Differentiated Data Literacy: A Professional Development Using NASA Data Literacy Cubes

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Differentiated Data Literacy: A Professional Development Using NASA Data Literacy Cubes

Differentiated data literacy using NASA Data Literacy Cubes professional development training was offered to the science and social studies department teachers at Ken Caryl Middle School. Ken Caryl Middle School is located in Littleton, CO and has a population of 848 students in sixth, seventh and eighth grades. The science department consists of two teachers at each grade level. The attendees at the professional development included five of those science teachers (as the sixth was the presenter.) The social studies department also has two teachers per grade level. There were four attendees from the Social Studies department, as two were absent this day. In addition, an assistant principal who used to teach sixth grade science and social studies was in attendance. Due to absences and scheduling, data was unable to be collected from two social studies teachers, a second assistant principal that previously taught Social Studies and the school instructional coach. The professional development training took place at the department's weekly scheduled Professional Learning Community (PLC) meeting times.

The departments were chosen based on pedagogy and content that could be supported using the NASA data cubes tool. At the beginning of this school year during the department PLC meetings, state testing data was presented that represented students' scores on the state standardized tests in the areas of english language arts and math. The data was analyzed by the departments to identify how the content area standards in science and social studies can support the English Language Arts and Math concepts. The science department selected data interpretation to incorporate into our planning for the year with the goal to implement practicing these skills once per week. However, neither department has had enough pedagogical tools or content resources to make this a manageable task. The year had thus far progressed with little to no work from the PLC's on this task. Therefore, this professional development was designed to provide a pedagogical tool using the NASA data cube as well as facilitate the gathering of content resources to use with this tool that are based on the subject area standards. All standards for both science and social studies will be used by the participants as a guide to find and organize data sources for interpretation. The Jeffco Public Schools Science and Social Studies department standards are based on the Colorado Academic Standards, which are developed by the Colorado Department of Education (see Appendix A). The Next Generation Science Standards (NGSS) are the basis of the science standards used in the Colorado Academic Standards and are the focus of this professional development training program. Within the NGSS, all middle school performance expectations relate to data interpretation (see Appendix B). However, the NGSS is based on three-dimensional learning. The first dimension are the standards, which are the disciplinary core ideas (performance expectations and standards.) The second are the behaviors scientists engage in called science and engineering practices. These are a set of skills and knowledge-based behaviors that scientists use. The third dimension are the cross cutting concepts that connect the standards across grade levels. This professional development is focused specifically on applying the science and engineering practice number four analyzing and interpreting data to all middle school standards identified by the NGSS.

NGSS Science and Engineering Practice Four: Analyzing and Interpreting Data

Scientific investigations produce data that must be analyzed in order to derive meaning. Because data patterns and trends are not always obvious, scientists use a range of tools—including tabulation, graphical interpretation, visualization, and statistical analysis—to identify the significant features and patterns in the data. Scientists identify sources of error in the investigations and calculate the degree of certainty in the results. Modern technology makes the collection of large data sets much easier, providing secondary sources for analysis.

Specific to Middle School: *Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.*

- *Construct, analyze and/or interpret graphical displays of data and/or large data sets to identify linear and nonlinear relationships.*
- *Use graphical displays (maps, charts, graphs and/or tables) of large data sets to identify temporal and spatial relationships.*
- *Distinguish between causal and correlational relationships in data.*
- *Analyze and interpret data to provide evidence for phenomena.*
- *Apply the concept of statistics and probability to analyze and characterize data, using digital tools when feasible.*
- *Consider limitations of data analysis and/or seek to improve precision and accuracy of data with better technological tools and methods.*
- *Analyze and interpret data to determine similarities and differences in findings.*
- *Analyze data to define an optimal operational range for a proposed object, tool, process or system that best meets criteria for success.*

Professional Development Summary and Description

Summary of Project

Data literacy skills practice is useful within all subject areas but the explicit teaching of the fundamentals of creating and interpreting data is often left to Math and Science. In middle school, students' knowledge of interpreting data is just beginning and is heavily assessed on state tests that reflect on the school. The Math curriculum has built in resources for instruction and skill practice; however, other subjects often lack resources that are easily accessible and/or explicitly connected to their standards. This creates the need for extra planning time by teachers to create their own lessons. The NASA Data Literacy Cubes and the corresponding resources on the My NASA Data website provide both the pedagogical tool for teachers of all subject areas to teach data literacy skills as well as specialized data visualizations for science teachers. The goal of this ongoing professional development is to provide science and social studies departments, tasked with teaching data interpretation, a differentiated tool to do so.

The second goal of the professional development is to create an ongoing schedule for the department's PLC meeting time to develop a resource bank of easily accessible data resources.

Training Description and Activities

The Professional Development training was scheduled during the departments' regularly scheduled Professional Learning Community (PLC) meeting times. The training session took place in the presenter's science classroom. Desks were set up in front for participants to face the board. Behind them, there were three group tables set up to model how to use the data literacy cubes in a group activity. Each of the three tables were set up for four students with a job role for each student, the differentiated questions and a NASA data cube. At one group table, there was a line graph for interpretation. At the second group table, there was a data table for interpretation. At the third table, there was a map for interpretation (see Appendix C).

Participants entered the session and sat up front facing the projector and whiteboard. They began by completing the pre survey questions independently (see Appendix D). To begin the training, three goals were identified: 1) define data literacy, 2) build data literacy skills using the pre-made, differentiated tool from NASA - the data cubes, and 3) build a library of curriculum resources to easily access and use with the data cube.

Description of each of the activities in the PD session

The training session began with goal number one- defining data literacy (see Appendix E). The participants viewed a Ted Talk by Jordan Morrow defining data literacy as well as explaining why it is important. Discussion took place to evaluate the participants' definitions and if they would change, based on the Ted Talk. This part of the session and the Ted Talk was also used to plan how teachers can initiate student buy-in to learning data literacy by relating it to decisions they will have to make as they become more and more independent. Next, we moved on to goal number two of the professional development training- the NASA data cube. Resources were viewed online at My NASA Data website showing the overview of the tool and how it can be used. Participants then circulated around the three tables that were set up with the cubes and resources. They were asked to observe the resources, especially the differentiated question sheets. Next, participants were assigned to one of the three tables and assigned a task role/job for their participation in the group activity. Each group participated in one full round of activity (one dice roll per participant in groups of four) with either a map, graph or data table. The participants were able to practice the group roles (job tasks) for each student as well as practice answering and comparing the question sheets. Participants then returned to the front of the room to discuss their experiences modeling the group activity. Finally, we moved on to goal number three- building a data bank of easy to access resources to use with the data cubes. The participants were divided into their departments and tasked with finding their standards for each grade level and organizing them onto a shared document. The science department document was modeled (see Appendix F). The goal of this task is to create a working shared document for easy access to all teachers in the department. On the document, teachers organize and store data resources that can

be used with the Data Cubes. As the allotted time for the training was nearing an end, the participants moved back to the front facing desks and completed the post training survey questions (see Appendix G).

The structure of this professional development was inspired by two of the seven components of effective professional developments identified by Darling-Hammond et al. (2017), active learning and modeling. A component of active learning that helped drive the design of this training is that "design of professional development must address how teachers learn." We should be taught as we are expected to teach, activate prior knowledge/learning experiences, offer choices, reflect and assess, etc. Active learning moves away from lecture and incorporates collaboration, coaching, feedback and reflection. It has opportunities to try out new strategies. The second component, modeling, "helps teachers to have a vision" and "engage in the model lesson just as students would" (Darling-Hammond et al., 2017, p.21-22). Seeing models of what we are working toward as well as learning through the experiences of our students will help make planning more efficient and provide confidence in implementation. This connects to the portion of the training in which participants role-modeled the dice in the group settings.

Professional Development Reflection and Follow-up Plan

The outcomes of the professional development training session were analyzed using the post training session questions (see Appendix G). 60% of the participants said their definition of data literacy changed after the training. All participants indicated they felt comfortable teaching data literacy skills and try to have students create tables, graphs or maps at least once per week. 100% reported that students regularly (3-4 times per month) interpret tables, graphs or maps. It was surprising that 100% of the participants stated they have data sources within their curriculum, yet 70% said they still have to spend their own time searching for better or more appropriate data to use. The biggest challenges identified were that the data provided already could be subjectively interpreted, that students are not embracing critical thinking when asked to interpret data, narrowing down the best resources to use and declining mathematical abilities limited student success. This professional development training is considered successful because 100% of the participants indicated the data cubes would be useful and appreciated the ability to use the tool immediately with low prep. The participants identified the cubes as being interdisciplinary and differentiated.

The plan for after this initial training is to use each departments PLC meeting times to continue the training. The design of this professional development incorporates the subject area PLC meetings to provide the scheduled time for ongoing training and support. This is supported by the work of Cheung et al., (2018) which reports on the framework of Science Teacher Leaders. Ken Caryl Middle School does not have a Science Teacher Leader but the information in the Cheung article inspired the use of the PLC time to incorporate what the authors stated can be provided by a teacher leader, "collaboration, resources for efficient instruction, inquiry-oriented teaching practices with the goal of advocating for the successful implementation" of the

NGSS (p. 42). Further, the structure of the PLC meetings at Ken Caryl has needed improvement and focus all year. The feedback from a middle school teacher in the Cheung article about the science teacher leader program connected both what is experienced in the Ken Caryl PLCs and what a structured, ongoing professional development sessions could help us with which is to "… facilitate collaboration around the skills we are teaching as well as the content (Cheung et al., 2018, p.43).

On the next PLC meeting date, each department will work on finishing their collaborative resource document. The science department will continue to explore the data visualizations tool at My NASA Data and the mini lessons on this site. The next meeting, which is the first follow up to the initial training, was scheduled as a help session for each department in which the presenter will review the data cube resources and the supports that the participants indicated they need on their post training questions. These supports included personalizing the question sets (like keywords and combining questions for relevancy to the subject area), locating more resources, practicing more with student jobs and setting up the resources (cube versus dice, digital versus paper, etc.) The second follow up to the initial training was designed to offer individual support to the teachers using the cubes so to analyze their experience including their successes and challenges thus far. This session would also help teachers who have not used the cubes yet by identifying support structures needed for implementation next school year. As we move forward into next year, the science department has also planned to implement the data cubes for analyzing and interpreting student made graphs. These ongoing sessions of the professional development training are designed to provide formal and informal peer support for teachers. As stated by Berry et al., (2010) teacher preparation programs and professional development trainings are shown to be most effective when ongoing and supportive. Further, professional development opportunities throughout a teacher's career show to be more effective when teachers participate in interactive programs, feel supported and have peer relationships. As of the date of this paper submission, the two department PLC meetings following the initial professional development have been cancelled due to field trips, state testing and other administrator absences. Therefore, discussion is underway with administration to begin the first follow up training session during our first week back to school in August. During this session, the science department will finalize the shared document of resources and practice with the My NASA Data visualization tools and mini lessons. At that time, the next PLC agendas will be developed for the second and third follow up sessions.

References

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Appendix A

Jeffco Public Schools Academic Standards for Middle School Science and Social Studies

Jeffco Public Schools Middle School Curriculum
https://www.jeffcopublicschools.org/cms/one.aspx?portalId=627965&pageId=926792

Full list of Jeffco Science Standards addressed in Grades 6-8
https://docs.google.com/document/d/1qYQo1gDh6s94ZTthVwHPqfUbVO1_drT3CWFRa2RmARM/edit?usp=sharing

Full list of Jeffco Social Studies Standards addressed in Grades 6-8
https://docs.google.com/document/d/1QFr-i94jM7Js6EnYO6loCDFcnNYbE8Qlq_sL0yHLM_I/edit?usp=sharing

Appendix B

NGSS Performance Standards

(Click (CTRL click) the middle school (grades 6-8) performance standards below to be linked to the NGSS detail of that standard.)

MS-ETS1-3 Engineering Design

Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

MS-ESS3-2 Earth and Human Activity

Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.

MS-ESS2-3 Earth's Systems

Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.

MS-ESS1-3 Earth's Place in the Universe

Analyze and interpret data to determine scale properties of objects in the solar system.

MS-LS4-3 Biological Evolution: Unity and Diversity

Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.

MS-LS4-1 Biological Evolution: Unity and Diversity

Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.

MS-LS2-1 Ecosystems: Interactions, Energy, and Dynamics

Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

MS-PS3-1 Energy

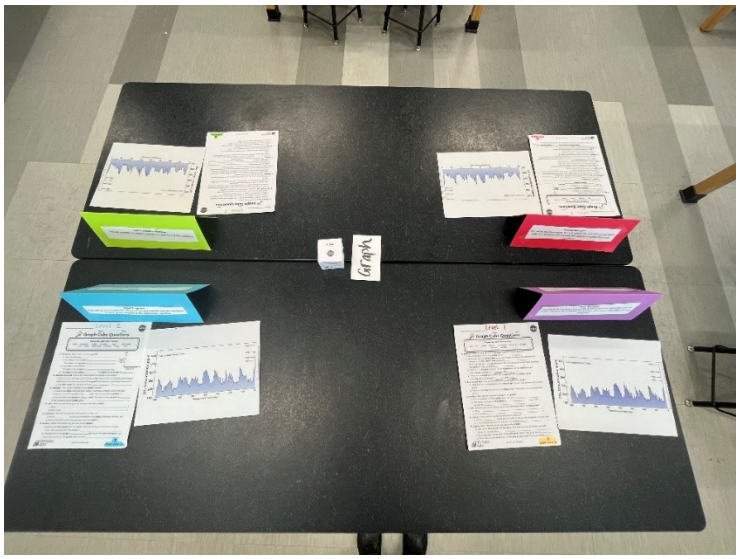
Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.

MS-PS1-2 Matter and its Interactions

Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

Appendix C

Picture of Table Groups in the Training

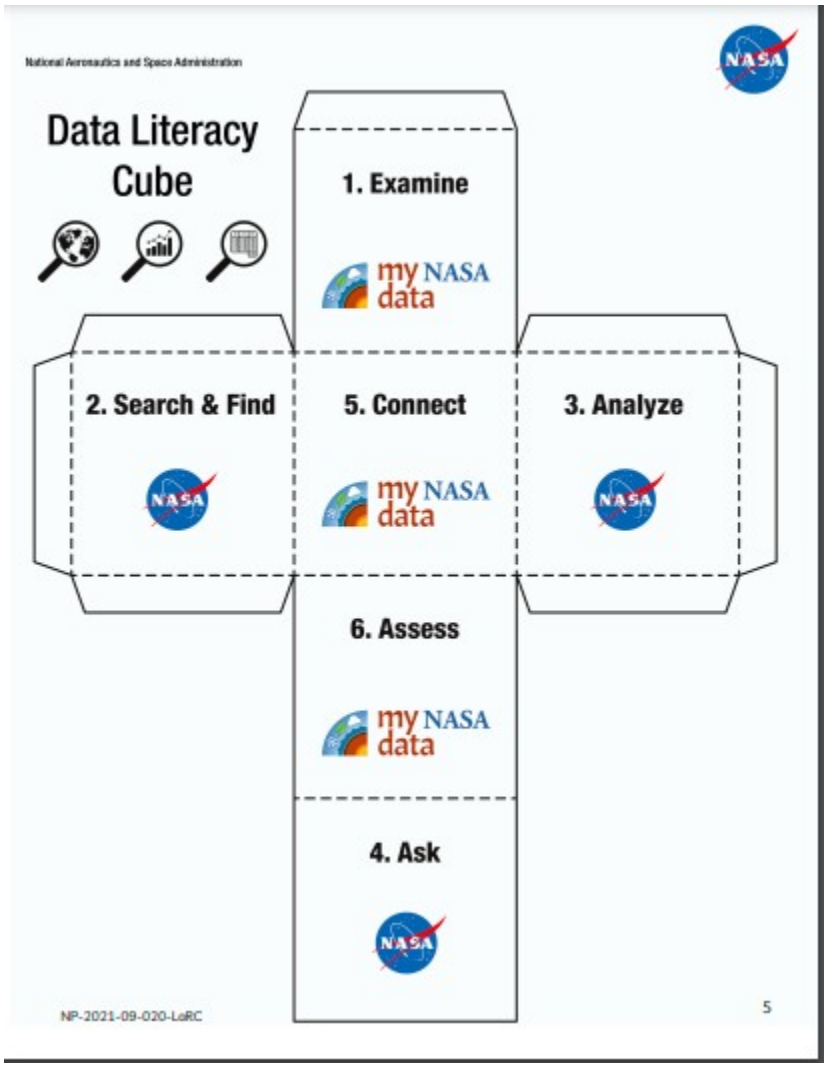


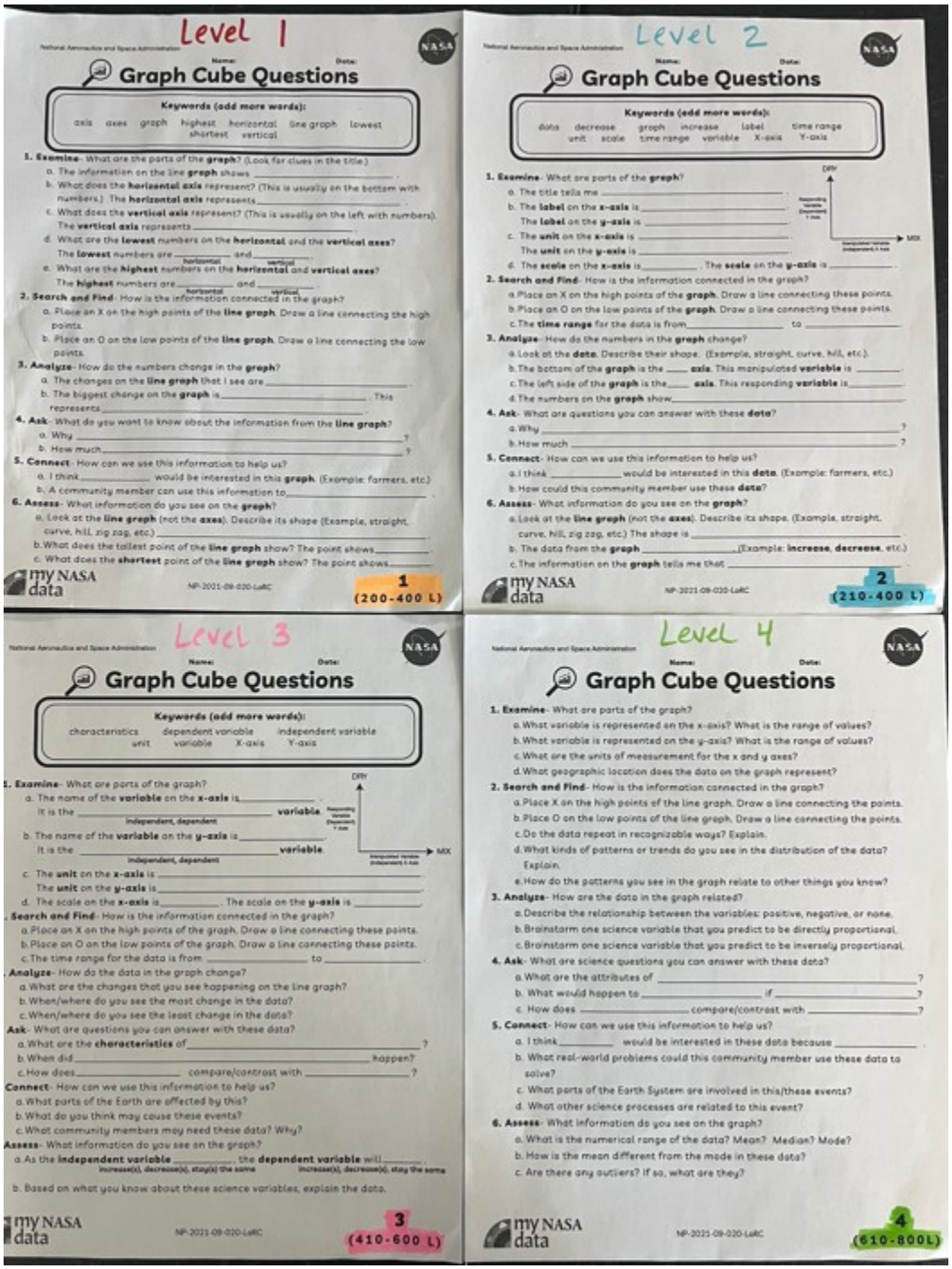
National Aeronautics and Space Administration

Task Card

Group _____

Role	Name of Student
Project Manager: You will help the group stay focused (no distractions), including keeping up with time.	
Data Manager: You will write the group's answers to the questions, and the group's summary of the data you are assigned.	
Chief Engineer: You will be responsible for selecting the random number (i.e., rolling the die, etc.) and making sure the members in your group respond to the appropriate question.	
Communications Manager: You will present and explain your group's summary of the questions.	
Extra Position:	


National Aeronautics and Space Administration
Data Literacy Cube
1. Examine
my NASA data
2. Search & Find
5. Connect
my NASA data
3. Analyze
6. Assess
my NASA data
4. Ask
NP-2021-09-020-LaRC
5



Level 1

National Aeronautics and Space Administration

Name: Date:

Graph Cube Questions

Keywords (add more words):

axis axes graph highest horizontal line graph lowest shortest vertical

1. Examine- What are the parts of the **graph**? (Look for clues in the title.)

a. The information on the line **graph** shows _____.

b. What does the **horizontal axis** represent? (This is usually on the bottom with numbers.) The **horizontal axis** represents _____.

c. What does the **vertical axis** represent? (This is usually on the left with numbers). The **vertical axis** represents _____.

d. What are the **lowest** numbers on the **horizontal** and the **vertical axes**?
The **lowest** numbers are _____ (horizontal) and _____ (vertical).

e. What are the **highest** numbers on the **horizontal** and **vertical axes**?
The **highest** numbers are _____ (horizontal) and _____ (vertical).

2. Search and Find- How is the information connected in the graph?

a. Place an X on the high points of the **line graph**. Draw a line connecting the high points.

b. Place an O on the low points of the **line graph**. Draw a line connecting the low points.

3. Analyze- How do the numbers change in the **graph**?

a. The changes on the **line graph** that I see are _____.

b. The biggest change on the **graph** is _____. This represents _____.

4. Ask- What do you want to know about the information from the **line graph**?

a. Why _____?

b. How much _____?

5. Connect- How can we use this information to help us?

a. I think _____ would be interested in this **graph**. (Example: farmers, etc.)

b. A community member can use this information to _____.

6. Assess- What information do you see on the **graph**?

a. Look at the **line graph** (not the **axes**). Describe its shape (Example, straight, curve, hill, zig zag, etc.) _____.

b. What does the tallest point of the **line graph** show? The point shows _____.

c. What does the **shortest** point of the **line graph** show? The point shows _____.

my NASA data

NP-2021-08-020-LaRC

1 (200-400 L)

Level 2

National Aeronautics and Space Administration

Name: Date:

Graph Cube Questions

Keywords (add more words):

data decrease graph increase label time range unit scale time range variable X-axis Y-axis

1. Examine- What are parts of the **graph**?

a. The title tells me _____.

b. The **label** on the **x-axis** is _____.
The **label** on the **y-axis** is _____.

c. The **unit** on the **x-axis** is _____.
The **unit** on the **y-axis** is _____.

d. The **scale** on the **x-axis** is _____. The **scale** on the **y-axis** is _____.

2. Search and Find- How is the information connected in the graph?

a. Place an X on the high points of the **graph**. Draw a line connecting these points.

b. Place an O on the low points of the **graph**. Draw a line connecting these points.

c. The **time range** for the data is from _____ to _____.

3. Analyze- How do the numbers in the **graph** change?

a. Look at the **data**. Describe their shape. (Example, straight, curve, hill, etc.).

b. The bottom of the **graph** is the ____ **axis**. This manipulated **variable** is _____.

c. The left side of the **graph** is the ____ **axis**. This responding **variable** is _____.

d. The numbers on the **graph** show _____.

4. Ask- What are questions you can answer with these **data**?

a. Why _____?

b. How much _____?

5. Connect- How can we use this information to help us?

a. I think _____ would be interested in this **data**. (Example: farmers, etc.)

b. How could this community member use these **data**?

6. Assess- What information do you see on the **graph**?

a. Look at the **line graph** (not the **axes**). Describe its shape. (Example, straight, curve, hill, zig zag, etc.) The shape is _____.

b. The data from the **graph** _____ (Example: **increase**, **decrease**, etc.)

c. The information on the **graph** tells me that _____.

my NASA data

NP-2021-08-020-LaRC

2 (210-400 L)

Level 3

National Aeronautics and Space Administration

Name: Date:

Graph Cube Questions

Keywords (add more words):

characteristics dependent variable independent variable unit variable X-axis Y-axis

1. Examine- What are parts of the graph?

a. The name of the **variable** on the **x-axis** is _____.
It is the _____ **variable**.
(independent, dependent)

b. The name of the **variable** on the **y-axis** is _____.
It is the _____ **variable**.
(independent, dependent)

c. The **unit** on the **x-axis** is _____.
The **unit** on the **y-axis** is _____.

d. The scale on the **x-axis** is _____. The scale on the **y-axis** is _____.

. Search and Find- How is the information connected in the graph?

a. Place an X on the high points of the graph. Draw a line connecting these points.

b. Place an O on the low points of the graph. Draw a line connecting these points.

c. The time range for the data is from _____ to _____.

. Analyze- How do the data in the graph change?

a. What are the changes that you see happening on the line graph?

b. When/where do you see the most change in the data?

c. When/where do you see the least change in the data?

Ask- What are questions you can answer with these data?

a. What are the **characteristics** of _____?

b. When did _____ happen?

c. How does _____ compare/contrast with _____?

Connect- How can we use this information to help us?

a. What parts of the Earth are affected by this?

b. What do you think may cause these events?

c. What community members may need these data? Why?

Assess- What information do you see on the graph?

a. As the **independent variable** _____ (increase(s), decrease(s), stay(s) the same), the **dependent variable** will _____ (increase(s), decrease(s), stay the same).

b. Based on what you know about these science variables, explain the data.

my NASA data

NP-2021-08-020-LaRC

3 (410-600 L)

Level 4

National Aeronautics and Space Administration

Name: Date:

Graph Cube Questions

1. Examine- What are parts of the graph?

a. What variable is represented on the x-axis? What is the range of values?

b. What variable is represented on the y-axis? What is the range of values?

c. What are the units of measurement for the x and y axes?

d. What geographic location does the data on the graph represent?

2. Search and Find- How is the information connected in the graph?

a. Place X on the high points of the line graph. Draw a line connecting the points.

b. Place O on the low points of the line graph. Draw a line connecting the points.

c. Do the data repeat in recognizable ways? Explain.

d. What kinds of patterns or trends do you see in the distribution of the data? Explain.

e. How do the patterns you see in the graph relate to other things you know?

3. Analyze- How are the data in the graph related?

a. Describe the relationship between the variables: positive, negative, or none.

b. Brainstorm one science variable that you predict to be directly proportional.

c. Brainstorm one science variable that you predict to be inversely proportional.

4. Ask- What are science questions you can answer with these data?

a. What are the attributes of _____?

b. What would happen to _____ if _____?

c. How does _____ compare/contrast with _____?

5. Connect- How can we use this information to help us?

a. I think _____ would be interested in these data because _____.

b. What real-world problems could this community member use these data to solve?

c. What parts of the Earth System are involved in this/these events?

d. What other science processes are related to this event?

6. Assess- What information do you see on the graph?

a. What is the numerical range of the data? Mean? Median? Mode?

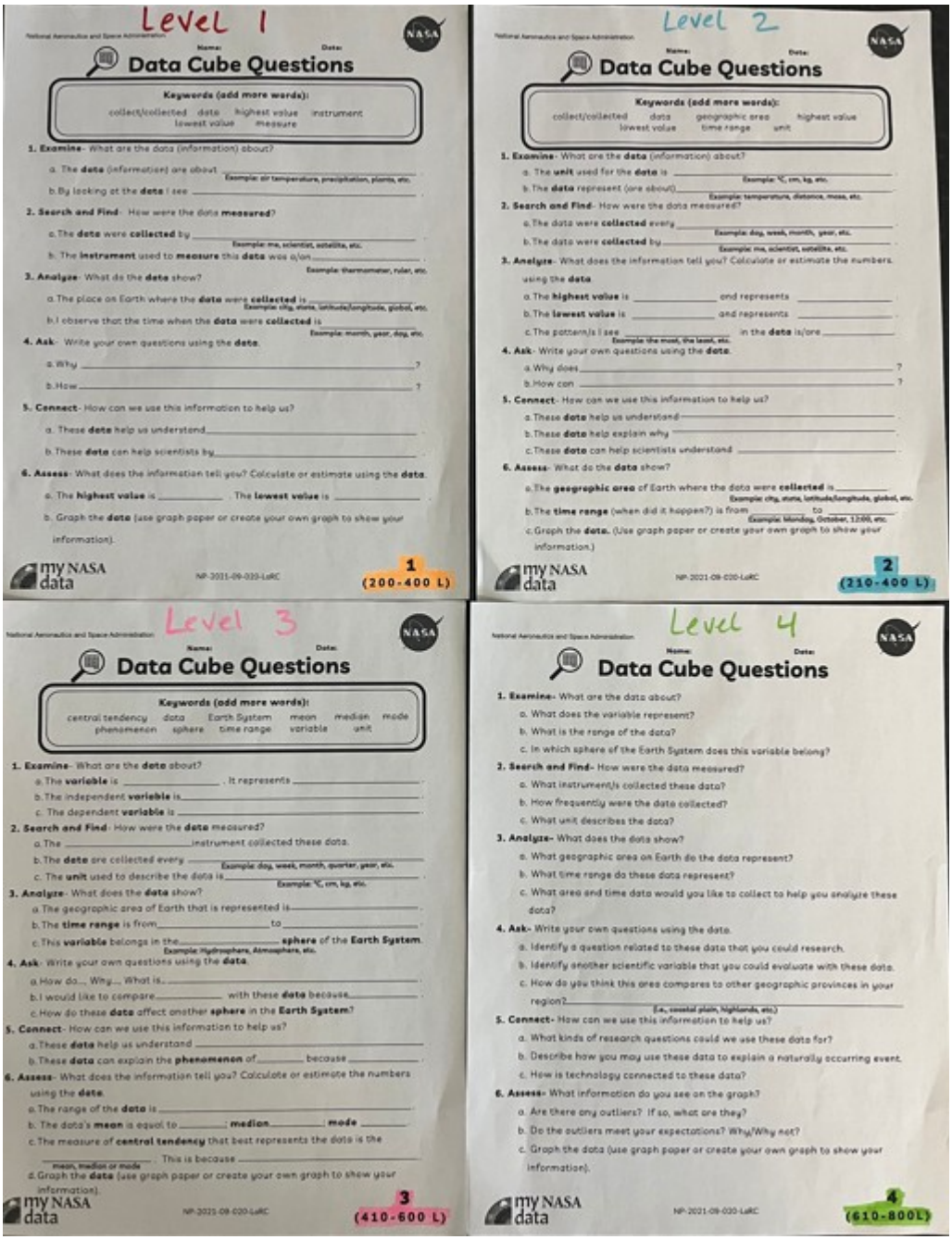
b. How is the mean different from the mode in these data?

c. Are there any outliers? If so, what are they?

my NASA data

NP-2021-08-020-LaRC

4 (610-800L)



Level 1

National Aeronautics and Space Administration

Name: Date:

Data Cube Questions

Keywords (add more words):

collect/collected data highest value instrument
lowest value measure

1. Examine- What are the data (information) about?

a. The **data** (information) are about _____ .
Example: air temperature, precipitation, plants, etc.

b. By looking at the **data** I see _____ .

2. Search and Find- How were the data **measured**?

a. The **data** were **collected** by _____ .
Example: me, scientist, satellite, etc.

b. The **instrument** used to **measure** this **data** was a/an _____ .
Example: thermometer, ruler, etc.

3. Analyze- What do the **data** show?

a. The place on Earth where the **data** were **collected** is _____ .
Example: city, state, latitude/longitude, global, etc.

b. I observe that the time when the **data** were **collected** is _____ .
Example: month, year, day, etc.

4. Ask- Write your own questions using the **data**.

a. Why _____ ?

b. How _____ ?

5. Connect- How can we use this information to help us?

a. These **data** help us understand _____ .

b. These **data** can help scientists by _____ .

6. Assess- What does the information tell you? Calculate or estimate using the **data**.

a. The **highest value** is _____ . The **lowest value** is _____ .

b. Graph the **data** (use graph paper or create your own graph to show your information).

my NASA data

NP-2021-09-020-LaRC

1
(200-400 L)

Level 2

National Aeronautics and Space Administration

Name: Date:

Data Cube Questions

Keywords (add more words):

collect/collected data geographic area highest value
lowest value time range unit

1. Examine- What are the **data** (information) about?

a. The **unit** used for the **data** is _____ .
Example: °C, cm, kg, etc.

b. The **data** represent (are about) _____ .
Example: temperature, distance, mass, etc.

2. Search and Find- How were the data measured?

a. The data were **collected** every _____ .
Example: day, week, month, year, etc.

b. The data were **collected** by _____ .
Example: me, scientist, satellite, etc.

3. Analyze- What does the information tell you? Calculate or estimate the numbers using the **data**.

a. The **highest value** is _____ and represents _____ .

b. The **lowest value** is _____ and represents _____ .

c. The pattern/s I see _____ in the **data** is/are _____ .
Example: the most, the least, etc.

4. Ask- Write your own questions using the **data**.

a. Why does _____ ?

b. How can _____ ?

5. Connect- How can we use this information to help us?

a. These **data** help us understand _____ .

b. These **data** help explain why _____ .

c. These **data** can help scientists understand _____ .

6. Assess- What do the **data** show?

a. The **geographic area** of Earth where the data were **collected** is _____ .
Example: city, state, latitude/longitude, global, etc.

b. The **time range** (when did it happen?) is from _____ to _____ .
Example: Monday, October, 12:00, etc.

c. Graph the **data.** (Use graph paper or create your own graph to show your information.)

my NASA data

NP-2021-09-020-LaRC

2
(210-400 L)

Level 3

National Aeronautics and Space Administration

Name: Date:

Data Cube Questions

Keywords (add more words):

central tendency data Earth System mean median mode
phenomenon sphere time range variable unit

1. Examine- What are the **data** about?

a. The **variable** is _____ . It represents _____ .

b. The independent **variable** is _____ .

c. The dependent **variable** is _____ .

2. Search and Find- How were the **data** measured?

a. The _____ instrument collected these data.

b. The **data** are collected every _____ .
Example: day, week, month, quarter, year, etc.

c. The **unit** used to describe the data is _____ .
Example: °C, cm, kg, etc.

3. Analyze- What does the **data** show?

a. The geographic area of Earth that is represented is _____ .

b. The **time range** is from _____ to _____ .

c. This **variable** belongs in the _____ **sphere** of the **Earth System**.
Example: Hydrosphere, Atmosphere, etc.

4. Ask- Write your own questions using the **data**.

a. How do..., Why..., What is... _____ .

b. I would like to compare _____ with these **data** because _____ .

c. How do these **data** affect another **sphere** in the **Earth System**?

5. Connect- How can we use this information to help us?

a. These **data** help us understand _____ .

b. These **data** can explain the **phenomenon** of _____ because _____ .

6. Assess- What does the information tell you? Calculate or estimate the numbers using the **data**.

a. The range of the **data** is _____ .

b. The data's **mean** is equal to _____ ; **median** _____ **mode** _____ .

c. The measure of **central tendency** that best represents the data is the _____ . This is because _____ .
mean, median or mode

d. Graph the **data** (use graph paper or create your own graph to show your information).

my NASA data

NP-2021-09-020-LaRC

3
(410-600 L)

Level 4

National Aeronautics and Space Administration

Name: Date:

Data Cube Questions

1. Examine- What are the data about?

a. What does the variable represent?

b. What is the range of the data?

c. In which sphere of the Earth System does this variable belong?

2. Search and Find- How were the data measured?

a. What instrument/s collected these data?

b. How frequently were the data collected?

c. What unit describes the data?

3. Analyze- What does the data show?

a. What geographic area on Earth do the data represent?

b. What time range do these data represent?

c. What area and time data would you like to collect to help you analyze these data?

4. Ask- Write your own questions using the data.

a. Identify a question related to these data that you could research.

b. Identify another scientific variable that you could evaluate with these data.

c. How do you think this area compares to other geographic provinces in your region? _____
(i.e., coastal plain, highlands, etc.)

5. Connect- How can we use this information to help us?

a. What kinds of research questions could we use these data for?

b. Describe how you may use these data to explain a naturally occurring event.

c. How is technology connected to these data?

6. Assess- What information do you see on the graph?

a. Are there any outliers? If so, what are they?

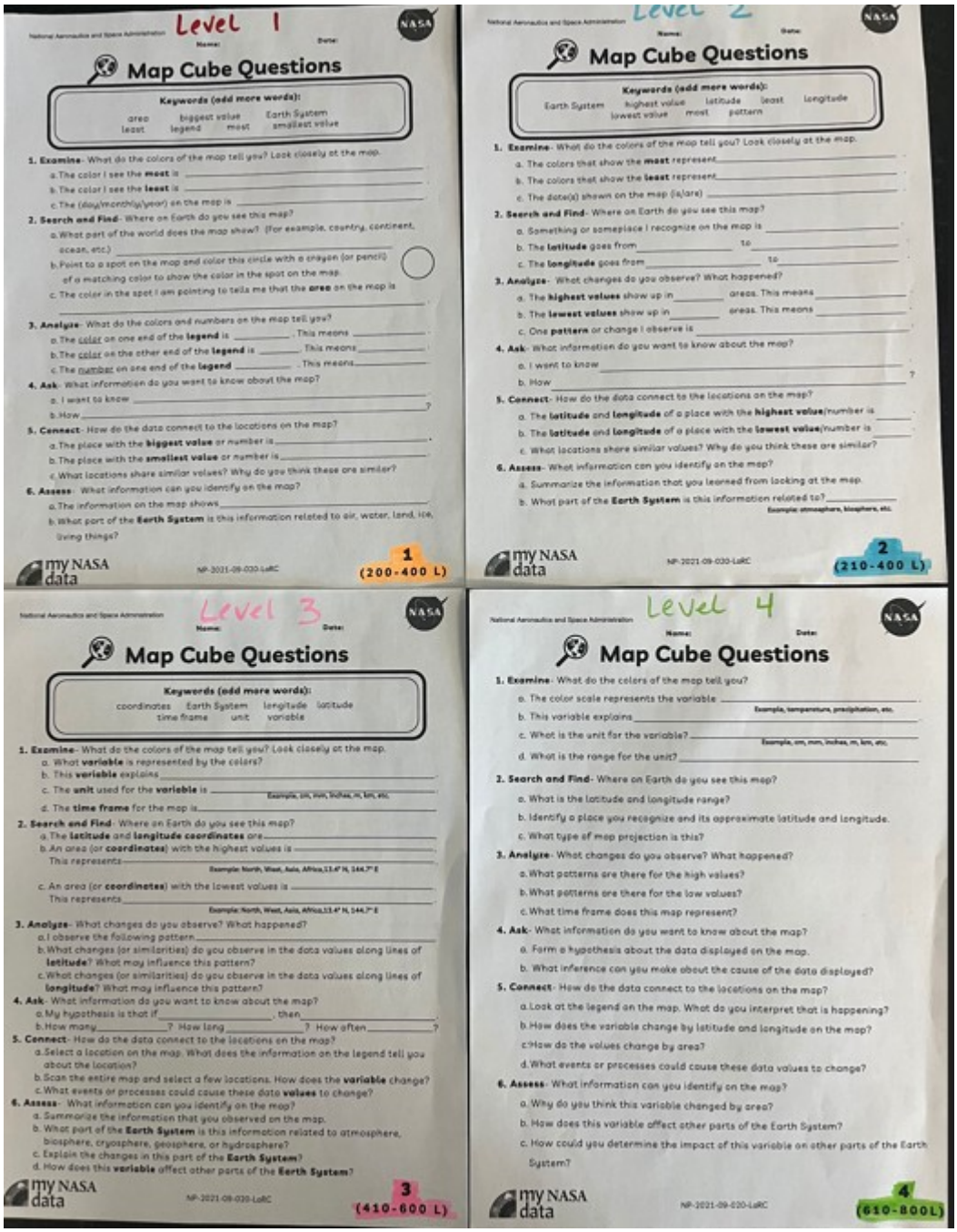
b. Do the outliers meet your expectations? Why/Why not?

c. Graph the data (use graph paper or create your own graph to show your information).

my NASA data

NP-2021-09-020-LaRC

4
(610-800L)



Level 1

Map Cube Questions

Keywords (add more words):
area, biggest value, Earth System, least, legend, most, smallest value

1. **Examine**- What do the colors of the map tell you? Look closely at the map.
   a. The color I see the **most** is _____
   b. The color I see the **least** is _____
   c. The (day/month/year) on the map is _____
2. **Search and Find**- Where on Earth do you see this map?
   a. What part of the world does the map show? (For example, country, continent, ocean, etc.) _____
   b. Point to a spot on the map and color this circle with a crayon (or pencil) of a matching color to show the color in the spot on the map.
   c. The color in the spot I am pointing to tells me that the **area** on the map is _____
3. **Analyze**- What do the colors and numbers on the map tell you?
   a. The color on one end of the **legend** is _____. This means _____
   b. The color on the other end of the **legend** is _____. This means _____
   c. The number on one end of the **legend** _____. This means _____
4. **Ask**- What information do you want to know about the map?
   a. I want to know _____
   b. How _____?
5. **Connect**- How do the data connect to the locations on the map?
   a. The place with the **biggest value** or number is _____
   b. The place with the **smallest value** or number is _____
   c. What locations share similar values? Why do you think these are similar?
6. **Assess**- What information can you identify on the map?
   a. The information on the map shows _____
   b. What part of the **Earth System** is this information related to air, water, land, ice, living things?

my NASA data NP-2021-09-030-LaRC 1 (200-400 L)

Level 2

Map Cube Questions

Keywords (add more words):
Earth System, highest value, lowest value, latitude, least, most, longitude, pattern

1. **Examine**- What do the colors of the map tell you? Look closely at the map.
   a. The colors that show the **most** represent _____
   b. The colors that show the **least** represent _____
   c. The date(s) shown on the map (is/are) _____
2. **Search and Find**- Where on Earth do you see this map?
   a. Something or someplace I recognize on the map is _____
   b. The **latitude** goes from _____ to _____
   c. The **longitude** goes from _____ to _____
3. **Analyze**- What changes do you observe? What happened?
   a. The **highest values** show up in _____ areas. This means _____
   b. The **lowest values** show up in _____ areas. This means _____
   c. One **pattern** or change I observe is _____
4. **Ask**- What information do you want to know about the map?
   a. I want to know _____
   b. How _____?
5. **Connect**- How do the data connect to the locations on the map?
   a. The **latitude** and **longitude** of a place with the **highest value**(number is _____
   b. The **latitude** and **longitude** of a place with the **lowest value**(number is _____
   c. What locations share similar values? Why do you think these are similar?
6. **Assess**- What information can you identify on the map?
   a. Summarize the information that you learned from looking at the map.
   b. What part of the **Earth System** is this information related to? _____
   Example: atmosphere, biosphere, etc.

my NASA data NP-2021-09-030-LaRC 2 (210-400 L)

Level 3

Map Cube Questions

Keywords (add more words):
coordinates, Earth System, longitude, latitude, time frame, unit, variable

1. **Examine**- What do the colors of the map tell you? Look closely at the map.
   a. What **variable** is represented by the colors?
   b. This **variable** explains _____
   c. The **unit** used for the **variable** is _____
   Example: cm, mm, inches, m, km, etc.
   d. The **time frame** for the map is _____
2. **Search and Find**- Where on Earth do you see this map?
   a. The **latitude** and **longitude coordinates** are _____
   b. An area (or **coordinates**) with the highest values is _____
   This represents _____
   Example: North, West, Asia, Africa, 13.4° N, 144.7° E
   c. An area (or **coordinates**) with the lowest values is _____
   This represents _____
   Example: North, West, Asia, Africa, 13.4° N, 144.7° E
3. **Analyze**- What changes do you observe? What happened?
   a. I observe the following pattern _____
   b. What changes (or similarities) do you observe in the data values along lines of **latitude**? What may influence this pattern?
   c. What changes (or similarities) do you observe in the data values along lines of **longitude**? What may influence this pattern?
4. **Ask**- What information do you want to know about the map?
   a. My hypothesis is that if _____, then _____
   b. How many _____? How long _____? How often _____?
5. **Connect**- How do the data connect to the locations on the map?
   a. Select a location on the map. What does the information on the legend tell you about the location?
   b. Scan the entire map and select a few locations. How does the **variable** change?
   c. What events or processes could cause these data **values** to change?
6. **Assess**- What information can you identify on the map?
   a. Summarize the information that you observed on the map.
   b. What part of the **Earth System** is this information related to atmosphere, biosphere, cryosphere, geosphere, or hydrosphere?
   c. Explain the changes in this part of the **Earth System**?
   d. How does this **variable** affect other parts of the **Earth System**?

my NASA data NP-2021-09-030-LaRC 3 (410-600 L)

Level 4

Map Cube Questions

1. **Examine**- What do the colors of the map tell you?
   a. The color scale represents the variable _____
   Example, temperature, precipitation, etc.
   b. This variable explains _____
   c. What is the unit for the variable? _____
   Example, cm, mm, inches, m, km, etc.
   d. What is the range for the unit? _____
2. **Search and Find**- Where on Earth do you see this map?
   a. What is the latitude and longitude range?
   b. Identify a place you recognize and its approximate latitude and longitude.
   c. What type of map projection is this?
3. **Analyze**- What changes do you observe? What happened?
   a. What patterns are there for the high values?
   b. What patterns are there for the low values?
   c. What time frame does this map represent?
4. **Ask**- What information do you want to know about the map?
   a. Form a hypothesis about the data displayed on the map.
   b. What inference can you make about the cause of the data displayed?
5. **Connect**- How do the data connect to the locations on the map?
   a. Look at the legend on the map. What do you interpret that is happening?
   b. How does the variable change by latitude and longitude on the map?
   c. How do the values change by area?
   d. What events or processes could cause these data values to change?
6. **Assess**- What information can you identify on the map?
   a. Why do you think this variable changed by area?
   b. How does this variable affect other parts of the Earth System?
   c. How could you determine the impact of this variable on other parts of the Earth System?

my NASA data NP-2021-09-030-LaRC 4 (610-800L)

Appendix D

Pre-Professional Development Training session questions

1. How do you define data literacy?

2. Circle any examples below of how you use data in your classroom?
   a. Tables
   b. Charts
   c. Graphs
   d. Maps
   e. Other:

3. How would you rank your comfort level with teaching data analysis skills?

0	1	2	3
Not comfortable	Somewhat	Comfortable	Confident

4. My students ***make*** tables, graphs or maps.

0	1	2	3
None	Sometimes (1-2 times/month)	Regularly (3-4 times/month)	Frequently (once or more a week)

5. My students ***interpret*** meaning from tables, graphs, or maps.

0	1	2	3
None	Sometimes (1-2 times/month)	Regularly (3-4 times/month)	Frequently (once or more a week)

(1-3 I have resources built into my curriculum that allow me to access data tables, charts, graphs and/or maps. Yes or no

6. I have had to search for my own resources of data for students to use. Yes or no

7. What is the biggest challenge to using data in your classroom?

Answers from participants for the pre survey questions are in below in bolded italics.

1. How do you define data literacy?
   - ***Being able to take data and results and use those numbers to change/adapt/refine techniques to improve performance.***
   - ***Using data to make logical conclusions.***
   - ***The ability to understand how to interpret data in multiple formats.***
   - ***Ability to analyze and utilize student data to help students grow.***
   - ***The ability to understand charts, graphs and other representations of data and how to explain it to others.***
   - ***The ability to make sense of and analyze data to meaningful use of.***
   - ***The ability to discern/discriminate/create information and infographics***
   - ***Ability to read and decode words in textual settings.***

- ***Being able to read, interpret and analyze data.***
- ***Fluency and comfort level of dissecting and analyzing data.***

2. Circle any examples below of how you use data in your classroom?
   a. Tables
   b. Charts
   c. Graphs
   d. Maps
   e. Other:
   - ***All participants who answered this question circled A-D above except one who circled just C and D.***
   - ***For E, "other," one participant indicated "simulations and layered data on maps." One participant added "infographics" Another added "pictures like paintings, posters and propaganda."***

3. How would you rank your comfort level with teaching data analysis skills?

0	1	2	3
Not comfortable	Somewhat	Comfortable	Confident
		6 participants	***4 participants***

4. My students ***make*** tables, graphs or maps.

0	1	2	3
None	Sometimes (1-2 times/month)	Regularly (3-4 times/month)	Frequently (once or more a week)
1 participant	***6 participants***	***3 participants***	

5. My students ***interpret*** meaning from tables, graphs, or maps.

0	1	2	3
None	Sometimes (1-2 times/month)	Regularly (3-4 times/month)	Frequently (once or more a week)
		6 participants	***4 participants***

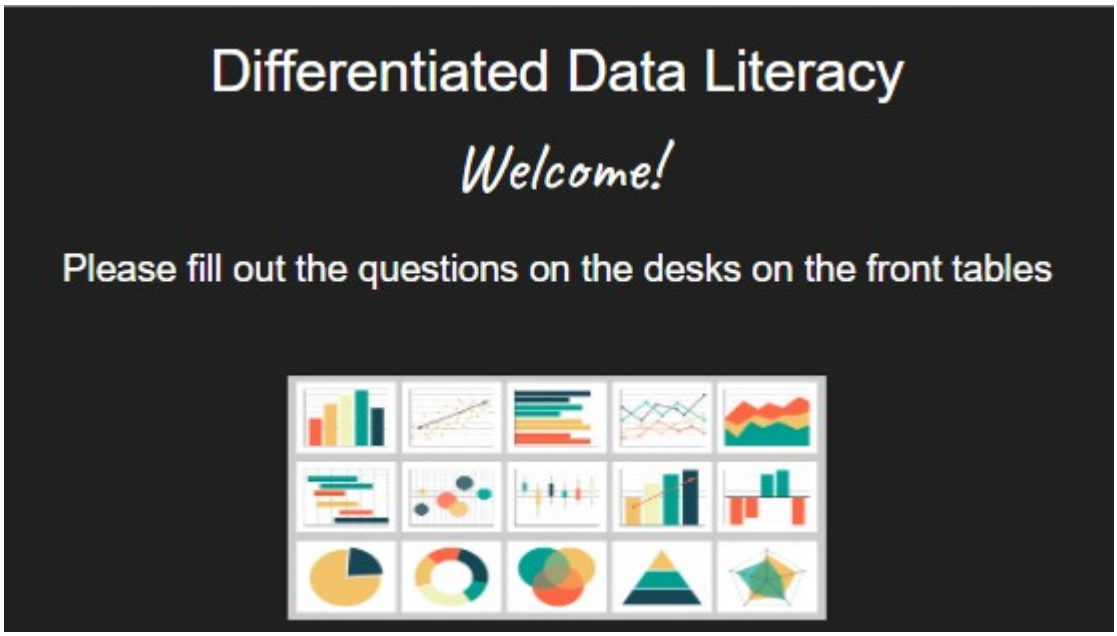
6. I have resources built into my curriculum that allow me to access data tables, charts, graphs and/or maps. Yes or no
   All participants indicated they have some resources built into their curriculum but not enough to use weekly to practice data literacy skills

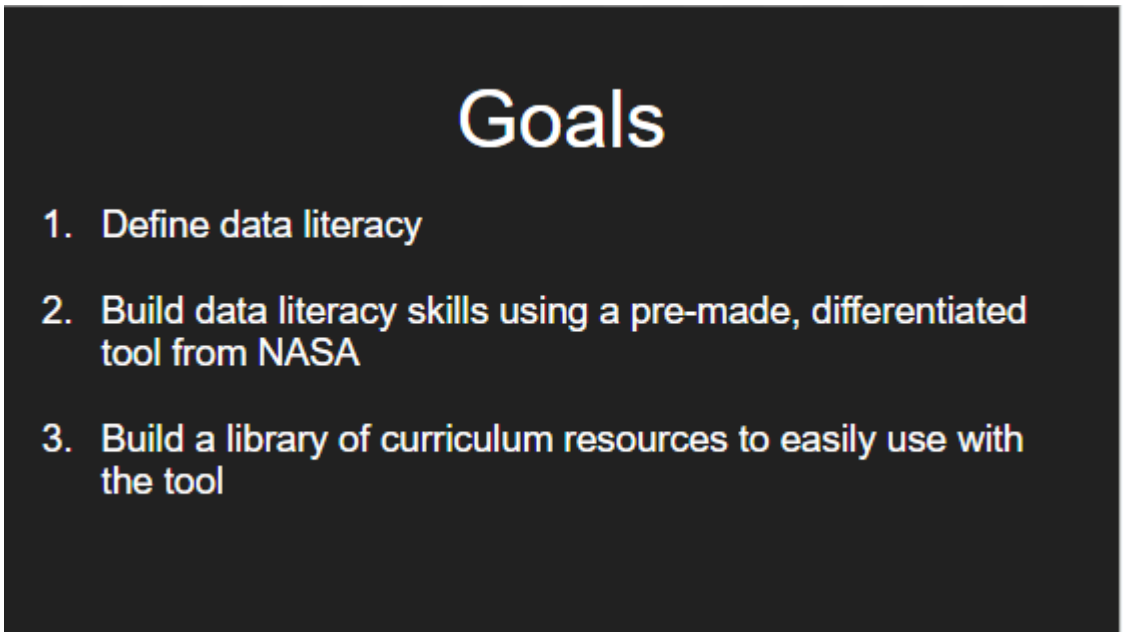
7. I have had to search for my own resources of data for students to use. Yes or no
   7 participants indicated they have had to search or build their own resource bank. 3 participants said they do not.

8. What is the biggest challenge to using data in your classroom?
    - ***In social studies it seems that you can take data and make it defend your claim or opinion. Sometimes the data can be subjective.***
    - ***Students struggle with number sense and that can inhibit progress.***
    - ***Making it easy for students to understand and do.***
    - ***Subject matter.***
    - ***Not really anything.***
    - ***Teaching students to make/interpret data.***
    - ***Kids resist thinking***
    - ***Having kids use it correctly and using it to back up or help with arguments.***
    - ***Students not trying- not using skills from other classes.***
    - ***There is so much out there- finding what is most important.***

Appendix E

Slide Presentation from Professional Development Training





1. Define Data Literacy

- ability to read data (comprehend)
- analyze data (understand the why)
- argue with data

Why should students care?

2. NASA Data Literacy Cubes- digital or paper

- Data analysis and interpretation using built in prompts and scaffolded questions in a collaborative setting.
- Purpose: students work together to recognize patterns, relate cause and effect, observe stability and change, and explain events and phenomenon.

Cubes and Task cards linked here. Differentiated questions

Procedure, Student Communication(use Learning Lab Resource on questioning)

3. Apply your individual curriculum resources and follow up

- Build a library of data resources for student interpretation and consistent development of data literacy skills.
- Create a shared doc within your department to begin compiling data resources for use within your whole subject area. (maps, charts, graphs, tables, visuals, etc.)

Science Teachers (doc to organize)

Thank you for your time today

Please complete the last questions on the survey and have a wonderful rest of the day!

Appendix F

Middle School Science NGSS by topic

Physical Science

NGSS Topic	Links to data	Misc. info
Structure and Properties of Matter		
Chemical Reactions		
Forces and Interactions		
Energy		
Waves and EM radiation		

Life Science

NGSS Topic	Links to data	Misc. info
Structure, Function and Information Processing		
Growth, Development and Reproduction of Organisms		
Matter and Energy in Organisms and Ecosystems		
Independent Relationships in Ecosystems		
Natural Selection and Adaptation		

Earth and Space Science

NGSS Topic	Links to data	Misc. info
Human Impacts	Keeling Curve	Graph of CO2 levels
Weather and Climate		

Earth's Systems	Sea Level	Graph of sea level rise
History of Earth		
Space Systems		

Appendix G

Post Professional Development Training session questions

1. Did your definition of data literacy change after today's pd? Yes or No

2. Do you feel NASA data cubes might be useful in your classroom? Yes or no
    a. If YES, what support or resources do you feel like you would need to use this tool?
    b. If YES, can I follow up with you in April to find out more about your experience with the data cubes? Yes or no

3. What is one thing you can take away from Differentiating Data Literacy with NASA cubes?

4. Do you have anything else you would like to add?

5. Do you provide permission to use your name to be used within the final research paper on this topic for Adams State University and the NASA Endeavor program? Yes or No

Answers from participants for the post training questions are below in bolded italics.

1. Did your definition of data literacy change after today's pd? Yes or No
   6 participants stated Yes, with two comments:
    - ***When we originally started, I was thinking of data literacy as educators but now I see it for our students.***
    - ***Arguing with the data was a level to the definition.***

   4 participants stated No.

2. Do you feel NASA data cubes might be useful in your classroom? Yes or no
   All participants indicated Yes

a. If YES, what support or resources do you feel like you would need to use this tool?
   - ***I loved this- made data analysis feel so much easier and manageable.***
   - ***Keyword box changes and sources of data.***
   - ***Help printing and assembling the cubes.***
   - ***See the student jobs in action.*** *(we practiced this in the PD session)*
   - ***Can this be used for diagrams too?***
   - ***I kind of feel all the questions mattered- more likely to use the questions not the cubes.***
   - ***The data to analyze*** *(we began this in the PD session)*
   - ***Graphs and data to use that are relevant*** *(we began this in the PD session)*
   - ***No support needed***
   - ***I like the resources on slavery in the 1790 census***

b. If YES, can I follow up with you in April to find out more about your experience with the data cubes? Yes or no
   - ***7 participants indicated Yes***
   - ***4 said no or unknown and two explained they didn't think they would have enough time***

3. What is one thing you can take away from Differentiating Data Literacy with NASA cubes?
   - ***I could use this tomorrow***
   - ***Love that the question sets are already done and this tool is interdisciplinary.***
   - ***A go-to for data analysis questions.***
   - ***Since questions will repeat with repeated use, students will build skills over time.***
   - ***The leveled abilities to read data.***
   - ***I liked the leveled questions the best.***
   - ***The importance of data literacy.***
   - ***The leveling of questions.***
   - ***I have a tangible resource that I could use tomorrow.***
   - ***The four different levels- differentiation on how to evaluate the data yet same results.***

4. Do you have anything else you would like to add?
   - ***So many awesome resources! Wish I would have had this years ago.***
   - ***Not sure the advantage of the cube is.***
   - ***Could students make their own tables (for class data) and use this tool to analyze?***
   - ***This would be a cool way to have kids give feedback on student made graphs/maps, etc.***

5. Do you provide permission to use your name to be used within the final research paper on this topic for Adams State University and the NASA Endeavor program? Yes or No
   All participants indicated Yes.