Numeracy: Constructing, Reading and Interpreting Graphs

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Introduction

Conrad Schools of Science is a grades 6-12 biotechnology and allied health magnet school. Located in Wilmington, Delaware, Conrad is one of the two magnet schools in the Red Clay Consolidated School District. In the 2013-2014 school year Conrad enrolled 1,153 students, with 515 students making up the middle school, and 638 students making up the high school. Besides being a science magnet school, Conrad is also one of the two middle schools that house the bilingual programs in our district. English Language Learners (ELL) in the bilingual program makes up 7.7% of our school. The ethnicity of Conrad's student population is 65.1% white, 18.9% Hispanic/Latino, 11.2% African American, 3.9% Asian, 0.8% Multi-Racial and 0.1% American Indian.

Conrad is unique in that it is a bioscience magnet school. Exploratory programs such as forensics, plant and animal science, anatomy, emergency response skills, etc. are used to prepare middle school students for the rigor of the high school programs. The pathways within the high school, which are three-year programs, include biotechnology research, biomedical science, veterinary science, nurse tech, and physical therapy/athletic healthcare. Our goal at Conrad is to ensure college and career readiness.

I am a seventh grade science teacher at Conrad. The five sections of seventh grade science that I teach have a total of 155 students. Each section is made up of 28-34 students. At Conrad, we utilize the block scheduling which allows me to meet with my students every other day for 85 minutes at a time. My seventh grade students at Conrad are extremely diverse learners, but they all seem to have one thing in common: they love a challenge.

The middle school science curriculum at Conrad is unique compared to the remainder of the state. Throughout the state of Delaware the science curriculum is integrated for each grade (6, 7 and 8). At Conrad, we use the state curriculum units, but in an altered sequence. Instead of having integrated science for each grade in the middle school, we divided the units into biology, physical science, and Earth and space science. In 6^{th} grade students are taught the biology units. In 7^{th} grade students are taught the physical science units. In the 8^{th} grade students learn the Earth and space science units. Since I am a seventh grade science teacher at Conrad, my curriculum focuses on physics and chemistry. I am creating this graphing unit for my seventh grade science students,

although it can be used for all middle school students in science and/or mathematics courses.

Rationale

Creating, reading, and analyzing graphs are essential tasks. These tasks are not only done in elementary, middle, and high school, but are done throughout our everyday lives. As an adult, it is important that I know how to read and analyze a graph that is presented to me. In my career as a teacher, I encounter many data sets that are presented using graphs. It is crucial that I know, not only how to read these graphs that I encounter, but that I need to know how to analyze this data to find out just what it really means. Reading, and analyzing graphs may seem like a simple task, but it is a challenge for school-aged students.

Understanding how to read and interpret graphs is beneficial for students both in and outside of school. Students will need to know how to construct a graph using data they have collected from a science experiment. Students will need to determine a relationship between two variables in science class, math, and even in a social studies course. Since graphing is used cross-curricular it is essential that students learn, understand, and master the skills needed to create, read, and analyze graphs.

Not only is graphing used in different subjects, students are also assessed on their ability to read and create graphs on the state test. Data is given to students in the form of a graph, and students need the ability to read and interpret these graphs in order to answer the questions that align with the graph. One of the Delaware state middle school science standards states that students need to be able to understand that in a scientific investigation, data collection involves making precise measurements and keeping accurate records so that others can replicate the experiment. This standard also states that students need to be able to accurately construct tables, diagrams and graphs showing relationships between two variables, and to display and facilitate analysis of data. Students will then need to compare and question results with and from other students. Throughout my curriculum, students do a number of investigations where they conduct an experiment, and collect data. Students are then instructed to graph this data, and use the graph to answer conclusion questions at the end of the investigation. Within the middle school science curriculum there are no suggested activities that teach students what graphs are, how to construct a graph, what types of graphs should be used for specific data sets, how to read graphs, or how to analyze and interpret graphs. The curriculum expects students to already have this knowledge. Yet students in middle school lack knowledge of graphing which makes it a challenge to analyze the data they have collected. It is also a challenge for students to score well on the state standardized test since they do not have the necessary skills.

This graphing unit will enhance my 7th grade science curriculum. I start my year off each year reviewing the steps of the scientific method. My curriculum lends itself to hands-on investigations. Students need to know the importance of conducting an experiment, and the importance of precise measurements and accurate data. I will then implement my graphing unit. When students collect data, they will need the skills necessary to organize this data into a visual diagram that shows a relationship between two variables. Not only will students learn how to construct a graph, they will also learn how to read and interpret a graph. Students will learn when and why graphs are used, and what kind of information they can gather from graphs. Through this unit students will discover the different types of graphs, and what type of graph is appropriate for the data they have collected. The ability to construct, read and interpret a graph will be a skill that will not only help them in the courses they take throughout their years in school, but will also be valuable to them outside of school in their every day lives as kids, and as adults.

Essential Questions

- When and why are graphs used?
- How can data be used to construct a graph?
- How are graphs interpreted?
- What kind of information can we get from different types of graphs?
- How do you determine the type of graph to use based on the data you have collected?

Background

What is Numeracy?

"Today's students spend more years studying mathematics than their counterparts in the past, yet critics argue that innumeracy remains a serious problem, that students have difficulty applying their math training to real-world situations. In response, instruction in numeracy seeks to help students apply their quantitative skills to reading graphs, understanding interest rates on home loans and credit cards, and other practical situations."[1] Through my Delaware Teachers Institute (DTI) seminar: "Numbers and Social Problems" - I learned the importance of numeracy, along with the importance of numeracy in social problems. Students need to think about the numbers around them. The ability to critically think about and understand numbers is necessary for both school aged students and adults. We need to teach our students the importance of thinking about the numbers that they use on a daily basis. Middle school students don't normally think about the numbers they use day-to-day, let alone think critically about these numbers. Teaching our students to take a second to think about these numbers is key for students to comprehend them. We need to ask students to think about where these numbers came from, what these numbers really mean, and how accurate these numbers really are. When

it comes to finding statistics about social problems, middle school students tend to see a number, and assume it is accurate without even thinking twice about it. Teaching students to think critically about the numbers they find through research will tremendously aid their numeracy skills in their everyday lives.

What is a Graph?

Graphs are used to communicate data or information visually.[2] We see graphs more often than we think. Graphs are found all around us: in newspapers, magazines, textbooks, and on the Internet. Graphs are used to show the relationship between variables. The data that is graphed is sometimes very difficult to comprehend through reading words. The visual that is presented through a graph should make it easy for an audience to read and interpret. Through my Delaware Teachers Institute seminar: "Numbers and Social Problems" - I learned that good graphs should meet the following criteria: they should be easy to read, complete and comprehensive, labeled clearly, use an appropriate scale, and they should be visually appealing.

When and Why Are Graphs Used?

Graphs are used to visually make sense of data that has been collected. We use graphs to organize data in a visual approach.[3] In middle school science I teach students how to pick out the variables for each experiment. The students learn that the independent variable is the variable that we are changing on purpose. We are changing this variable to see how it affects the dependent variable. I teach my students that the dependent variable is the variable in the experiment that we are keeping track of, or measuring. The dependent variable depends on the independent variable. In my science classroom I teach my students that we graph our data to give us a better visual overview of the data we collected. It is challenging for students to understand the data they have collected when it is organized in a data table. Taking this data and creating a visual is much easier for middle school students to read and understand. After graphing the data that has been collected, students seem to have a better idea of the essential outcome of the investigation or the lab. Using a graph allows the students to see any trends or patterns in the data they have collected.[4] Trying to find trends, or patterns in data is very challenging for students when it is organized in a data table format. I teach my students that we will use a graph when we are collecting quantitative data. Students need to understand that quantitative data is the information in the form of numbers or quantities. After each experiment that we conduct in my science classroom, I ask the students to look at their data. If the data is quantitative we are going to create a graph to give us a better visual and a better understanding of what they measured during the experiment.

Types of Graphs

There are several different types of graphs. Each graph is unique in its own way. Different types of graphs are used to show different types of data. All graphs show a relationship between different variables. The two graphs that I am going to focus on in my graphing unit are the bar graph and the line graph.

First, one of the most common graphs that students learn about is the bar graph. A bar graph is a graph that uses individual rectangles that are not connected in any way. The rectangles can be displayed either vertically or horizontally. The rectangles are typically different lengths allowing viewers to easily compare the different categories. The length of the rectangles or bars displays the quantity within that category. Bar graphs allow us to make conclusions generally and quickly.[5] I teach my students that bar graphs are used when we have categories or qualitative data along one of the axes. Since bar graphs clearly show patterns or trends within the data, I teach my students that bar graphs are used to quickly and easily compare different categories.

Second is the line graph. Like a bar graph, the line graph is used to show the relationship between the independent and dependent variable. A line graph is used to display data that changes continuously. A line graph displays the independent variable along the X-axis, and the dependent variable along the Y-axis.[6]

Constructing Graphs

Before starting the construction of a graph, you need to determine the type of graph that is going to be used. Choosing the correct type of graph is a challenge for middle school students. Most students feel as if a bar graph is suitable for all types of data. Other students feel like a line graph should be used for all types of data. Students need to learn that different types of graphs are used for different types of data. Before creating a graph, I teach my students to think about the data in front of them. Students should be considering whether their data is quantitative or qualitative. If the data set that has been collected is comparing categories, I teach my students to create a bar graph to display that data. The bar graph will allow students to quickly and easily compare the different categories. If the data that has been collected is quantitative and continuous, I teach my students to create a line graph.

When creating a graph I teach my students the TAILS acronym. TAILS is what every graph must have. The T in Tails stands for title. The title must be clear, and must describe what the data represents.[7] In science, I teach my students to title their graph using the problem or purpose question from the experiment. For example, if students were experimenting to find out how the height of a ramp affects the speed of a golf ball, I tell them to title their graph “How does the ramp height affect the speed of a golf ball?” In other words, how does the independent variable affect the dependent variable? Next, the A in the acronym TAILS stands for axes.[8] I teach my students to label their x and y-axis with a small x and y. If students are drawing their own graph, I teach them that their axes

must be drawn neatly and straight. The I in the acronym TAILS stands for intervals. Intervals are the numbers used along the x and y-axes.[9] I teach my students to find the range for both the independent variable and the dependent variable. Students can find the range by subtracting the lowest data value by the highest data value. Once students have the range they can determine a scale that best fits the range for each variable. Students need to know that their intervals must be equal and clearly numbered along each axis. Next, the L in the TAILS acronym stands for labels. The labels are the variables along with the unit that was used to measure them.[10] It is essential that students know to label both the x and y-axis. Along the x-axis they will label the independent variable. Along the y-axis they will label the dependent variable. Next to each variable on the x and y-axes, students must label the correct units. The units will be in parentheses next to the variable. Finally, the S in the TAILS acronym stands for scale. The scale portion should be done along with the I (intervals) step of graphing. The scale refers to the numbers used along each axis. The scale typically indicates the minimum and maximum numbers used on each axis.[11] It is essential to stress to students that the scale allows you to make the graph as big as possible. I teach my students to spread their numbers out, so the graph takes up the majority of the graph paper.

After setting up your graph, it is now time to plot your points to create your graph. First: the bar graph. After setting up the graph using TAILS, I teach my students to draw rectangles starting on the x-axis, drawing a bar up to the numerical value it matches on the y-axis. I teach my students that the bars should not be touching since we are comparing different categories. I also teach my students that the rectangles should all be the same width, and each bar should look different. I teach my students to use different colors, or different symbols when coloring in each bar in order to make it easier for the readers to quickly compare each category. Next is plotting points on a line graph. After setting up the graph using TAILS, students are ready to plot their data points. I teach the students that when plotting your points in a line graph, each point will have two values. One value will be for the x-axis, and the second value will be for the y-axis. Students will then find the x-axis value on the bottom line, and will go up to find the y-axis value. Where the two values intersect is where students will plot their point. Once all points are plotted, I tell students to connect the dots from left to right.

Once students are done creating their graphs, I provide them with a "Good Graph Checklist" where they will be able to determine if their graph meets the requirements. The "Good Graph Checklist" students will ask the following questions: Have you selected the appropriate graph type for your set of data? Does your graph have a title? Does the title describe what is being displayed? Is the independent variable on the x-axis? Is the dependent variable on the y-axis? Do you have units of measurement in parenthesis next to your variables on both axes? Did you find the range for your data? Are your intervals increasing by an equal amount? Did you spread your numbers out so that you used as much of the graph paper as possible? Are your data plotted appropriately?[12] If students are able to answer "yes" to all of these questions, then they know they have

constructed their graph properly. If students answer “no” to any of these questions, they will need to make the appropriate changes to their graph.

Reading and Interpreting Graphs

Reading and interpreting graphs is a challenging task for most middle school students. Graphs are used to visually show the relationship between two variables using data that were collected. I start with how to read and interpret a bar graph. When looking at a graph, the first thing that needs to be done is reading the title. The title will tell the reader what kind of information is displayed in the graph. Next, we need to take a look at the two variables that are being compared. You will find the independent variable along the x-axis and the dependent variable along the y-axis on a vertical bar graph. You will find the independent variable long the y-axis and the dependent variable along the x-axis on a horizontal bar graph. Reading and knowing the variables will better help the reader to understand what the graph is presenting. The independent variable along the x-axis will show the categories that are being compared in this bar graph. The y-axis will show how the categories will compare, and what units of measure were used. It will be important for any reader to look at the intervals that are used on the graph. Looking at the minimum and maximum numbers will help the reader to understand the highest and lowest measurements. Next, the reader will look at the bars. The bars provide an instant comparison of data in a graph. Readers can look at the bars to determine which category measures highest, which category measures lowest, and which categories are similar. Seeing the bars will make it easy for readers to compare the categories, and find any trends and/or patterns within the data.

Reading and interpreting line graphs is a bit more difficult for middle school students. Unlike the bar graph, a line graph is not comparing different categories. You will know that you are looking at a line graph when there is a line on the graph that is connecting the data point that has been plotted. On a line graph, the line can be straight, curved, or show an up and down pattern. The line graph shows a relationship between the two variables presented.[13] The first thing that one should do when viewing a line graph is read the title. The title will tell the reader what information is displayed in the graph. When reading a graph one should also know that the independent variable is changing the dependent variable. Readers can ask themselves the following question “How does increasing the independent variable (on the x-axis) affect the dependent variable?” The reader should look at the variables along each axis. The variable along the x-axis is the independent variable, and the variable along the y-axis is the dependent variable. After finding the variables, the reader must find how these variables are being measured by finding the units in parentheses next to each variable. Once the variables and units have been established, the reader should then look at the intervals and scales along both the x and y-axes. Along with finding the interval and scale for each axis, the reader should find the minimum and maximum measurements. Knowing how the graph is numbered will allow for easier reading of the information. After determining the variables, units,

intervals and scales, the next thing the reader will look at is the line itself. The line will tell the reader a lot about the relationship between the two variables presented in the graph. If the line is going up as the independent variable in increasing, this tells the reader that the dependent variable is also increasing. If the line on a line graph goes downward as the independent variable increases, this line shows that the dependent variable is decreasing. Straight lines going upward on a line graph shows the dependent variable increasing as a steady rate. If the line goes downward in a straight line, this implies that the dependent variable is decreasing at a steady rate. If the line is curved, this implies that the dependent variable is changing, but not at a steady rate. By reading the line, the reader is able to determine the relationship between the two variables that are displayed in the graph.

Teaching Strategies

Think-Pair-Share

Think-Pair-Share is a strategy I use frequently in my science class. Students are given a question, or scenario that they need to think about independently to construct a solution. After students thought independently, they are to pair up with a student next to them, and share their responses. The two students have a conversation regarding their individual responses. This strategy promotes a high level of engagement and participation for all students. This strategy allows students to think to themselves, but also allows them to share their response with at least one other student. After students have the opportunity to think to themselves, and share with a partner, I then have a whole class discussion regarding the topic.

Jigsaw

Jigsaw is strategy that promotes cooperative learning. Students are grouped and each group is given a specific topic. Students research and discuss the topic with their group members. These groups are considered "expert groups" and I tell students that they are becoming experts in these topics, because they will have to share their findings. I then take one student from each expert group to form new groups. The new groups should have one expert from each topic. Within the new groups students share their findings with each other. The idea of the new group is to have each expert teach their group members about their topic. This strategy encourages students to take responsibility and ownership in their work. Students are able to teach their peers using the jigsaw strategy. After students are done teaching their expert topics to one another, I bring the entire class together and have a class discussion. The class discussion is essential at this time in order to confirm that all students have accurate information.

Stations

Students work in small groups to rotate through stations set up around the classroom. I use stations in many lessons. Using stations allows students to get up and move around, and to engage in various tasks. Stations can be created and set up for a variety of topics and lessons. Using stations allows students to work on different tasks such as hands-on activities, reading activities, use of technology, and many more. The use of stations allows me to differentiate the lesson.

Activities

What is a Graph?

When and why are graphs used? What kind of information can we get from different types of graphs?

This lesson is intended to give students a clear understanding of what a graph is. This lesson is also intended to teach students what information they can get from different types of graphs.

Anticipatory Set: In order to have students start thinking about graphs, I will ask them to respond to the following question: "In your own words, what is a graph?" I will use the Think-Pair-Share strategy where students will construct their own answer, then pair up with the student next to them, and share their responses. I will have an entire class conversation where I will ask students what a graph is in their own words.

Directed Instruction: Students will fill in the "What Is a Graph and Why Are They Used?" graphic organizer found in Appendix 2 throughout the short lecture to start the lesson. I will teach students that a graph is a visual representation of data. A graph shows a relationship between two variables. I will then ask students where they usually find graphs and ask them to fill it in on their graphic organizer. I will then ask students to share out where they usually find a graph. The student responses that I am looking for specifically are textbooks, magazines, newspapers, and on the Internet. I will teach students that there are two different types of graphs that we will focus on in 7^{th} grade science. The two types of graph are bar graphs and line graphs. I will teach students that they can read or learn different kinds of information through the two different types of graphs. Although all graphs show how the independent variable affects the dependent variable, bar graphs and line graphs are each unique. A bar graph is a graph that uses individual rectangles that are not connected in any way. The rectangles can be displayed either vertically or horizontally. The rectangles are typically different lengths allowing viewers to easily compare the different categories. The length of the rectangles or bars displays the quantity within that category. I teach my students that bar graphs are used when we have categories or qualitative data along one of the axes. Since bar graphs clearly show patterns or trends within the data, I teach my students that bar graphs are used to quickly and easily compare different categories. A line graph, like a bar graph, is

used to show the relationship between the independent and dependent variable. A line graph is used to display data that changes continuously. As a class we will discuss what makes a graph good. As a class we will complete our graphic organizer by filling in the five components of a quality graph. Quality graphs should be easy to read, complete and comprehensive, labeled clearly, use an appropriate scale, and they should be visually appealing.

Activity: Students will work in groups to rotate through five different stations. Each station will focus on one component of a quality graph. Students will research what each component really means, and they will also research what it looks like on an actual graph. At Station One students will use the laptops to investigate what it means for a graph to be easy to read. They will also look up an example of what a graph that is easy to read looks like. At Station Two students will find what it means for a graph to be complete and comprehensive. Students will also look up an example of a graph that is complete and comprehensive. At Station Three students will research that it means for a graph to be labeled clearly, and example of a graph that is clearly labeled. At Station Four students will research what it means for a graph to use an appropriate scale, and an example of a graph that uses an appropriate scale. At Station Five students will look up what it means for a graph to be visually appealing, and they will find examples of graphs that are visually appealing. Students will complete the graphic organizer found in Appendix 3. I will ask students to switch stations after 10 minutes. Also, before students leave each station, they will add to the poster posted at each station. On this poster, students will record their findings in one sentence, and they will include a drawing of their findings. Students will be instructed to write something different from what is already recorded on the poster. When students are done rotating through the stations, we will use the posters from each station to have a class discussion on their findings.

Assessment: I will add closure to the lesson by having students complete an exit ticket. The exit ticket question will ask the students what the five components of a quality graph are, and I will ask them to write down two other things they learned from the lesson today. I will use these exit tickets to assess student learning.

Constructing Graphs

How can data be used to construct a graph?

This lesson is intended to teach students how to construct a graph. Students will learn how to create a graph, and they will practice constructing both bar and line graphs.

Anticipatory Set: As a review from the previous lesson, I will ask students to answer two questions. First question will be “What are the component of a quality graph?” My second question will be “What is the difference between a bar graph and a line graph?” We will use these responses to begin the lesson.

Directed Instruction: I will review what a graph is, and the difference between a bar graph and a line graph with the students. With this review, I let the students know that through the activity today they will learn how to construct a graph. I teach my students that we use the acronym TAILS to help us to construct graphs. In order to construct a graph you will need a title, axes, intervals, labels, and a scale. Through the activity students will be placed in expert groups and will become experts in each component, then return to their group, and teach their group members what they learned. At then end of the activity students will be using what they learned from their expert group and from their peers to construct two graphs.

Activity: In this lesson activity students will be learning how to construct a graph. Students will also be teaching their peers what they learn. With this activity I am will use the jigsaw teaching strategy. There will be five expert groups (title, axes, intervals, labels, scale). When students are in their expert groups they will use the laptops to research information on their topic. While in expert groups, students will discuss their findings, and complete the top portion of the graphic organizer found in Appendix 4. After 20 minutes in expert groups, I will then regroup students. I will take one student from each expert group to form a new group. This new group will consist of a student who is an expert in the "T" in TAILS, an expert in the "A" in TAILS, an expert in the "I" in TAILS, an expert in the "L" in TAILS, and an expert in the "S" in TAILS. With this new group students will all have an opportunity to share their findings from their research. Students will complete the bottom portion of the graphic organizer found in Appendix 4. At the end of the jigsaw all students should know and understand the TAILS acronym and how it can be used to create a graph. I will keep students in their groups, and ask them to construct a graph together. Experts will take the lead on their portion of the graph. I will give groups two sets of data. In their groups, students will have to determine whether they will make a line graph or a bar graph for each data set.

Assessment: I will use the graphs constructed by students in order to assess student learning.

Reading and Interpreting Graphs

How are graphs interpreted?

This lesson is intended to teach students how to read and interpret a graph. Through this lesson students will practice reading and interpreting both bar graphs and line graphs.

Anticipatory Set: To start the lesson I will ask students the following question: "When looking at a graph, what should be the first thing you look at in order to read and interpret the graph?" Students will think and answer this question independently. Then students will pair up and share their responses. I will ask students to share their responses.

Directed Instruction: I will remind students that graphs are used to visually show the relationship between two variables using data that were collected. I will teach my students that when looking at a graph, the first thing that needs to be done is reading the title. The title will tell the reader what kind of information is displayed in the graph. Next, we need to take a look at the two variables that are being compared. I will explain to students that they find the independent variable along the x-axis and the dependent variable along the y-axis on a vertical bar graph. You will find the independent variable long the y-axis and the dependent variable along the x-axis on a horizontal bar graph. I will explain to students that reading and knowing the variables will better help to understand what the graph is presenting. The independent variable along the x-axis will show the categories that are being compared in this bar graph. The y-axis will show how the categories will compare, and what units of measure are being used. I will emphasize to students that it is important to look at the intervals that are used on the graph. Looking at the minimum and maximum numbers will help to understand the highest and lowest measurements.

Next, I will teach my students to look at the bars. The bars provide an instant comparison of data in a graph. Seeing the bars will make it easy to compare the categories, and find any trends and/or patterns within the data. I will then tell the students that while reading a line graph is similar to reading a bar graph, it does have differences.

Unlike the bar graph, a line graph is not comparing different categories. I will teach my students that they will know that they are looking at a line graph when there is a line on the graph that is connecting the data point that has been plotted. I will explain that on a line graph, the line can be straight, curved, or show an up and down pattern. Like reading a bar graph, the first thing that should be done when viewing a line graph is read the title. I will teach my students that when reading a graph they should know that the independent variable is changing the dependent variable. I will teach the students that they need to look at the variables along each axis. The variable along the x-axis is the independent variable, and the variable along the y-axis is the dependent variable. After finding the variables, they must find how these variables are being measured by finding the units in parenthesis next to each variable. Once the variables and units have been established, they should then look at the intervals and scales along both the x and y-axes. Along with finding the interval and scale for each axis, they should find the minimum and maximum measurements. Knowing how the graph is numbered will allow for easier reading of the information.

After determining the variables, units, intervals and scales, the next thing I will teach students to look at is the line itself. The line will tell them a lot about the relationship between the two variables presented in the graph. If the line is going up as the independent variable in increasing, this tells them that the dependent variable is also increasing. If the line on a line graph goes downward as the independent variable

increases, this line shows that the dependent variable is decreasing. Straight lines going upward on a line graph shows the dependent variable increasing as a steady rate. If the line goes downward in a straight line, this implies that the dependent variable is decreasing at a steady rate. If the line is curved, this implies that the dependent variable is changing, but not at a steady rate. By reading the line, students are able to determine the relationship between the two variables that are displayed in the graph.

Activity: Students will start by making a human bar graph. I will use tape in the middle of my classroom floor to create an x and y-axis. I will have this set up before students arrive. I will ask students various questions such as "What color eyes do you have?" Students will line up in the appropriate columns. This will give students a great visual of what a bar graph looks like. As students are lined up in their graph, I will ask them to look around, and tell me what is being compared, and identify the highest bar (line of students), and the lowest. This is a great way to easily compare eye color of students in the classroom. Other questions that I will ask students include "How many pets do you have living in your home? What is your favorite color? What is your favorite school subject?" Using the human bar graph is a great visual for students and gives them practice on reading a bar graph.

Students will then practice constructing then reading and interpreting line graphs. I will ask students to create a human line graph. Students will construct themselves into a graph based on their height. I will then give each group a different set of data. Students will use this data to create a line graph. I will then ask students to swap graphs with a different group. Students are then to read and interpret the graph they receive. Students will answer questions such as "What is the title of the graph? What are the variables that are being compared? Are there any patterns/trends in the data?" Students will answer these questions in their science journals.

Assessment: At the end of class students will take an assessment where they will answer, "Explain the process of reading an interpreting a graph." I will use this to assess student learning.

Appendix 1

Standards	
Delaware Science Standards	*Standard 1*: A. Understand that: Scientific inquiry involves asking scientifically-oriented questions, collecting evidence, forming explanations, connecting explanations to scientific knowledge and theory, and communicating and justifying the explanation.

	C. Understand that: In a scientific investigation, data collection involves making precise measurements and keeping accurate records so that others can replicate the experiment. Be able to: Accurately collect data through the selection and use of tools and techniques appropriate to the investigation. Construct tables, diagrams and graphs, showing relationships between two variables, to display and facilitate analysis of data. Compare and question results with and from other students.	
Next Generation Science Standards	**MS-PS3-1.** 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.** Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.	
Common Core Standards	*ELA/Literacy –* **RST.6-8.1** Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. **RST.6-8.7** Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).	*Mathematics –* **MP.2** Reason abstractly and quantitatively. **6.SP.B.5** Summarize numerical data sets in relation to their context. **7.RP.A.2** Recognize and represent proportional relationships between quantities.

Appendix 2

What Is a Graph and Why Are They Used?

Where do we find graphs?

Types of graphs & when they should be used...

Bar Graph:

Line Graph:

What is a graph?

Quality graphs should meet the following criteria:

1.
2.
3.
4.
5.

Appendix 3

Stations – Components of a Quality Graph		
Station	What Does This Mean?	What Does This Look Like?
1 Easy to read		
2 Complete and comprehensive		
3 Labeled clearly		
4 Use of an appropriate scale		
5 Visually appealing		

Appendix 4

Graphing With TAILS

	What does this component of the graph mean?	What did you learn?	What can you share with your group members that will help them to understand this component of the graph?
My Expert Group: _____			

Components of constructing a graph	What does this component of the graph mean?	How do you use this component to construct a graph?
T –		
A –		
I –		
L –		
S –		

Bibliography

"Afterschool Training Toolkit: Tutoring Four: Learning to Make Line Graphs." SDEL. January 1, 2014. Accessed December 4, 2014. http://www.sedl.org/afterschool/toolkits/science/pdf/ast_sci_line_graphs_checklist.pdf.

This source offers a great graphing checklist. This checklist can be used to create a graph, but can also be used to read a graph.

Best, Joel. "Birds–Dead and Deadly: Why Numeracy Needs to Address Social Construction." *Numeracy* 1, no. 1 (2008): 1.

This source is a great read with a lot of information on numeracy. This source also explains why numeracy is important to students.

"Create a Graph." Kids' Zone Learning with NCES. Accessed October 26, 2014. http://nces.ed.gov/nceskids/createagraph/.

This source has a great explanation of graphs. This source shows examples of five different types of graphs.

"Graphing in Science." Graphing in Science. Accessed December 4, 2014. http://iqa.evergreenps.org/science/resources/graphing/graphing.htm.

This source gives information on several types of graphs. This source also has great examples of each type of graph.

"TAILS Graph Creation." Mayfield City Schools. January 1, 2014. Accessed December 4, 2014. http://www.mayfieldschools.org/Downloads/graphs2013-14.pdf.

This source is great for using the TAILS acronym. It has a table that is clear and easy to understand.

"Using Graphs and Charts to Illustrate Quantitative Data." Evaluation Briefs. January 1, 2014. Accessed December 4, 2014. http://www.cdc.gov/healthyyouth/evaluation/pdf/brief12.pdf.

This source is great for information regarding types of graphs and formatting graphs.

Notes

[1] Joel Best, "Birds–Dead and Deadly: Why Numeracy Needs to Address Social Construction," *Numeracy* 1, no. 1 (2008): 1.

[2] "Graphing in Science," *Graphing in Science*, Web. 4 Dec. 2014, <http://iqa.evergreenps.org/science/resources/graphing/graphing.htm>.
[3] "Graphing in Science."
[4] Ibid.
[5] Ibid.
[6] Ibid.
[7] "TAILS Graph Creation," *Mayfield City Schools*, 1 Jan. 2014, Web. 4 Dec. 2014, <http://www.mayfieldschools.org/Downloads/graphs2013-14.pdf>.
[8] "TAILS Graph Creation."
[9] Ibid.
[10] Ibid.
[11] Ibid.
[12] "Afterschool Training Toolkit: Tutoring Four: Learning to Make Line Graphs," *SDEL*, 1 Jan. 2014, Web, 4 Dec. 2014, <http://www.sedl.org/afterschool/toolkits/science/pdf/ast_sci_line_graphs_checklist.pdf>.
[13] "Graphing in Science," *Graphing in Science*, Web. 4 Dec. 2014, <http://iqa.evergreenps.org/science/resources/graphing/graphing.htm>.

Curriculum Unit Title	Numeracy: Constructing, Reading and Interpreting	Author	Monica Corrigan

KEY LEARNING, ENDURING UNDERSTANDING, ETC.

This unit will be used to give students a better understanding of graphs. Through this unit students will learn what a graph is and why they are used. The unit is designed to teach students how to construct both bar graphs, and line graphs. Also through this unit students will learn how to read and interpret a graph.

ESSENTIAL QUESTION(S) for the UNIT

-When and why are graphs used?
-How can data be used to construct a graph?
-How are graphs interpreted?
-What kind of information can we get from different types of graphs?
-How do you determine the type of graph to use based on the data you have collected?

CONCEPT A	CONCEPT B	CONCEPT C
What is a graph?	Constructing Graphs	Reading and Interpreting Graphs
ESSENTIAL QUESTIONS A	**ESSENTIAL QUESTIONS B**	**ESSENTIAL QUESTIONS C**
When and why are graphs used? What kind of information can we get from different types of graphs?	*How can data be used to construct a graph?*	*How are graphs interpreted?*
VOCABULARY A	**VOCABULARY A**	**VOCABULARY A**
Graph, Data, Intervals, Scale, Line Graph, Bar Graph,	Independent Variable, Dependent Variable, Axis, Scale, Intervals, Labels	Trends/Patterns, Scale, Intervals, Minimum, Maximum, Labels, Variables

ADDITIONAL INFORMATION/MATERIAL/TEXT/FILM/RESOURCES

Through this unit I will use sample data sets that we collect from labs in our science class. Students will also learn and complete assignments through research on the Internet.