes their job well and works together, so the team can accomplish the goals. Today, you will need to work in teams of 4 people, so we can explore this idea of how fast water pours out over time. Each person on your team will have a special job. There are 4 jobs for each team (1 job per person):
  + **1st job: Pourer** (Person pouring the water)
  + **2nd job: Catcher** (Person steadying the container that catches the water)
  + **3rd job: Timekeeper** (Person watching the clock and telling the team when ten seconds is up)
  + **4th job: Measurer/ Recorder** (Person using the measuring container to measure the height of the water at the end of every ten seconds and recording the data after every measurement)
* When working as a team, it is important that everyone works together to complete the task safely and correctly. For this task, the Timekeeper must stay focused on the clock, so the Pourer knows when to stop. The Pourer will need to stop pouring, so the Measurer can measure accurately. The Catcher will need to hold the container still, so the Pourer can pour and the Measurer can measure. The Recorder will have to pay close attention to the measurements, so our data will be accurate. Each team member plays a very important part in the team’s success.
* Ask: What might be some variables that could affect our data?

(Ideas such as how fast someone pours, how they tip the bottle, if any splashes out)

* Ask. Are there any experiment rules we want to all agree on?
* After collecting your data, you will reflect on how your team worked together today (see Team Recording Sheet). *Teacher Note:* The recording sheet does not have a column for keeping a running total. The graph that students will construct will be representing the **total amount of water** that has been collected after each ten-second interval. The discussion after the data is collected will allow students to conclude that they need to do some totaling of their data. Some teams may notice that they are just collecting data for each ten second interval and you can call upon them to share their ideas in the discussion

***\*\*If necessary, consider modeling this process briefly for students. Give students an opportunity to ask any remaining questions, prior to beginning the task. Show this Instructions Card if needed!***

Instructions:

* Decide on the way you will pour the water.
* Pour water for 10 seconds.
* Record the number of milliliters on your recording chart.
* Pour water for another 10 seconds.
* Record the total number of milliliters poured.

(If your container becomes full, dump the water and then add the next amount to the recorded amount.)

**Activity 2: Discussing How to Show Data Over Time in a Line Graph (5 min.)**

* Say: *(Bring the class back together)* Now that you have gathered your data, we need to organize that data so that it can inform others and help us draw some conclusions. Since our data was collected over time, we will use a line graph to show the changes we observed.

*(In previous grades, students have conducted surveys and created bar graphs, line plots, and picture graphs. Remind students that the purpose of those graphs was to organize categorical and numerical data.)*

* Say: We can also measure things that change over time, such as: tree growth, gas prices, car prices, etc. We record that data on a line graph. Discuss things we could learn from reading a line graph about tree growth, gas prices, car prices, etc. (i.e. Trees grow approximately 1 foot per year. Gas prices increased an average of 12 cents during hurricane season.)
* If desired : Show Video (Length of video: 1:39):

[*http://www.watchknowlearn.org/Video.aspx?VideoID=42777&CategoryID=4106*](http://www.watchknowlearn.org/Video.aspx?VideoID=42777&CategoryID=4106)

* Ask: How is a line graph different from a bar graph? Line plot? What information do you need to create a line graph?
* Have students turn and talk about similarities and differences.
* Select student responses to share.

***\*\*Consider providing a sample line graph for students to reference as a guide for creating it.\*\****

**Activity 3: Creating a Line Graph (15 min.)**

* Say: Since we want to show how the amount of water we waste changes over time, what do you think we would want to show on the graph? How can we show how much water was wasted at the end of the one minute? After half a minute? (Students may think that they need to plot each data point on their table, instead of finding a running total. Continue to ask students how we would shoe how much water is wasted as time goes by.)
* Say: As teams, compile your data into a line graph, and begin thinking about what you can learn from that data. Remember to include the title for your line graph, and label each part, so others can learn from your data. Once finished, compare your line graph to the line graphs of other teams. Remember to work as a team to complete this task, and make sure that everyone has a part in the work.
* Students may need assistance in thinking about how to orient their graphs. Allow for productive struggle and inform them of graph conventions as they work and as the need arises. (IE the time in seconds is the *x-axis*, the number of milliliters is the y- axis, the intervals on the y and x axis do not need to be the same but they need to be consistent for each axis. If students make errors, and their data is not displayed correctly, it will provide for a discussion about conventions with line graphs.

**Informal Evaluation/ Formative Assessment**

As students work, ask questions that will help them pay attention to the aspects of a line graph.

* What numbers will you use to represent the number of seconds? (Note: this set of numbers will be on the x axis/ the scale could be by tens.)
* What numbers will you use to represent the amount of water? ( y axis)
* How will you decide where to plot the points on the graph?
* How do you predict the line will look when you connect the points?

Pose questions such as:

* + How did you use your recording sheet to help you create your line graph?
  + What similarities do you see in the line graphs?
  + What differences do you see in the line graphs?
  + What causes teams to have different line graphs?
  + What conclusions can you make from analyzing the data?
  + What do you wonder when you look at your data?
  + How does the data on the line graphs correlate to the speed at which each team poured their water?

As students work look for students who will share out in the whole group discussion. Look for (throughout today’s lesson):

* + Team collaboration: each team member completing their role.
  + Accurate measurement of water levels
  + Precise recording on table
  + Precise creation of line graph
  + Conversations about findings from the data

A few minutes before the Explore time is over, ask students to talk with their partners/groups and then write in their journal responses to these two questions:

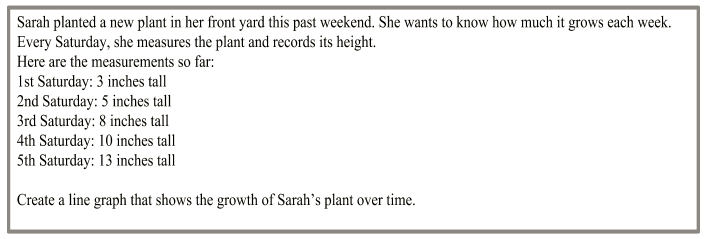
* + In what other areas of your life would you collect data over time?
  + Why would that information be helpful?

***EXPLAIN OUR LEARNING/ WHOLE GROUP DISCUSSION:***

* The main ideas to come up in this discussion are:
  + Line graphs show data that is collected over time.
  + As a team, it is important for each member to do their part in order for the team to be successful. It is also important for teams to reflect on how they are working together. Working as a team is much like working in partners. You have to listen to the ideas of others, and think about how your thinking is similar or different to theirs. Then, you and your teammates can share connections that you have made between your thinking. When you listen to one another, it is important to make eye contact and be sure to really focus on what your teammates are saying. Then, you can build on what they have said, too.
* Ask your selected students to share their strategies for working as a team to complete this task. Also, select students to use tables and line graphs to share findings from the data collected. Strategically, select two line graphs from different teams that had distinctly different results. Pose questions such as:
  + Can you tell during which part of the pouring there was more water wasted? ( longer distance between points, a steeper line)
  + Can you tell in which graph the water was poured the most consistently? (the distance between the points is about the same)
  + What part of the graph tells us how much water was wasted in one minute?
  + Show a liter of water. Say this is one liter… about how many water bottles of this size were wasted?
* Say: As mathematicians, we sometimes have arguments about mathematical ideas. When we have mathematical arguments, we don’t argue like you do when you get in trouble with your brother or sister. We argue by supporting our thinking with evidence from our work. When you share an idea with your teammates, you need to make sure to provide an explanation of your thinking, so they know how you came to that conclusion. In a mathematical argument, we also need to be listening well, so when we agree or disagree with someone, we can provide examples of our work to prove our thinking.
* Ask students to use their data to predict the amount of water they would waste if they let the water run for 2 minutes while brushing their teeth. They might also want to calculate how much water would be wasted by each student in the group or each student in the class if everyone let the water run for 1 minute and for 2 minutes. Encourage students to turn the water off while brushing their teeth to conserve it.
* Use the students’ ideas to target the mathematical goals of the lesson.

**Evaluation of Student Understanding**

Formal Evaluation/Exit Ticket:



**Meeting the Needs of the Range of Learners**

**Intervention:**

* There may be students who have not conceptualized the idea of organizing data. Support these students by discussing how data was organized in previous years (bar graphs, etc.) and help them make the connection to the line graph.
* Some students may not understand the concept of collecting data over time. Consider providing more examples for them of how things change over time and how we collect data on them.
* Some students may have difficulty drawing/creating the line graph. Consider providing a template (containing axes, places to write in labels, etc.) for them to complete with their new data.
* Some students may need additional support with group work. Have students review their roles within the group and reassure them that they will have additional opportunities to serve in different roles throughout the year. These students may also benefit from models of sentences to use when interacting with others (“Please be sure to hold the container still so I can pour into it.” “You might want to pour more slowly to keep the water from splashing out of the container.”)

**Extension:**

Activity 1: Before completing the activity, students predict how the data will look after each 10-second pouring and justify their reasoning in writing. After the activity, students will reflect on their predictions and discuss why they were similar or different.

Activity 2: As students are comparing data with another team, have them answer questions, such as:

-What caused your line graph to look different from another team’s line graph?

-What would have to happen to make the line graphs look the same?

-What conclusions can you draw about pouring water from looking at two different line graphs?

**Possible Misconceptions/Suggestions:**

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| **Possible Misconceptions** | **Suggestions** |
| Students may confuse a line graph with a line plot. | Display a line plot and a line graph side by side. Discuss what the data represents in each (using the context of the data). For instance, a sample line plot may describe the number of students in a family, and the line graph may show how one family member’s height changes as he grows older. Discuss how the two graphs have very different purposes. Allow students to brainstorm examples of data that could be represented by each. |
| Students may have difficulty constructing a line graph, and plotting the data points. | Provide graph paper for all students, so their data is best organized. Relate their understanding of other graphs to help them remember to add a title and labels for the data. Consistently ask, “What do these numbers mean?” and “What does this data point represent?” |

**Team Recording Sheet**

**Team Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

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| --- | --- |
| **Time** | **Measurement (milliliters)** |
| **10 sec.** |  |
| **20 sec.** |  |
| **30 sec.** |  |
| **40 sec.** |  |
| **50 sec.** |  |
| **60 sec.** |  |

**How did your team work together today? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

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**What are some things your team did well today?**

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**What are some things your team can do better next time?**

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**Exit Ticket**

**Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

Sarah planted a new plant in her front yard this past weekend. She wants to know how much it grows each week. Every Saturday, she measures the plant and records its height.

Here are the measurements so far:

1st Saturday: 3 inches tall

2nd Saturday: 5 inches tall

3rd Saturday: 8 inches tall

4th Saturday: 10 inches tall

5th Saturday: 13 inches tall

Create a line graph that shows the growth of Sarah’s plant over time.

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