Data Cycling:
Mathing Out the Right Course

BLANDY
EXPERIMENTAL FARM
University of Virginia

2025 Annual VAST PDI
November 13 -15

Alexandria, Virginia

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Session Agenda

- Introduction
- Session objective
- Accessing the VA Math SOLs
- Key differences at each grade level
- Engage in data collection
- Examples of the data cycle at different grade levels
- VDOE 2025 graph progression document
- Informal education and the data cycle
- Student resource for data representation
- Closing

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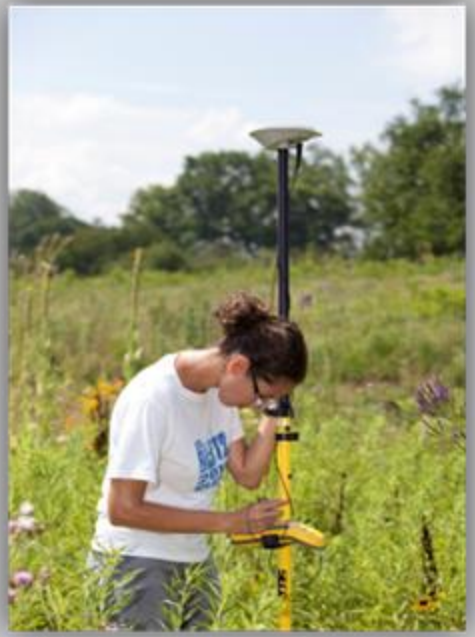
University of Virginia's Blandy Experimental Farm & The State Arboretum of Virginia

- Field ecological research station
- The State Arboretum of Virginia



University of Virginia's
Blandy Experimental Farm
&
The State Arboretum of Virginia

Blandy's Mission: To increase understanding of the natural environment through research and education

Education Outreach

BLANDY EXPERIMENTAL FARM
University of Virginia

- Hands-on, outdoor, experiential field investigations
- ~7000 PK-12 students per year
- Inquiry, Science Process and Skills focused programs
- Correlated to state and national standards
- Field-based STEM Learning
- Teacher professional development

Session Objective

During this session you will learn how to integrate the 2023 VA Mathematics SOLs into student inquiry-based learning of the data cycle. There will be a <u>focus on authentic data collection</u>.

The 2023 VA Math SOLs address how students apply the data cycle by:

- posing questions
- ***collecting data***
- organizing and representing data
- analyzing data
- communicating results

Accessing the 2023 VA Mathematics SOLs

Specific K-8th grade standards, addressing the data cycle, are found under the *Probability and Statistics* section in each grade.

https://www.doe.virginia.gov/home/showpublisheddocument/48908/638672685417270000

What are the key differences at each grade level?

- How data is organized and displayed
- Depth of analysis
- Questioning throughout the data cycle
- The number of data points/ categories

Early Elementary Application of the Data Cycle

According to the 2023 VA Math SOLs

Grade Level	Number of data points/ categories	Collecting/ Displaying Data	Questioning
K	25 or fewer data points; no more than 4 categories	sorting into groups; object graphs; picture graphs (vertically or horizontally)	*Pose questions, given a predetermined context,* that require the collection of data
1st	25 or fewer data points; no more than 4 categories; one or two attributes	tallying; T-charts; object graphs; picture graphs; tables	*Pose questions, given a predetermined context,* that require the collection of data
2nd	25 or fewer data points; No more than 6 categories	lists; tables; charts; tallying; pictographs (Symbols can represent up to 2 data points); bar graphs; graphs with title and labeled axes (increments increase by 1 or 2)	*Pose questions, given a predetermined context,* that require the collection of data

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Upper Elementary Application of the Data Cycle

According to the 2023 VA Math SOLs

Grade Level	Number of data points/ categories	Collecting/ Displaying Data	Questioning
3rd	30 or fewer data points; No more than 8 categories	Polls; observations; tallying; pictographs (Symbols can represent 1,2,5 or 10 data points); bar graphs; graphs with title and labeled axes (increments increase by 1, 2, 5, or 10)	*Formulate questions* that require the collection or acquisition of data
4th	No more than 10 data points on line graphs	Line graphs; graphs with title and labeled axes (whole number increments)	*Formulate questions* that require the collection or acquisition of data
5th	30 or fewer data points	stem-and-leaf plot (stems and leaves listed in ascending order); Line plot/ dot plot (may include whole numbers, fractions, or decimals); find mean, median, mode, and range; include keys	*Formulate questions* that require the collection or acquisition of data

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Middle School Application of the Data Cycle

According to the 2023 VA Math SOLs

Grade Level	Number of data points/ categories	Collecting/ Displaying Data	Questioning
6th	*Determine factors* that ensure that the data collected is *a sample that is representative of a larger population*	Circle graphs (denominators of 12 or less or those that are factors of 100); justify which graphical representation best represents the data	*Formulate questions* that require the collection or acquisition of data
7th	*Determine how sample size and randomness* will ensure that the data collected is a sample that is *representative of a larger population*	Histograms; justify which graphical representation best represents the data	*Formulate questions* that require the collection or acquisition of data
8th	20 or fewer items in plots; Determine whether two events are *independent or dependent*	Box plots; scatterplots; describe how outliers affect data distribution; justify which graphical representation best represents the data	*Formulate questions* that require the collection or acquisition of data; *Identify components of graphical displays that can be misleading*

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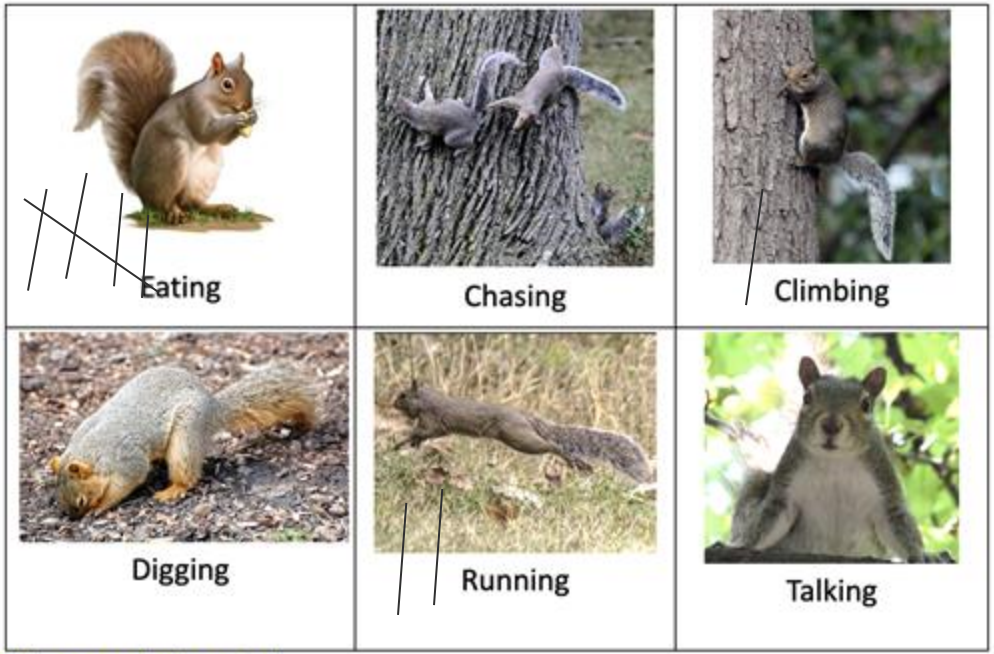
Example of K-2nd Data Collection



Students tally squirrel behaviors as they observe them in nature.

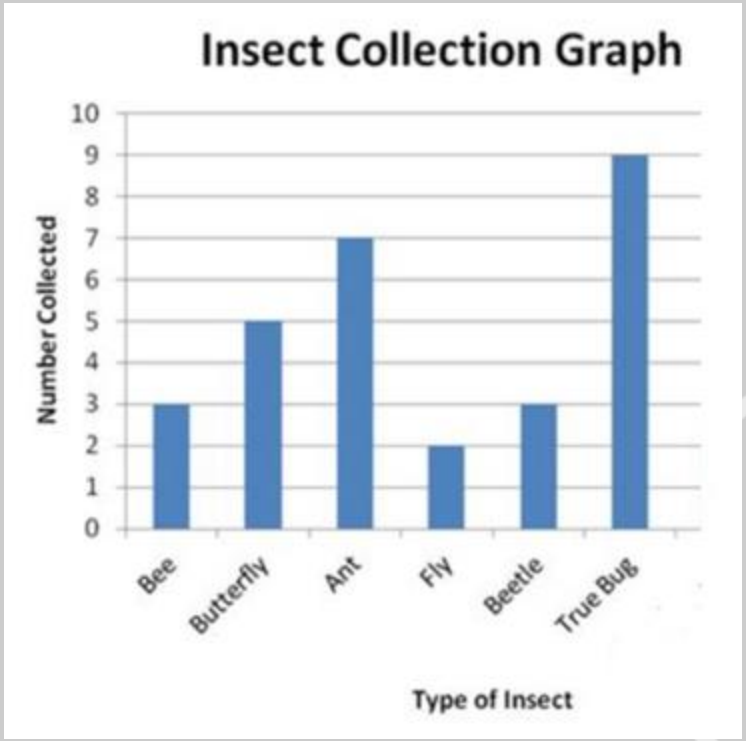
Option: Submit results to Project Squirrel

Let’s head outside to observe squirrel behavior!

Activity expectations:

- Collect data as a K-2nd grader.
- Discussion: How could this activity be adapted for a 3rd-5th grader? 6th-8th grader?

Example of 2nd-3rd Grade Data Collection



Students collect insects in the pollination garden and create a class bar graph displaying their data.

Example of 3rd-4th Grade Data Collection

Ornithologist(s):_____

My Bird Observations

Date:_____ Time: ____
Weather: _____
Location: _____

Field
Woods
Other

Species				
American Crow				
American Goldfinch				
American Robin				
Blue Jay				
Carolina Chickadee				
Carolina Wren				
Chipping Sparrow				
Dark-Eyed Junco				
Downy Woodpecker				
Eastern Bluebird				
Eastern Towhee				
Gray Catbird				
House Finch				
Mourning Dove				
Northern Cardinal				
Northern Mockingbird				
Red-Bellied Woodpecker				
Red-breasted Nuthatch				
Song Sparrow				
Tree Swallow				
Tufted Titmouse				
Turkey Vulture				
White-breasted Nuthatch				
White-throated Sparrow				

Others (list):

Ornithologist(s):_____

My Bird Observations

Date:_____ Time: ____
Weather: _____
Location: _____

Field
Woods
Other

Species

American Crow
American Goldfinch
American Robin
Blue Jay
Carolina Chickadee
Carolina Wren
Chipping Sparrow
Dark-Eyed Junco
Downy Woodpecker
Eastern Bluebird
Eastern Towhee
Gray Catbird
House Finch
Mourning Dove
Northern Cardinal
Northern Mockingbird
Red-Bellied Woodpecker
Red-breasted Nuthatch
Song Sparrow
Tree Swallow
Tufted Titmouse
Turkey Vulture
White-breasted Nuthatch
White-throated Sparrow

Others (list):

Students record the birds they identify during a birding walk.

Students create a graph based on their data.

Option: Submit results to eBird.

Example of 6th Grade Data Collection

Students record the quality of water based on the pollution tolerance of macros they identified. Students create a graph to represent their data. Macro data is submitted to DWR.

Macroinvertebrate Data Sheet

Pollution Tolerance Index

1. Place a tally next to each macroinvertebrate group present in your sample. **For example, whether you find one mayfly or fifty mayflies, place one check next to the mayfly line in Group 1.**
2. Calculate the group scores using the multipliers provided.
3. Find the sum of the group scores for your Total Score.
4. Compare your Total Score with the Water Quality Assessment Chart scores and record the relative water quality rating for your stream sample.

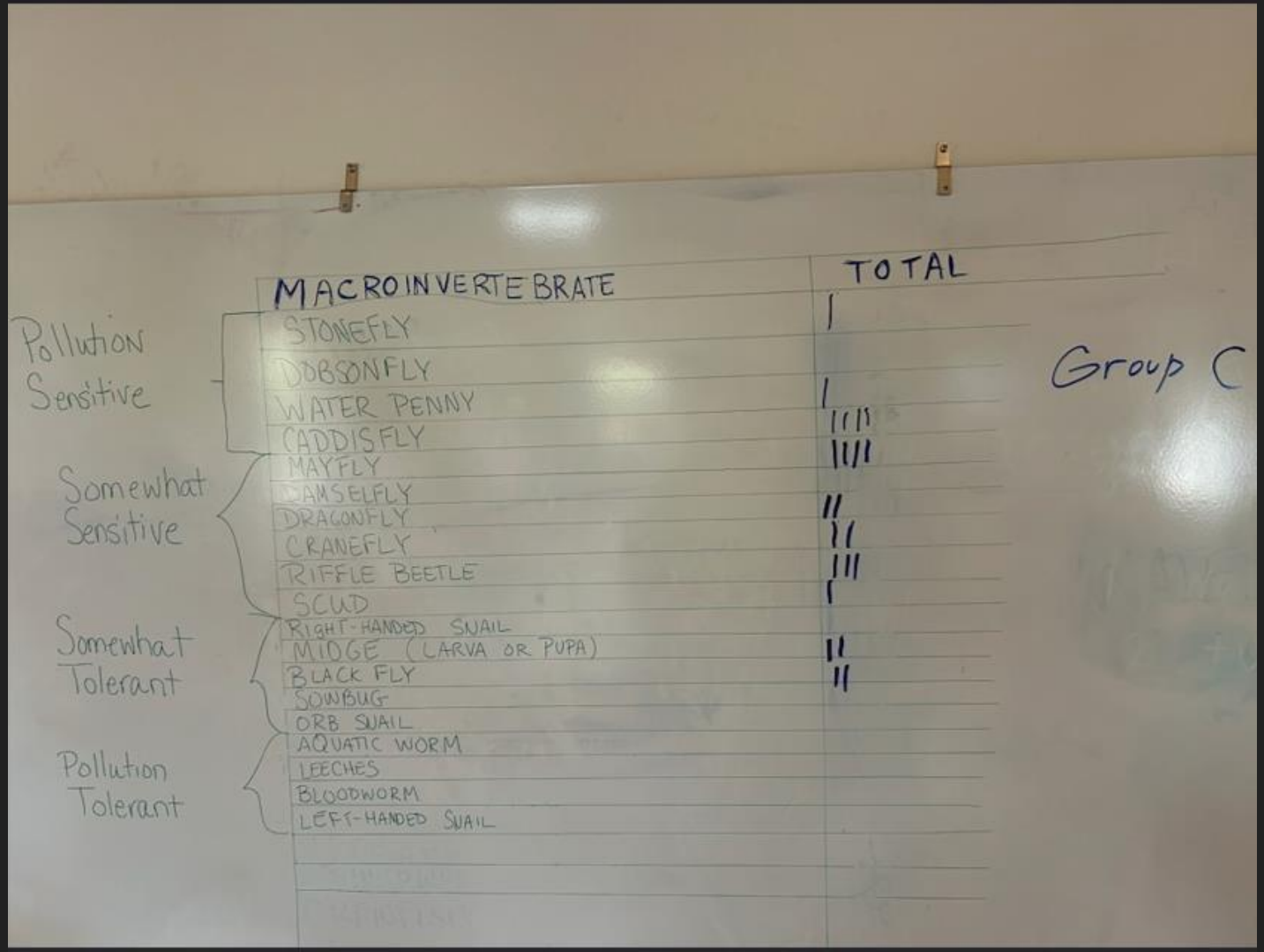
	Group I Macroinvertebrates: Very Intolerant	Group 2 Macroinvertebrates: Intolerant	Group 3 Macroinvertebrates: Tolerant	Group 4 Macroinvertebrates: Very Tolerant
1	__ Stoneflies __ Dobsonflies __ Water penny __ Caddisflies	__ Mayfly __ Damselfly __ Dragonfly __ Cranefly __ Riffle Beetle __ Scuds	__ Right-handed snail __ Midge __ Blackfly __ Sowbug __ Orb snail	__ Aquatic Worm __ Leeches __ Bloodworm __ Left-handed snail
2	# of checks= _____ x4 Group Score = ____	# of checks = ___ x3 Group Score = ____	# of checks = ____ x2 Group Score = ____	# of checks =__ X 1 Group Score =___

3	Your Water Quality Assessment: Total Score = _____	4	Water Quality Assessment Chart: ≥ 23 Potentially Excellent Water Quality 17-22 Potentially Good Water Quality 11-16 Potentially Fair Water Quality ≤ 10 Potentially Poor Water Quality

Examine the Data

- Does your data support your prediction? Why or why not?

Education Programs at Blandy Experimental Farm and The State Arboretum of Virginia
www.virginia.edu/blandyUpdated 2011, 2015, 2018, 2023.


MACROINVERTEBRATE
TOTAL
Pollution Sensitive
STONEFLY
DOBSONFLY
WATER PENNY
CADDISFLY
Somewhat Sensitive
MAYFLY
DAMSELFLY
DRAGONFLY
CRANEFLY
RIFFLE BEETLE
SCUD
Somewhat Tolerant
RIGHT-HANDED SNAIL
MIDGE (LARVA OR PUPA)
BLACK FLY
SOWBUG
ORB SNAIL
Pollution Tolerant
AQUATIC WORM
LEECHES
BLOODWORM
LEFT-HANDED SNAIL
Group C

Example of 8th Grade Data Collection

budburst
a project of the Chicago Botanic Garden

PHENOLOGY OBSERVATIONS
WILDFLOWERS AND HERBS

When did you observe?

Date

Which plant did you observe?

Common Name or Scientific Name

Plant Nickname e.g. Backyard Lily. This helps you make another observation on this plant in the future.

Where did you make your observation?
Provide address OR latitude/longitude.

Address

City, State/Province, Postal code

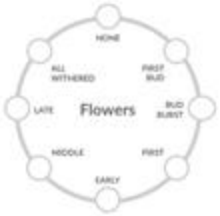
Latitude

Longitude

What is your plant doing? Check the most applicable option for **each** category below.

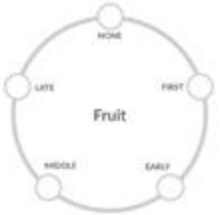
budburst
a project of the Chicago Botanic Garden

PHENOPHASE DEFINITIONS
WILDFLOWERS AND HERBS



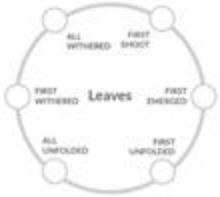
Flowers

None - No flowers or buds visible.
First Bud - First flower bud is visible.
Bud Burst - Flower sepals, also called bud scales, have opened to reveal the emerging flower. The color of the flower can be recognized.
First - First flower is fully open. When open, you will see the stamens/pistils among the unfolded petals.
Early - Few flowers are open (less than 5%).
Middle - Half or more of the flowers are completely open.
Late - Most flowers have wilted or fallen off (over 95%).
All Withered - All flowers have wilted or fallen off.



Fruit

None - No ripe fruits or seeds are visible. There is no fruit, or fruit is not yet ripe.
First - First fruits are fully ripe or a few seeds are dropping naturally from the plant. Ripening is usually indicated by a change in color to the mature color, or by drying and splitting open (for dry fruits such as capsules).
Early - Only a few ripe fruits or seeds are visible (less than 5%).
Middle - Half or more of the fruits are completely ripe or seeds are dropping naturally from the plant.
Late - Most fruits or seeds have been dispersed from the plant (over 95%).

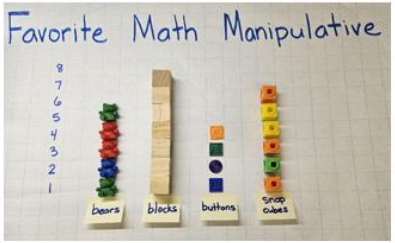
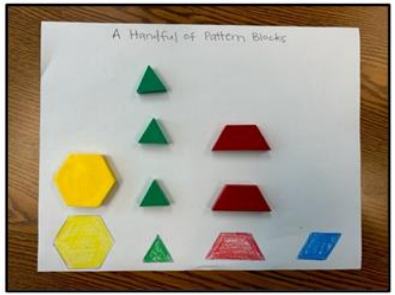


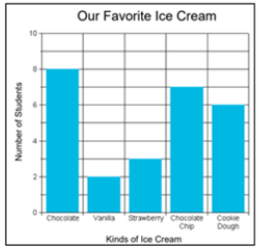
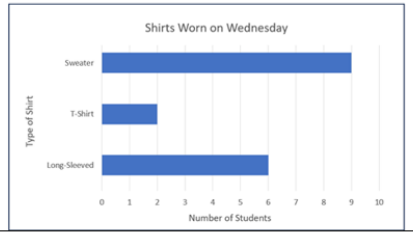
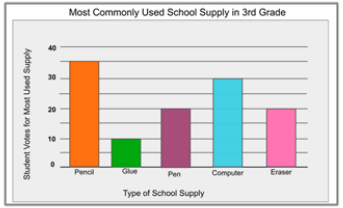
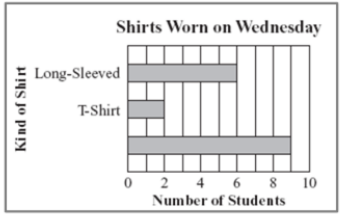
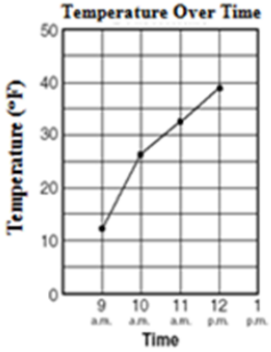
Leaves

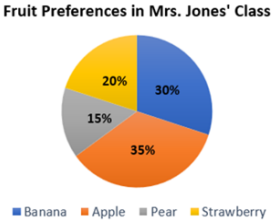
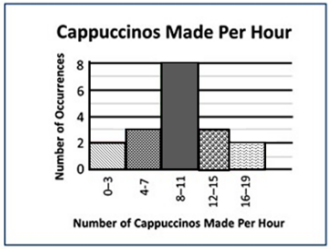
First Shoot - First appearance of the growing shoot is visible above ground.
First Emerged - First leaf has emerged. The leaf shape should be clearly visible, but it can still be partly folded.
First Unfolded - First leaf has unfolded and is at least 75% of its mature size.
All Unfolded - All emerged leaves are fully visible in their mature form.
First Withered - First leaf, of those that developed this season, has lost its green color or is dried and dead.
All Withered - Most or all of the leaves that developed this season have lost their green color or are dried and dead.

Project Budburst is a Community Scientist Project of the Chicago Botanical Garden.

Data Cycle Progression of Types of Graphs

Grade	Type of Graph Considerations	Example Graphs
Kindergarten	**Object Graphs and Picture Graphs** • Categorical data • Vertical or horizontal in orientation • Up to 4 categories • Picture graph symbols represent 1 data point. • Objects represent 1 data point.	  Pets Animals | Number Dogs ○○○ Cats ○○ Birds ○ Lizards ○○
Grade 1	**Object Graphs, Picture Graphs, and Tables** • Categorical data • Vertical or horizontal in orientation • Up to 4 categories • Picture graph symbols represent 1 data point. • Objects represent 1 data point. • Tables may include numbers or tally marks.	  Favorite Resource Class Gym |||| || Art |||| Music |||| |

Grade 2	**Pictographs and Bar Graphs** • Categorical data • Vertical or horizontal in orientation • Up to 6 categories • Pictograph symbols representing 1, 2, 5, or 10. • Bar graphs with scale increments of 1, 2, 5, or 10.	**Donuts Sold Each Day** Day / Number of Donuts Sold Thursday: 1 Friday: 3 Saturday: 5 Sunday: 4 Key: Each donut represents 10 donuts.  
Grade 3	**Pictographs and Bar Graphs** • Categorical data • Vertical or horizontal in orientation • Up to 8 categories • Pictograph symbols representing 1, 2, 5, or 10 data points. Not required to be multiples of given key. • Bar graphs with scale intervals of 1, 2, 5, or 10.	 **Rainfall** Week / Number of Inches 1: 2 clouds 2: 4 clouds + ½ cloud 3: 5 clouds 4: 3 clouds + ½ cloud Key: cloud = 2 inches 
Grade 4	**Line Graphs** • Numerical data that changes over time • Horizontal access is continuous data, a unit of time. • Scale increments of 1, 2, 5, 10, or 100.	 **Temperature Over Time** Time / Temperature 9 a.m. — 12 10 a.m. — 26 11 a.m. — 33 12 p.m. — 39

Grade 5	**Stem-and-leaf Plots and Line Plots** • Discrete numerical data • 30 or fewer data points • Line plots may contain whole numbers, fractions or decimals	Minutes Walked Per Student During the Weekend Stem | Leaf 0 | 6 1 | 5,7,8 2 | 1,4,5,6 3 | 1,3,7,7,7 4 | 0,0,4,8 5 | 6 | 2,2,2,3,8 Key 2|5 = 25  
Grade 6	**Circle Graphs** • Percent or frequency of categorical or discrete numerical data • Number of data values limited to allow for comparisons that have denominators of 12 or less or factors of 100.	Fruit Preference | # of students banana | 6 apple | 7 pear | 3 strawberry | 4 
Grade 7	**Histograms** • Frequency of numerical data • Vertical or horizontal in orientation	Number of Cappuccinos Made per Hour at the Cafe Number of Cups of Coffee | Tally | Frequency 0 - 3 | || | 2 4 – 7 | ||| | 3 8 – 11 | 𝍸 ||| | 8 12 – 15 | ||| | 3 16 – 19 | || | 2 

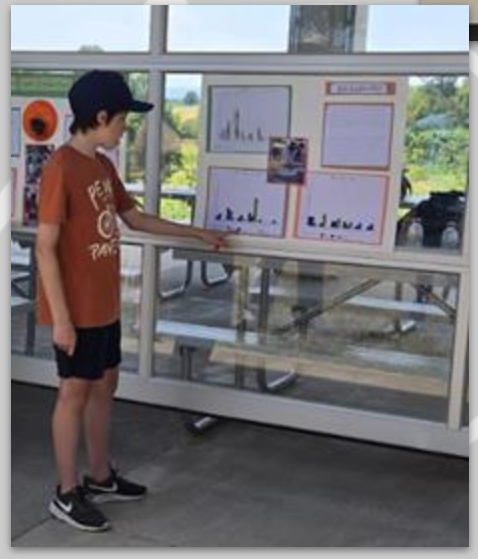
Link to data cycle progression document:

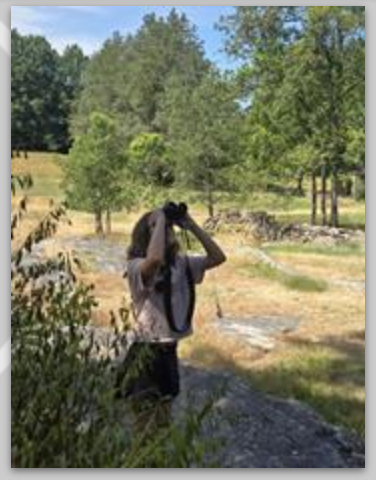
https://www.doe.virginia.gov/home/showpublisheddocument/61373/638815269230100000

Blandy Eco Explorers Camp

Campers in 6th-8th grade spend one week out of the summer completing an ecological research project. A research forum takes place at the end of the week when they share their results to parents, Blandy staff, and visiting scientists. They work in small groups:

- formulating a research question
- designing an observational study/ experiment
- collecting data
- designing poster presentations, displaying their findings on graphs/ charts/ plots



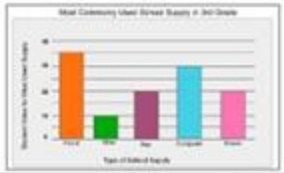


Resource for Middle Schoolers

Types of Graphs/ Charts Used to Represent Data

Pictographs and Bar Graphs

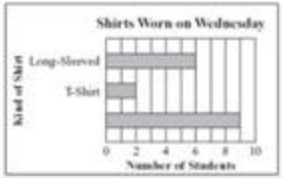
- **Categorical data**
- Vertical or horizontal in orientation
- A pictograph displays symbols representing data points.



Rainfall

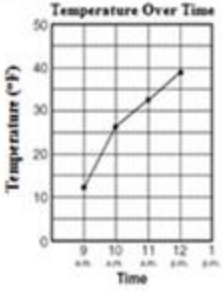
Week	Number of Inches
1	☁☁
2	☁☁☁☁◜
3	☁☁☁☁☁
4	☁☁☁◜

Key: ☁ = 2 inches



Line Graphs

- Numerical data that displays **change over time**
- The x-axis typically represents time, while the y-axis represents the variable being measured.
- It connects data points with lines that display trends, patterns, and fluctuations in the data.



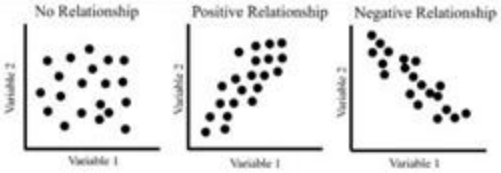
Temperature Over Time

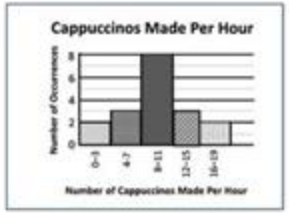
Time	Temperature
9 a.m.	12
10 a.m.	26
11 a.m.	33
12 p.m.	39

Note: The table above shows the same information displayed on the line graph

Scatter plots

- Each point represents a pair of values from two different variables
- The plot **shows the relationship (if any) between two different variables**



Stem-and-leaf Plots and Line Plots	• These graphs help you **visualize the distribution of data, including patterns, clusters, and outliers.** • A stem-and -leaf plot is a way to display numerical data by splitting each data point into a stem (the lead digit or digits) and leaf (usually the last digit) • A line plot uses a number line and Xs or dots are placed above each value to show how many times that value occurs in the dataset.	Minutes Walked Per Student During the Weekend Stem | Leaf 0 | 6 1 | 5,7,8 2 | 1,4,5,6 3 | 1,3,7,7,7 4 | 0,0,4,8 5 | 6 | 2,2,2,3,8 Key 2|5 = 25  
Circle Graphs	• **Displays percentages and frequency** • A visual representation of data that uses a circle divided into portions, each portion represents a part of the whole	Note: The table below shows the same information displayed on the circle graph. **Fruit Preferences in Mrs. Jones' Class** **Fruit Preference** | **# of students** banana | 6 apple | 7 pear | 3 strawberry | 4  the
Histograms	• **Displays the distribution of a dataset** • **Useful for showing the frequency or count of data with different ranges or intervals** • Vertical or horizontal in orientation	Note: The table below shows the same information on the histogram. **Number of Cappuccinos Made per Hour at the Cafe** **Number of Cups of Coffee** | **Tally** | **Frequency** 0 - 3 | || | 2 4 - 7 | ||| | 3 8 – 11 | 𝍸 ||| | 8 12 – 15 | ||| | 3 16 – 19 | || | 2  displayed

Graph images derived from Virginia Department of Education's *Data Cycle Graph Progression* document.

Thank you!

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https://blandy.virginia.edu/pk-12-education

Accessing Project Squirrel

https://scistarter.org/form/project-squirrel

Accessing eBird

https://ebird.org/home

Accessing Budburst

https://budburst.org/

Course	Number of data points/categories	Collecting/Displaying Data	Questioning
Algebra 1	30 or fewer data points, determine method to collect a representative sample, to answer a question.	Scatterplot, use available technology to determine whether a linear or quadratic function would represent the relationship	*Formulate Questions* that require the collection of bivariate data
Algebra, Functions & Data Analysis	Investigate, describe, and determine the best sampling techniques, such as simple random sampling, stratified sampling, and cluster sampling	Collect or acquire bivariate data. Investigate, describe, and determine the best sampling techniques, such as simple random sampling, stratified sampling, and cluster sampling	*Formulate investigative questions* that require the collection or acquisition of bivariate data, where exactly two of the variables are quantitative.
Algebra II	Collection or acquisition of a large set of univariate quantitative data Determine whether the relationship between two quantitative variables is best approximated by a linear, quadratic, exponential, or a combination of these functions.	Collect or acquire univariate data through research, or using surveys, observations, scientific experiments, polls, or questionnaires. Describe and interpret a data distribution represented by a smooth curve by analyzing measures of center, measures of spread, and shape of the curve.	*Formulate investigative questions* that require the collection or acquisition of a large set of univariate quantitative data or summary statistics of a large set of univariate quantitative data and investigate questions using a data cycle.
Descriptive Statistics	Compare and contrast two or more univariate data sets, numerically and graphically	Create and interpret graphical displays of data, including dot plots, stem plots, box plots, cumulative frequency graphs, and histograms, using appropriate technology	*Investigate and explain the influence of outliers* on a univariate data set. Investigate and explain ways in which standard deviation addresses variability