10 Using data visualizations in the content areas

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Why is delivering content through data visualizations important for motivating different learner types, developing literacy skills, delivering content, addressing standards, and improving performance on standardized tests?

"A picture is worth a thousand words" is a phrase that applies to any visualization. Sharing real-world data visualizations with students is informative and fun — it sparks interest and generates discussion. A graph, chart, table, or infographic packs a lot of data in a small space.

By analyzing graphs, charts, tables, and infographics students gain insight, identify patterns, and uncover new meanings while developing literacy skills. Student comprehension is enhanced through good data visualizations and students develop inquiry skills demanded by today's standardized tests.

This chapter considers how incorporating different texts into instruction can motivate students in all content areas. Examples of data visualizations and lesson tips are provided across content areas. Sample data visualization questions from high school level standardized tests are discussed to help educators understand how important data literacy skills are to performance on these tests. How does this look in your classroom? Let's find out.

Why is data visualization instruction important in the classroom?

Students learn best when motivated. My 15-year-old son can explain all aspects of a virtual world video game he's been involved

with for hours (if I let him). Yet, he insists on a 15-minute break for every 30 minutes of homework. Why can he focus with no *brain break* while gaming but cannot study U.S. history for more than 30 minutes? It's simple: he's not interested in U.S. history. He's not motivated.

High school students can often recite endless facts about popular movies, a YouTube channel, or Kobe Bryant's last game, but they don't have a lot to say about *Romeo and Juliet,* earth science, world history, or personal finance. Elizabeth Moje (2006) hypothesizes that students' motivation to obtain information shapes their ability to make sense of a text. If a student is not interested in a text, she argues, the student will not be interested in decoding, comprehending, or expressing information from that text. Moje asks whether the literacy skills obtained in a student's out-of-school literacy pursuits can transfer to in-school contexts where academic literacy skills are required. Motivating texts can encourage struggling students to employ known reading strategies that they might not already employ while reading a traditional text.

Students may not have the inherent motivation to decode, comprehend, and express information. Yet, a text itself can motivate or demotivate. Students can regain interest in any content area by reading a motivating text. A student's perceived value of a text determines its usefulness, which in turn engages the student's interest. Moje explains that students' preferred out-of-school texts "(a) represent aspects that feel real… in terms of age, geography, and ethnicity/race of the protagonists, (b) impart life lessons, (e.g.,resilience/survival, inspiration) (c) offer utility/practical knowledge, and (d) allow [students] to explore relationships" (p. 13). This is great news! By providing students with *useful texts*, i.e., data visualizations that offer practical knowledge, we are engaging (and sometimes re-engaging) content-area interest. We know students constantly engage themselves with visual information, so why not use data visualizations as a more intriguing entry point into content?

Many struggling students can benefit from using multiple texts to supplement a more traditional text (Moje 2006). Did you catch that? The intent of incorporating data visualization into content areas is not to *replace* traditional texts, but to *supplement* traditional texts. We do not want you to abandon the linguistic challenges of traditional texts. Data visualizations are tools to scaffold instruction and can be incorporated to differentiate instruction to meet the needs of varying types and levels of learners in our classrooms. Alternative texts such as tables, charts, graphs, and infographics can help struggling readers better understand traditional texts while piquing content-area interest.

Data literacy skills can be the same as literacy skills

Incorporating data visualizations into content areas is not all about statistics and probability (thank goodness). Considering the three key visualization types (chart, graph, or infographic) as new kinds of text, we can gather information the same way we gather information from a traditional text. Increasing a student's data literacy increases a student's literacy. Strategies that apply to decoding, comprehending, and expressing information in a traditional piece of text apply to any type of data visualization.

Minding the GAP

Student comprehension increases when using a strategy of the Reading Apprenticeship Framework, "Mind the GAP" (WestEd 2017). GAP is the acronym for genre, audience, and purpose. Students can "Mind the GAP" as a simple strategy to begin to understand any data visualization.

Consider using this strategy with an infographic:

- **G (genre)** – Students can determine why an infographic (the genre) was used to represent the information visually. Why is an infographic, with its combination of numerical, statistical, and text snippets, the best format?
- **A (audience)** – Audience can be determined by reviewing the source of the data, the creator of the text, and the means in which it is published. Who is the creator envisioning the reader or viewer of this work to be?
- **P (purpose)** – Purpose is determined by extracting the text's data and studying it. Is it meant to inform or persuade?

In addition, simple strategies such as "Think Alouds" (teachers and students verbally expressing their comprehension of the text as it is read aloud) and "Talk to the Text" (written or digital text annotation as it is read through) can be applied to any data visualization to find the claim and its supporting evidence to achieve comprehension (Greenleaf 2014). These lend themselves to an ongoing conversation about how and what students are thinking when they read. Later in this chapter we will provide some examples of how data visualizations as text can deliver (and/or enhance) traditional content in the core curriculum areas and provide some lesson tips for "reading" visualizations.

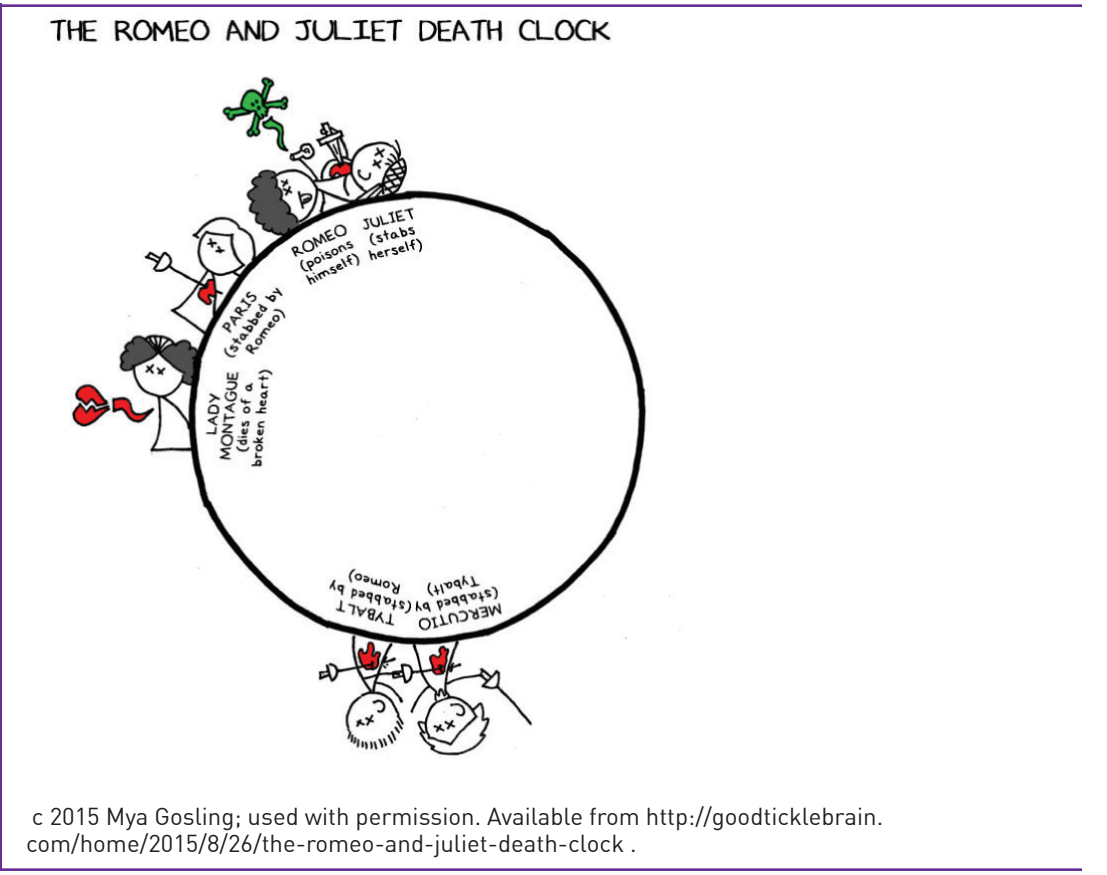
Students develop real-world skills of interpreting information when data visualizations are incorporated into any content area. As a society, we are bombarded with charts, tables, and graphs. If we are unprepared to evaluate and interpret the data used to create a visualization, we are unable to learn from (or question) it. Consider associated data visualizations help us to better understand and decode articles in magazines and newspapers because they provide us with a quick summary of the data contained within the article. All a reader needs then is a basic understanding of statistics to be able to evaluate the information presented in

a graph, chart, or table "with a more critical eye" (Gilmartin and Rex 2016, 5). Understanding the "language" of data visualizations helps our students interpret, analyze, and question information presented in multiple formats.

Example: *Romeo and Juliet*

There are many opportunities to mine data from traditional math and science textbooks. But what if we take text we do not traditionally think of as visual and make it so? Let's consider William Shakespeare's *Romeo and Juliet.* Quick — who dies in the play, how do they die, and in which order? Most of us read Shakespeare's play at some point in high school, but remembering the sequence is as big a challenge today as it was back in our freshman year.

The key to student understanding is giving students the opportunity to gather information from supplemental texts as well, because many students cannot comprehend the action of *Romeo and Juliet* just by reading the unfamiliar prose. There are many ways to comprehend the tragedy inherent to *Romeo and Juliet* – including movies, audio recordings, and *No Fear Shakespeare* – but we can also use visualizations to help our students gain memory hooks upon which to map their knowledge of an extended text. We've actually been using visualizations for decades in our classes. Graphic organizers, drawing rising/falling action in plot lines, even diagramming sentences have all been part of the ELA toolkit. Modern visualizations just take this to the next step. Let's look at how this information can be presented visually for better understanding. Consider this data visualization, "The *Romeo and Juliet* Death Clock" by Mya Gosling (2015):



c 2015 Mya Gosling; used with permission. Available from http://goodticklebrain.com/home/2015/8/26/the-romeo-and-juliet-death-clock .

Because the deaths are presented graphically, we can interpret this visualization and immediately determine:

- **how many people die**
- **who dies**
- **at what point they die in the story**
- **how they die**
- **and even their countenance upon dying (those aren't ears ... they're smiles)**

Looking at the graphic, how long did it take you to decipher those main plot points? How much time would it take to decipher the same main plot points from reading the text? This is a unique visualization. Gosling has created death clocks for just about every Shakespearean tragedy on her web site (goodticklebrain.com). Many students could quickly and easily interpret this

visualization to add to their understanding of the text. This is not to suggest that data visualizations should replace traditional content — data visualizations should enhance traditional content.

At the end of this chapter, Appendix A provides a sample template for constructing data visualization conversations in your classroom. Appendix B brings another *Romeo and Juliet* infographic to ELA courses, while Appendices C-E preview other visualization activities across content areas that will help you think expansively about how to employ them in your curriculum.

Addressing national standards

When developing classroom curriculum, we must consider the applicable national standards. Let's consider how the learning goals for college-and-career-ready students of the Common Core State Standards (CCSS) can be achieved through the integration of data visualizations into your content area. There is a link at the back of this book to a list of national standards that mention data and statistical literacy.

CCSS Learning Goals for English, Science, and Social Studies (College and Career Ready)

Using data visualizations as companion texts to traditional texts can help students discern key components they otherwise may have overlooked. A student's level of comprehension can be misrepresented if the information is only presented in a wordier text. This is especially true for English language learners. Necessary skills are outlined for students who are college and career ready in the CCSS English Language Arts Introduction. While not part of the numbered standards, these capacities provide a description of students working toward meeting the standards while frequently displaying these skills. Incorporating data visualizations as com-

panion texts can help develop the following CCSS capacities in our students (CCSSI 2017b).

Demonstrating independence

Think of the information students are exposed to through social media platforms like Twitter, Instagram, Pinterest, Tumblr, Facebook, Reddit, and dozens of others. A simple Internet search for the "top 10 social media platforms" will give you a better understanding of the most popular "news" sources on the Internet. How are these "news" sources different from pre-social media news sources? The answer is simple — most social media sources are not vetted.

The Internet is full of inaccurate and unauthoritative information. But it gets worse — every "fact" is passed on from one social media account to another with no regard for the source or the accuracy of the information it contains. Students should be armed with the ability to comprehend and evaluate "complex texts across a range of types and disciplines" so they're able to "construct effective arguments and convey intricate or multifaceted information" (CCSSI 2017b). In short, our students need to be able to gather, evaluate, expand on, and articulate information to demonstrate comprehension.

Possessing a strong knowledge of content

Of course, we want our students to build strong subject content knowledge, but this content can come from varying texts, not just classroom textbooks. Students build strong knowledge by establishing "a base of knowledge across a wide range of subject matter by engaging with works of quality and substance" (CCSSI 2017b). Content knowledge can be gained through purposeful

research and study of great data visualizations (as explained with the previous examples of content-area infographics). Students can then create their own data visualizations to share with others.

Responding to the varying demands of audience, purpose, task, and discipline

Our students are bombarded with information every minute of every day. A quick way to share information is through tables, charts, and graphs presented in authoritative daily news sources. In the analysis of these types of data visualizations, students must respond to the varying CCSS-aligned demands of audience, task, purpose, and discipline set forth by the creator of the visualization. Data visualizations give students a great opportunity to discern the target audience and whether the text is meant to inform or persuade.

Comprehending and critiquing

Everyone has opinions and everyone is exposed to others' opinions. Through the analysis of data visualizations, students comprehend new information to help "understand precisely what an author or speaker is saying" (CCSSI 2017b). Students must determine and question the audience, purpose, and intent set forth by the creator of the visualization as they evaluate its credibility, accuracy, and effectiveness. Understanding the claim of the text and how it is (or is not) supported is crucial to student comprehension. Students can also critique student-created data visualizations.

Valuing evidence

Many conversations start with, "I was listening to," or "I saw on," or "I read online," but rarely is the specific source remembered. We also sometimes tweak or exaggerate our evidence to better support our argument. Students must learn to cite specific evidence from a text/data visualization. Relevant evidence must be clearly presented to support their argument. They must also be able to constructively evaluate and assess others' use of textual evidence.

Using technology and media capably and strategically

Students must use technology and digital media "thoughtfully to enhance their reading, writing, speaking, listening, and language use" (CCSSI 2017b) as they integrate what they learn from traditional texts with what they learn online. They must understand the strengths and limitations of the technological tools and digital mediums they choose to use and interact with. Creating data visualizations using tech tools gives students a great opportunity to determine which tool best delivers their message.

Understanding other perspectives and cultures

As more and more school curriculums reflect a world focus, students can develop an understanding of other perspectives and cultures by appreciating "that the twenty-first century classroom and workplace are settings in which people from often widely divergent cultures and who represent diverse experiences and perspectives must learn and work together" (CCSSI 2017b). The health and safety of our world depends on students' active knowledge-gathering about those next door *and* across the globe. Students must be able to effectively communicate

with people of diverse backgrounds and critically and constructively evaluate others' varied points of views. Considering data visualizations created in other countries (look, for example, at international newspapers) gives students insight into other perspectives.

CCSS Learning Goals for Mathematics (Standards for Mathematical Practice)

Incorporating data literacy content into the mathematics curriculum helps students better understand how statistics and probability shape the information we are presented with daily and how the intent of a visualization can shape our understanding of content. Students can show understanding by creating their own data visualizations to justify a claim and then comparing their work with others' work. Incorporating data visualizations can help develop skills that address several CCSS math standards in our students.

CCSS.MATH.PRACTICE.MP1: Make sense of problems and persevere in solving them

Students need entry points to begin to develop understanding of mathematical concepts. Introducing current, content-related data visualizations help generate student interest in problem solving. Interested students are better able to make meaning of a problem in order to analyze it, make conjectures from it, plan solutions for it, and consider analogous problems, while asking themselves, *Does this make sense?*

CCSS.MATH.PRACTICE.MP2: Reason abstractly and quantitatively

Students need to understand quantities and their relationships in many different contexts. Numbers represented visually (e.g., data

visualizations) help students to decode the numerical information. Asking questions about the meaning of symbols, such as, "What is involved?" and "How many are there?" are necessary to gain competency in computation. Data visualizations not only provide the decontextualized information (symbols), but can also be easily contextualized (subject/content) to develop a better understanding of the visualization's purpose and meaning.

CCSS.MATH.PRACTICE.MP3: Construct viable arguments and critique the reasoning of others

Developing questions about content and analyzing that content leads to discovering and justifying answers. By using inductive reasoning to identify and predict a trend in a graph, table, or chart, students can learn how to question and critique arguments by identifying the information's flaws and strengths.

CCSS.MATH.PRACTICE.MP4: Model with mathematics

Data is and can be collected for just about anything. Students can compare what they already know to what they see to make new conclusions. Creating new data visualizations with newly student-collected information can confirm or deny an existing argument. Students can interpret data already being collected in many schools (i.e., the number of disposable trays used in the cafeteria per day, the number of library patrons counted per day, the number of water bottles saved per day by using the filtered water fountain) to determine whether the data makes sense or not based on assumptions they already have about their school. Students should "routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose" (CCSSI 2017a).

CCSS.MATH.PRACTICE.MP5: Use appropriate tools strategically

There are many data visualization tools available to students, from simple graph paper to online statistics portals for finding and generating data visualizations from collected data. Students must choose the appropriate tool for the appropriate purpose. They must "use technological tools to explore and deepen their understanding of concepts" (CCSSI 2017a).

CCSS.MATH.PRACTICE.MP6: Attend to precision

Communication is successful only if it is precise enough to understand. Communicating through the presentation and creation of data visualizations (with appropriate and consistent labeling) can help students examine and present claims with accuracy and efficiency.

Data visualizations can do all that?

Many national standards can be addressed with content delivery through data visualizations. Don't be overwhelmed. As with any new idea for curriculum delivery, applicable standards can be easily identified through a simple comparison of lesson goals and the content material that supports them. The "hard work" of identifying applicable standards has been done for you, so now it is your job (as a curriculum expert in your content area) to match the standards with your content and determine how you will deliver it to students. It isn't hard – just think of data visualizations as variations of any traditional text that you are already using to deliver your content.

Though incorporating data visualizations is not only applicable to the mathematics curriculum, many of the statistics and prob-

ability concepts in math relate directly to how students decode, comprehend, and express information drawn from data visualizations. It is important that students have an understanding of the basic mathematical concepts presented in a data visualization. So many different types of data visualizations exist (and can be created) to express information from any content area. It may seem surprising that there are just as many English standards that can be addressed by content delivery through data visualizations as there are for math (if not more).

We know that standards are simply guidelines for excellent teaching, and to be excellent teachers we must continually reflect on and revise our content and its delivery. It is not necessary to include data visualizations in every lesson (as it is not necessary to address every standard in every lesson), but it is important to provide varied modes of content to ensure access to knowledge for different types of learners.

A 2015 study of secondary school students found that the preferred learning style was visual (45.7%), followed by auditory (21%), tactile (18.3%), and kinesthetic (15%) (Laxman, Govil, and Rani 2015). These findings support the incorporation of more visual learning experiences into the curriculum. Knowing our students' preferred learning style best determines how we deliver content. Incorporating data visualizations such as charts, graphs, histograms, and infographics into any content area will lead to a better understanding of concepts and subjects that our visually-oriented high schoolers have previously found very difficult to understand (Laxman, Govil, and Rani 2015).

How does developing data literacy skills help students with standardized testing?

Today's standardized tests require students to gather information from many different types of sources. Even within a single

question there can be multiple modes in which information is presented. It is important for students to not skip over a data visualization because it is "just a picture." Visualizations need to be "read" and understood. As we know, data visualizations can present information more quickly and more clearly than blocks of texts. Understanding how to read these "texts" can increase comprehension speed. As students better understand how to read, interpret, and comprehend data visualizations they will perform better on standardized tests that integrate graphs, charts, and tables into questions.

ELA testing

For the purposes of ELA testing, students do not need to understand how the data was collected or to determine the reliability of the data. Therefore, students do not need to apply the "Mind the GAP" strategy to data visualizations on these tests.

Students do need to be able to

- **extract information from multiple forms of text**
- **make sense of that information,** including synthesizing information found in text with that found in graphics
- **determine how this information best answers the question.** In fact, some questions require the student to "interpret graphics and to edit a part of the accompanying passage so that it clearly and accurately communicates the information in the graphics" (College Board 2017a).

What does that look like? Take a look at https://collegereadiness.collegeboard.org/sample-questions/reading/6 . This sample, which includes sample questions 6-8, is deemed appropriate for both SAT and PSAT practice. Students must interpret the bar chart and read the 526-word companion passage to answer the questions.

According to the College Board's preparatory materials (College Board 2017b),

- **The objective of the questions in this sample is to "reasonably infer an assumption that is implied in the passage."** This is a common objective for many questions on the SAT. Students need to find evidence in multiple forms of text (in a short amount of time) to answer the questions.
- **Students have 65 minutes to complete the Reading test.**
- **There are 52 questions in the test.**

This gives students an average of *1 minute and 15 seconds* in which to process and answer each question. Therefore, building up students' *comprehension speed* and *ability to shift quickly between data and text* is critical to their success.

For a sample ELA lesson you can use with your students with sample test questions and data visualization, please see Appendix F. For additional preparatory materials, the College Board (developer of the PSAT/SAT) provides free access to sample questions in all tested content areas at https://collegereadiness.collegeboard.org/sample-questions/. Additional free online SAT practice is available through Khan Academy at https://www.khanacademy.org/sat. Many state tests provide access to online portals for students to practice sample questions. Consider accessing these resources to provide quick, daily classroom practice.

Science and standardized testing

Science standards still vary widely by state, but knowing how to draw meaning from graphed data is likely to appear on high school standardized tests. Appendix G provides sample teaching ideas related a released test question from the California Stan-

dards Test in Biology. In the sample, students must interpret the chart, a combination histograph/bar chart/scatter plot, to answer the question. This question requires students to find information from within an unfamiliar type of graph. Students must consider not only the length of each "bar," but also the shape of the bar (in regard to its width at a specific point).

Additional subjects and standardized testing

A lesson to help high school students approach sample test questions for the California Standards Test in U.S. History is available in Appendix H. Appendix I provides ideas for approaching visualizations in math.

Differentiation in testing

Before we move to the next section of this chapter, a quick word about how to approach data visualization test questions with your students with disabilities. Be aware that students with disabilities and/or English language learners may qualify for standardized test accommodations. To be compliant with the Every Student Succeeds Act (ESSA), all states must provide alternative assessments to students if deemed necessary by an individual student's individualized education plan (IEP) requirements (Advocacy Institute & Center for Law and Education n.d.). Check with your State Board of Education to determine the availability of alternative assessments and to determine how data visualizations are incorporated into those assessments.

So, now are you ready to incorporate data literacy instruction into your content area?

This chapter demonstrates how data literacy integration motivates different learner types, develops literacy skills, delivers

content, addresses standards, and improves standardized test performance. All information needs to be questioned and reflected on before we can make an informed decision. Incorporating data visualizations into these conversations about "real world" issues sparks interest about and enthusiasm for classroom content.

To develop literacy skills among our diverse learners, we need to be flexible in how we deliver content. We can do this by utilizing a variety of teaching modalities, providing information that will overlap with information our students already have, and by reiterating and reinforcing information throughout a unit or during the course of a year (Friedman 2012, 11-15).

Integration of data visualizations into existing classroom lessons can help students to read, analyze, comprehend, and create information while addressing national standards. This type of integration better prepares our students to be able to extract information from multiple forms of text, in order to evaluate it and determine how the information best answers questions posed on standardized tests. These test questions contain claims (with supporting evidence) presented in charts, images, graphs, diagrams, tables, and text blocks. This data, in all forms, must be interpreted and understood in a prescribed amount of time to ensure success on all standardized tests.

Integrating data literacy into classroom learning is NOT about replacing your content, changing your teaching style, or dumbing things down. Integrating data literacy into your classroom is about supplementing your content, amplifying your teaching style, and developing inquiry learners. Because having the power to gain knowledge and make informed decisions means students understand data and where it comes from, are able to extract data from charts, graphs, tables, and other types of visualizations, and can present data as evidence to make a claim. Numbers representing any type of statistic can be used in any content area — from the breakdown of a college student's bud-

get, to water pollution, to the Olympic medals won over time, and even to theatrical deaths. Data representation can take place in many forms from traditional texts to data visualizations. Data is information and information helps our students to better understand content.

Resources

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Appendix A: Tips for integrating data visualizations into any content area

If you have 30 minutes,

Share these rules of thumb of the Reading Apprenticeship "Mind the GAP" strategy with students before they begin analyzing an infographic:

- Consider the genre, audience, and purpose of the data visualization. Every text:
  - » is created to embrace a specific **genre**.
  - » is directed toward a specific **audience**.
  - » has an intended **purpose**.

If you have one class period,

Then ask students to:

- Determine the claim of the text.
- Determine how it is presented. Is it meant to inform or persuade?
- Identify the evidence that supports it and engage students in conversations that address the rules of thumb above, using the "Mind the GAP" terms of genre, audience, and purpose.

If you have multiple class periods,

Then ask students to compare the information found in a traditional text to information in a data visualization by:

- Providing students with a more traditional text (textbook, novel, article, etc.) and an infographic related to that text.
- Asking students to find the information presented in the data visualizations within the traditional text to determine if the facts are represented accurately in the infographic. This can be accomplished through talking to the text, close reading, and/or using the search tool COMMAND+F (on a Mac) or CTRL+F (on a PC) to search for words and phrases in an electronic version of a text.
- Asking students to compare how claims are made and supported by each type of text.

If you have an entire unit,

Have your students create an infographic by:

- Looking around your school/community to find out how data is already being collected or considering the data presented in a required text.
- Considering the purpose/goal of the data collection.
- Finding existing data or collecting new data.
- Analyzing the data to determine what it means.
- Determining the best method to convey the data.
- Generating data visualizations.
- Presenting and critiquing student-created data visualizations.

Appendix B: Integrating an infographic about *Romeo and Juliet* into the ELA classroom

Visit "Infomania Fact-checking the famous: *Romeo and Juliet*." While originally published in December 2016 by *The Guardian* online, this is now archived at http://web.archive.org/web/20140513090230/http://www.theguardian.com/culture/picture/2013/oct/11/romeo-and-juliet-infomania .

This infographic does not document the deaths in *Romeo and Juliet* but instead pulls data from the text to compare the author, themes, main characters, and references to current events and movies. It's not just a poster about the tragic story of two star-crossed lovers: it's the research process in visual form.

Before you ask your students to create their own infographics, a useful activity is to unpack an existing infographic to help students understand its intent, what claims it makes, and its success in doing so.

If you have 30 minutes,

Use the Reading Apprenticeship "Mind the GAP" strategy outlined in Appendix A.

If you have one class period,

Ask students to:

- **Determine the claim of the text**. This text is providing information about William Shakespeare, his original play of *Romeo and Juliet*, subsequent and varied incarnations of *Romeo and Juliet* throughout the years, and modern *Romeo and Juliet* connections.
- **Determine how the text is presented.** Is it meant to inform or persuade? The intended purpose of this text is to inform the reader. It's labeled as a fact-checker, but it also includes some veiled humor. Ask: *to what extent is this an appropriate source of information for a scholarly analysis of Romeo and Juliet?*

- **Identify supporting evidence and engage students in conversations about the rules of thumb to "Mind the GAP".**
  - » **Genre:** This text is visually representative of an infographic. Infographics are visual documents composed of text blocks, images, graphs, quotes, timelines, and statistics.
  - » **Audience:** By looking at the sources of information at the bottom of the text, students can determine if the information is from a reliable and authoritative source. This helps determine if the intended audience is a scholarly reader or a casual fan. A visual scan can also help determine the intended audience. The infographic's look and language are informal. Therefore, the audience is anyone interested in the play.
  - » **Purpose:** The intended purpose of this text is to inform the reader, not persuade. This infographic is not trying to convince the reader that *Romeo and Juliet* is the best play ever written … or even trying to persuade the reader to read *Romeo and Juliet*. It is merely providing information about William Shakespeare and about the play over the years.

If you have multiple class periods,

Compare the information found in a more traditional text to information in a data visualization by:

- **Providing students with Shakespeare's original *Romeo and Juliet*.**
- **Asking students to compare the infographic's content to that of the traditional text to determine if the infographic represents the play accurately.** This can be accomplished through talking to the text, close reading, and/or using the search tool COMMAND+F (on a Mac) or CTRL+F (on a PC) to search for words and phrases in on a website or PDF version of the play.
  - » **Compare** basic facts such as how old the protagonists are, the length of their relationship, how they died, and more.
  - » **Search for language.** Shakespeare's plays provide students with a great opportunity to go on word searches to find uses of his unique language. For

example, students can search for the word "bump" to determine how many times it is used, where it is used, by whom, and what it means in context. You can then discuss how "bump" used today may or may not have a different definition or connotation.

  - » **Visualize word frequency.** From the activity above, students gain data they can use to graph word frequency in the original text.
  - » **Track words over time.** Students can use the Google Books Ngram viewer to chart a Shakespearean words usage or popularity over time (https://books.google.com/ngrams).

- **Asking students to compare how claims are made and supported by each of the text types.** For example, evidence of one of the tragedy's themes (the forceful nature of romantic love) can be found in the original text and in the infographic. Ask students to provide supporting evidence in both texts to determine if the infographic accurately represents the theme.

If you have an entire unit:

Refer to the unit-length strategies in Appendix A.

Appendix C: Integrating an infographic about water into the science classroom

Visit "Ten Things You Should Know About Water" at http://www.circleofblue.org/2009/world/infographic-ten-things-you-should-know-about-water/ .

If you have 30 minutes,

Use the "Mind the GAP" strategy outlined in Appendix A.

If you have one class period,

Ask students to:

- **Determine the claim of the text**. This text highlights the value of water, how it is used, and how easily it can become polluted.
- **Determine how it is presented**. Is it meant to inform or persuade? This text is meant to convince the reader that water is a valuable and scarce resource.
- **Identify supporting evidence and engage students in "Mind the GAP" conversations:**
  - » **Genre** – This text is visually representative of an infographic as defined in Appendix B.
  - » **Audience** – By looking at the sources of information at the bottom of the text, students can determine if the information is from a reliable and authoritative source. This helps determine if the intended audience is a scholarly or casual. Students can also go to the Circle of Blue website (http://www.circleofblue.org) and look at the organization's "About" page. This will help students understand if this organization has a political agenda, constituency, or point of view. A visual scan of this infographic helps determine the intended audience. The look and language is formal, yet it is still approachable and understandable for most high school readers. The intended audience is anyone who can understand the science behind the claims being made.

» **Purpose** – The purpose of this text is to provide information in such a way that the reader becomes persuaded that water should be conserved. The title of the infographic is a discussion starter to determine if the text is meant to inform or persuade. Why should the reader know these facts about water? What's the purpose for sharing these ten pieces of evidence? Should water be conserved? If so, why?

If you have multiple class periods,

Compare the information found in a more traditional text to information in the data visualization by:

- **Providing students with textbook information or a pertinent article for use as comparison**. Or, in the case of this specific infographic, students can compare the text on the Circle of Blue website to the visualization.
- **Asking students to find the visualized information within the traditional text to determine if the facts are represented accurately in the infographic**. Students could also search online to find other reliable sources that confirm or disprove the infographic's information. This can be accomplished through talking to the text, close reading, and/or using the search tool COMMAND+F (on a Mac) or CTRL+F (on a PC) to search for words and phrases in a digital document. For example, how much of Earth's water is used for agriculture? What percentage of Earth's water is salt versus fresh? How much water is used to produce different products? etc.
- **Asking students to compare how claims are made and supported by each type of text.** For example, students could study the water cycle within a traditional text to make inferences and connections as to why the infographic claims may or may not be accurate and supportable in reference to what they already know (or are learning) about the natural processes of Earth.

If you have an entire unit,

Refer to the unit-length strategies in Appendix A.

Appendix D: Integrating an infographic about the Olympics into the social studies classroom

Visit "How The Olympic Medal Tables Explains The World" at http://www.npr.org/sections/thetorch/2016/08/05/488507996/how-the-olympic-medal-tables-explains-the-world .

If you have 30 minutes,

Refer to the 30-minute "Mind the Gap" strategies in Appendix A.

If you have one class period,

Ask students to:

- **Determine the claim of the text.** This visualization claims that the number of medals a country wins (or doesn't win) in an Olympic games correlates to an event in history.
- **Determine how it is presented.** Is it meant to inform or persuade? This text is meant to inform the reader. Upon discerning the share of Olympic medals won by each country, the reader is then supposed to make connections to historical, political, and social events to determine why a country's medal tally during a specific Olympics reflects what was occurring in that country (or the world) at that time.
- **Identify supporting evidence and engage students in "Mind the GAP" conversations.**
  - » **Genre** – This text is a series of bar charts (or bar graphs). A bar chart is a visual display of data presented in a series of bars of different heights (proportional to the data they represent) plotted over time. A bar chart is a type of data visualization.
  - » **Audience** – By looking at the sources of information at the bottom of the text, students can determine if the information is from a reliable and authoritative source. This helps determine if the intended audience is a scholarly reader or a casual reader. Because the source of the text is "Sports Reference," the reader can infer that this text is first intended for those interested in sports. Students can also go to NPR's

website (http://npr.org), and look at the organization's "About" page. This will help students understand if this organization has a political agenda and a particular following that the site caters to. A visual scan of this infographic can also help to determine the intended audience. The entire look of the data visualization is formal yet easy to understand. This is intended for high school (and possibly middle school) students and above who are interested in making connections between sports and world history.

» **Purpose** – The purpose of this text is to inform. The text makes connections between sports and world history — a perfect discussion starter for those who otherwise may not be interested in world history.

If you have multiple class periods,

Compare the information found in a traditional text to information in a data visualization by:

- **Providing students with textbook information or a pertinent article to compare to this infographic.** Or in the case of this specific infographic, students can compare it to the accompanying text on the NPR website (http://www.npr.org/sections/ thetorch/2016/08/05/488507996/how-the-olympic-medal-tables-explains-the-world).
- **Asking students to find the information presented in the data visualizations within the traditional text to determine if the facts are represented accurately in the infographic**. This can be accomplished through talking to the text, close reading, and/or using the search tool COMMAND+F (on a Mac) or CTRL+F (on a PC) to search for words and phrases in an electronic version of a world history textbook or article, or on a website. For example, students could go back to the source, Sports Reference (sports-reference.com), and determine if the website information regarding the number of medals won per country per Olympic Games has been transposed accurately in the bar charts.
- **Asking students to compare how claims are made and supported by each type of text.** For example, students can search their world history textbook for key events occurring around the world or within the specific countries of the United States, Russia, China, and Germany in the

past 100 years. They can then compare this information to the information presented in the bar charts, discern why such events would affect each country's performance at an Olympic Games. A comparison between the NPR article (URL above) and the easy-to-comprehend visualization can help diverse types of learners better understand the intent of the word-dense article.

If you have an entire unit,

Knowledge of founding documents is crucial to student success on the SAT. The Reading Test and the Writing and Language Test of the SAT asks students to read and answer questions about "works that explore challenging ideas, offer important insights, reveal new discoveries, and build deep knowledge in numerous disciplines" (College Board 2014).

Social studies content lessons may already incorporate these kinds of documents — consider the extra insight that could be gained by making them visual. Ask your students to create data visualizations of founding documents such as the U.S. Constitution. Assign students sections of the U.S. Constitution and guide them in identifying data from the document (i.e. age/residency requirements, term lengths, voting majorities, Electoral College representation, amendments, etc.) with which to create data visualizations. (Refer to Chapter 9 for strategies for building high-impact infographics with students.)

For more ideas, refer to the unit-length strategies in Appendix A.

Appendix E: Integrating an infographic about budgeting into a math classroom

Visit "Breakdown of Average Student Budget" (#5 at http://blog.socrato.com/2-mind-blowing-infographics-on-education/).

If you have 30 minutes,

Use the "Mind the GAP" strategy outlined in Appendix A.

If you have one class period,

Ask students to:

- **Determine the claim of the text**. This text's claim is to present a breakdown of today's average college student's budget and to compare it to a 1915 college student's budget in today's dollars.
- **Determine how it is presented**. Is it meant to inform or persuade? This infographic is informative, but it also may effectively persuade students to save for college!
- **Identify supporting evidence and engage students in "Mind the GAP" conversations:**
  - **Genre** – This text is visually representative of an infographic as defined in Appendix B.
  - **Audience** – By looking at the information sources at the bottom of the text, students can determine if the information is from a reliable and authoritative source. This helps determine if the intended audience is scholarly or casual. Because the sources include a professional tax and accounting firm, government statistics, and a professional survey company, the reader can infer that this text is first intended for those interested in finances. The infographic's title, "Breakdown of Average Student Budget," also identifies the text's intended audience — college-bound students and their parents. The reader must look at the text more closely to discern that this budget breakdown is indeed that of the average college student. A visual scan of this infographic can also help to determine the intended audience. The entire look of the infographic is polished yet easily understood.

» **Purpose** – This text's purpose is to inform. The text breaks down a college student's budget to highlight proportional spending and decision making. This infographic would be a good discussion starter for students in a personal finance class (and their parents) to provoke a conversation about financial responsibility.

If you have multiple class periods,

Compare the information in the infographic to a more traditional text by:

- **Providing students with related formulas and concepts from a math textbook to compare how the same formulas and concepts are represented in this infographic.** Concepts might include averages, percentages, adjustment for inflation, comparisons, etc.
- **Asking students to find the information presented in the data visualizations within a traditional text to determine if the infographic's information is accurate.** For example, students can look for inconsistencies in how the infographic represents the data (for example, in the pie chart breakdowns) to better understand why that kind of visualization was used and suggest how it could be better explained or represented. Why do the smaller pie chart percentages not add up to 100? How is it explained (or not) in the infographic?
- **Asking students to compare how claims are made and supported by each text type.** For example, students could determine the amount of money they will have available to spend in college and then break down that budget into the infographic's categories and percentages. The infographic's claim that the average student's budget is 40% discretionary could lead to conversations about financial inequities between students. Searching the sources for the current information (this infographic is from 2009) could help students make an updated version.

If you have an entire unit:

Refer to the unit-length strategies in Appendix A.

Appendix F: Using a sample assessment question for an ELA classroom

Please access https://collegereadiness.collegeboard.org/sample-questions/reading/8 for this activity.

If you have 15 minutes,

Ask students to review the bar graph and draw out as much information as they can. For example, you might encourage them to ask:

- What question needs to be answered?
- What is the graph's purpose, according to its title?
- What is measured in the bar graph according to the labels on the x- and y-axes?
- What is the significance of the varying heights of the bars?
- What is the significance of the downward trend of the bars as the graph moves from left to right?
- What is the significance of the darker gray bar?

If you have one class period,

Ask students to compare how claims are made and supported in each text in the sample problem. To answer question 8, students need to choose from a list of claims to discern which claim is best represented by the graph and the information (evidence) it contains that supports the claim. Students should also consider information from the companion text to answer the sample question. The information (or evidence) provided in both texts will support a specific claim. Students should look at the length of the bars representing the cities mentioned in each answer choice to determine which claim the graphs supports. After doing so, students can identify choice "C" as the correct answer.

Appendix G: Using a sample assessment question for a science classroom

Please access http://www.cde.ca.gov/ta/tg/sr/documents/cstrtqbiology.pdf and find question 73 (p. 25) for this activity.

If you have 15 minutes,

Ask students to discern the information found in the visualization. For example:

- What question needs to be answered?
- What is the purpose of the graph, according to the title?
- What is being measured on the graph, according to the labels on the x- and y-axes?
- What is the significance of the varying lengths, widths, and shapes of the "bars"?

If you have one class period,

Ask students how claims are made and supported in the graph. For example, after students understand how the information is presented in the graph, they need to apply that knowledge to choose the correct answer. This may be an unfamiliar graph type to many students, so letting them know that all the information they need exists in the graph will help ease their anxiety. By looking at the question, they can infer that they need to focus on the segment of the graph labeled "Cretaceous" to determine which group demonstrated the greatest biodiversity. Limiting the focus to just that segment helps eliminate confusion. The students can then see that all the different animal groups have varying widths in this segment. The lizard group has the widest shape at that point, so the correct answer is choice "D."

Appendix H: Using a sample assessment question for a social studies classroom

Please access http://www.cde.ca.gov/ta/tg/sr/documents/cstrtqhssmar18.pdf for this activity.

If you have 15 minutes,

Ask students to discern the information found in the data visualization. For example, students should determine:

- What question needs to be answered?
- According to its title, what is the purpose of the table?
- What do the numbers in the table represent?
- How do the numbers in the table correlate to a sector?

If you have one class period,

Ask students to compare their pre-existing knowledge to the evidence in the graph to support a claim. In this case, all the information necessary to support a claim (or answer the question) is NOT provided in the table. Students need to consider their pre-existing knowledge of world history to identify which factor created the trend the table represents. Since the table title identifies "Employment Figures," we can determine that the numbers under the three sector headings represent people (in millions according to the table). The student needs to already understand the history of the factors listed in the answer choices in order to choose the factor that is most responsible. Students must already know that advances in technology during the first half of the 20th century (i.e., the assembly line) spurred production and increased demand for manufactured goods, thereby creating more jobs for more people. Students also need to understand that the U.S.'s involvement in World War II (in the 1940s) spurred demand for weaponry, also creating more jobs in manufacturing. It is necessary for students to have this prior knowledge and be able to interpret the table in order to choose the correct answer, "A". That's a lot of pre-existing knowledge to bring to the table (pun intended)!

Appendix I: Using a sample assessment question for a math classroom

Please access https://collegereadiness.collegeboard.org/sample-questions/math/calculator-permitted/20 for this activity.

If you have 15 minutes,

Ask students to discern the information found in the data visualization. For example:

- What question needs to be answered?
- What is the purpose of the scatter plot according to its title?
- What is being measured according to the labels on the x- and y-axes?

If you have one class period,

Ask students to compare how claims are made and supported in the graph. Students first need to understand what type of graph this is. This graph, a scatter plot, plots the values of two variables along two axes. The resulting pattern of points reveals a correlation between the two variables. The straight line in the scatter plot runs through the center of the points and is called the "line of best fit." To answer this question, students need to read the graph and then use their pre-existing knowledge of mathematical formulas to determine the closest value to the average yearly increase in the number of manatees. By looking at the horizontal x-axis in comparison to the line of best fit, the student can determine that growth occurred from about 1991to about 2011. This is the time period the question is concerned with. By looking at the vertical y-axis in comparison to the line of best fit, the student can determine that the number of manatees grew from about 1,000 to 4,000 during this time period. This indicates a population increase of about 3,000 manatees. The student needs to determine the average yearly increase over the 20 years the graph represents. The student should then divide 3,000 manatees by 20 years to determine that choice "C" is the correct answer.