Setting a Foundation

Section 1: Building Our Foundation

Overview

From the beginning of the course, students should see that *Integrated Statistics and Quantitative Reasoning* is a different experience from what they may have had in other courses. The intent of this lesson is to expose students to some of the core ideas of the course, including:

- a welcoming environment;
- a strong community-building component—including establishing trust with the instructor and clarifying course expectations in a fun, inclusive way;
- stimulating motivation for attendance and participation; and
- connecting the purpose of this course with students' personal interests and future direction.

Often our inclination is to jump straight into presenting specific course material on the first day. However, both research and practice show that moving at a slower pace initially, building strong connections among students (and between students and the instructor), and establishing the right mindset early lay the foundation for a high level of student engagement that is maintained throughout a student's educational experience.

In this course, students will pose and answer questions, defend their conclusions with data, and engage in rich discussions as a class. Setting the tone and expectations for collaboration in the class early is crucial to the success of the course.

This lesson begins with your sharing your personal story, followed by an activity designed to help students understand they can overcome anxiety by identifying and using available resources and support in stressful times. The activity is a starting point for helping students reduce anxiety and increase self-efficacy.

Learning Outcomes

- Develop mathematical habits of mind, such as engaging in sense making; communicating effectively verbally, in writing, and using graphical displays; justifying conclusions; and critiquing their own work and the work of their peers.
- Employ systematic problem-solving processes, including the statistical problem-solving process (formulating questions that can be answered by data, collecting or assembling data, analyzing data, and interpreting and summarizing conclusions).

Suggested Pacing

- One 45-minute day

Prerequisite Skills

This section has no prerequisite skills.

Materials and Technology

- A display of the success quotes and positive affirmations, either printed on cards or pieces of paper and placed on the walls (so students can see them as soon as they enter the room) or shown as a revolving series of quotes on an overhead projector
- 4 different kinds of candy (enough for each student to have 1 piece), each kind in its own bowl
- Several packets of balloons (enough for each student to have 1 balloon, plus a few extras in case some burst)
- Thick, dark-colored markers (for writing on the balloons)
- Appendices 1A, 1B, 1C

Facilitation Notes

This section is an important start to setting the tone and expectations for this course. Students should feel a sense of belonging and purpose in the course.

Background Context

Select and decide how to showcase positive affirmations and quotes related to success that students will see when they enter the classroom. Quotes can be found online by searching for "success" on the following websites.

- www.brainyquote.com/quotes/topics/topic_success.html
- www.goodreads.com/quotes/tag/success
- http://under30ceo.com/50-best-success-quotes-of-all-time/

For Activity 1:

- Prepare cards or small pieces of paper with questions that you are willing to answer about yourself. Use the List of Personal Questions (Appendix 1A) to guide you, adding or eliminating questions. Include one question on each card or piece of paper, making sure to have more questions prepared than the number of registered students in the class.

- Gather chart paper and markers.
- Prepare notes for your own math story, based on My Story Example (Appendix 1B).

For Activity 2:

- Blow up a few balloons before students arrive.
- Gather markers.
- Warn colleagues (especially those teaching in classrooms nearby) that there will likely be considerable noise, including loud popping sounds (balloons bursting), coming from your classroom during the first part of the class period.

Instructional Framing and Flow

Greet students.

- There is no one right way to greet your students on the first day, but you do want to foster a feeling of belonging in the classroom. One way to do this is to smile and say hello as each student enters. This is also a good time to start learning and using your students' names, a gesture that helps them feel valued within your class.
- Introduce yourself to students.
- Consider asking students to read the success quotes and positive affirmations you have displayed and discuss which ones they already know or like best.

Direct students to the Student Information Sheet (Appendix 1C).

- If time permits, students can complete the form in class and return it to you then. Otherwise, ask them to return it at the start of the next class period.

Invite each student to select 1 piece of candy (but not to eat it yet!) and 1 balloon.

- For Activity 2, students will get into groups based on the candy they selected.
- Students should blow up their balloon before the start of Activity 2. Note: If any students are allergic to latex, they can be part of the observer group during the balloon activity. They will be able to make unique contributions to the debrief portion of that activity.

Briefly introduce yourself and the course.

- Encourage students to contact you outside of the classroom. Make sure students know when and where you hold office hours and, if you're willing, provide your cell number. Be sure to outline what is and is not acceptable to you in terms of times for calls and texts, etc.
- Outline the purpose of the course based on the course description in the syllabus.

Activity 1: My Story

- Ask students to listen to your story and, if they feel so moved, to write down their own question(s) that they would like you to answer.
- Share your own perspectives on and experiences with success at math by telling a personal story. Your story serves not only to introduce you to the students, but also helps to establish a common understanding that struggle and effective effort are expected of students in your course. Use the My Story Example (Appendix 1B) as a guide and ensure that your own story embeds similar key themes (e.g., personal choice and motivation to succeed, effort over natural ability, making a plan, finding resources, keeping the big picture in mind).
- Bring students' attention to the success quotes and positive affirmations in the room. Invite students to contribute additional affirmative quotes throughout the semester. Reinforce your commitment to making a fun, satisfying, and valuable course for your students and state your expectations for their participation.

Activity 2: Letting Go of Fears and Anxiety About Math

In this demonstration activity, balloons will represent the many things that students must juggle (e.g., roles they must play, emotional ups and downs, academic demands, anxiety about math). Each student will play a role—as students, challenges, resources, or observers—in the activity. The objective is for the "students" to keep the balloons in the air as "challenges" try to knock the balloons down, and "resources" help to keep the balloons aloft while "observers" keep a record of process.

Arrange students into 4 groups according to the type of candy they selected.

- Talk briefly about how group work will evolve throughout the course. Let students know that they will have many opportunities to work with different groups throughout the year and to expect to participate in class discussions. If they have not already done so, have students blow up their balloons.

Assign roles to each group.

- Students: Their task is to "be students," trying to keep all balloons in the air for as long as possible. The balloons will represent the things that students juggle; therefore, keeping the balloons in the air represents students' successfully completing the course.
- Challenges: Their task is to represent the things that interfere with the students' obligations by trying to knock all balloons to the ground.
- Resources: Their task is to represent all resources available on and off campus that can support students by helping to keep the balloons in the air.

- Observers: Their task is to record the challenges and solutions they hear and see during the activity; this group will help lead the debrief portion of the activity.

Have students write answers to the question "What are the things that you juggle in your life?" on the balloons.

- Students will need to share markers as they write one answer per balloon. Make sure that everyone does not record the same answer on their balloon.
- The following questions can help your students identify what they juggle more specifically.
    - *What roles do you play in your life (e.g., student, employee, sibling, caregiver, friend)?*
    - *What classes are you taking this semester (e.g., math, English, science)?*
    - *What are some of your feelings about studying math?*

Let students know that what they write on the balloons is anonymous. It may help to offer some prompts according to emotions (*excited, frustrated, unhappy*), physical sensations (*sweaty, feeling sickly*), actions (*lashing out, avoidance, persistence*), or thoughts (*distracted, can't think, unable to make a decision*). Students with math anxiety may use words such as *fearful, hatred, anxious, worried, tearful, emotional, sick, desire to escape, threatened, can't think, hopeless, stupid,* or *useless*. Join the game by writing a few of your own adjectives, especially around a category of consequences that may not be given much coverage by students themselves.

Have students in the other groups give their blown-up balloons to the Students group. Then have the Students group stand, toss the balloons in the air, and try to keep them aloft.

Meanwhile, ask the Challenges and Resources groups to brainstorm in preparation for entering the demonstration.

- Challenges: *What in your lives (consider family and work, motivation, bad habits, stressors, and unexpected road bumps such as illness or loss of income) can affect your ability to meet your commitment to doing well in school?*
- Resources: *What resources are available to help you overcome challenges? Consider people and services available through the school as well as personal resources such as family and friends.*

Then invite the Challenges and Resources groups to join in and try to keep or knock down the balloons.

- The Challenges and Resources groups should state the challenge or resource they are representing as they knock down or prop up balloons.

- If students in the Challenges group are each representing a specific challenge, they do not need to try to knock down a balloon that matches with their challenge. It is fine if they do, but trying to be that specific during this activity could become cumbersome and distracting.
- However, the members of the Resources group *should* identify a specific challenge that matches with the specific resource they represent, and they should focus on keeping the balloon aloft that the challenge is trying to knock down. For example, if a balloon has been knocked to the ground by the challenge "I've never been very good at math," the resource could be "Visit the tutoring center." For the challenge "My car breaks down on my way to the math exam," the resource could be "Talk with the instructor as soon as there is a problem. Work with her to come up with a solution."

Debrief with a whole class discussion.

- Ask the Observers group to discuss what they noted about the activity.
  - *What combination of challenge/resource did you think is most helpful?*
  - *Did your perception of what was happening change as the demonstration went along?*
- Ask the Students, Challenges, and Resources groups to discuss their experience during the activity.

  It is easy to get overwhelmed and struggle to keep things afloat when there are so many things going on—like trying to keep too many balloons in the air at once. No single student could have kept so many balloons in the air—the class needed to work together to be as successful as it was. The same is true for success in this course: Everyone will need to identify resources they can use when they feel overwhelmed.

  You have control over what you think and feel. Any time you find yourself obsessively worry or become anxious during the semester, reflect on the balloon activity and the resources and solutions you and your classmates generated. The challenges themselves are not the issue; rather, it is our beliefs about what those challenges represent that can contribute to anxiety and fear or propel us to take action and meet the challenge head on. We will work this semester to support one another and build smart habits to help us use our resources wisely and persist through challenges.
- Ask:

  How did you feel as you were trying to juggle all of your responsibilities?

Wrap-Up

Emphasize the three most important ideas from this lesson with your students.

- *This course supports you in taking personal responsibility for your success in this course by helping you identify and use key strategies and resources.*
- *In this course, everyone is part of a supportive learning community where it is okay to make mistakes and ask for help.*
- *The instructors of this course have high expectations and are committed to supporting you in meeting them.*

Setting a Foundation

Section 2: Building Learning Norms

Overview

A community of learners fosters learning by inviting all members to share their expertise and leverage their strengths. It is a community characterized by feelings of safety and belongingness among members, as well as a willingness to ask questions, take risks, and make mistakes. In this course, students need to build their learning community. To help reach that goal, you can set norms for how the class will interact and collaborate within our learning community. Norms are agreements about how you want our learning community to look, sound, and feel.

Learning Outcomes

Develop mathematical habits of mind, such as engaging in sense making; communicating effectively verbally, in writing, and using graphical displays; justifying conclusions; and critiquing their own work and the work of their peers.

Suggested Pacing

🕔 One 45-minute day

Prerequisite Skills

This section has no prerequisite skills.

Materials and Technology

- Poster paper and markers
- Sticky notes
- *Optional:* Shared document (e.g., Google doc, Padlet)

Facilitation Notes

- Let students know that they will collaborate in setting norms for our learning community.
- Give them 2 minutes of quiet think time to craft 2 or 3 norms for the learning community by completing the sentence frame:
    - *In our learning community, we…*
- Have students record 1 norm per sticky note. The words on the sticky note may start after the ellipsis in the sentence frame.

- Form groups of 3 or 4 students. Ask each group to use the Affinity Grouping strategy to help share, consolidate, and distill their brainstormed norms within their group.
    - Take 1 minute of quiet think time to read all of the group members' notes.
    - Without talking, each student looks for 2 or 3 norms that seem to be related, and groups them together. Others can write additional notes to a group or move notes from an existing group.
    - Continue until all notes have been grouped.
    - Now discuss the groupings. Generate short, descriptive phrases or sentences that describe each group and use them as group labels.
- Items can be moved from one group to another if a consensus emerges during the discussion.
- Facilitate the consolidation of student-generated norms onto 1 poster to create a set of community norms. Ask each group to contribute 1 norm at a time until all unique norm titles are posted.
- Try to consolidate similar norms so that the list is limited to 5 or 6 norms. Too many norms make them less effective and useful.
- Look for a norm related to "Mistakes are expected, respected, and inspected." A norm related to mistakes transitions nicely into growth mindset ideas. It also may be more helpful to center the conversation around something a teacher has done in their classroom rather than an abstract norm. For example, "One teacher had a 'favorite mistakes' activity they did after each exam, where they would review a common mistake, what it shows about students' understanding, and why learning from that mistake will help students grow and learn further. What message might this convey to students?"
- Once the norms are posted, emphasize that we will honor these norms during synchronous sessions as well as in our asynchronous online community. Be sure to name and reinforce these community norms throughout the session.

Setting a Foundation

Section 3: Windows and Mirrors

Overview

In this lesson, the class understands the value of a multiculturalism in learning and problem solving. Culturally responsive teaching, as defined by Ladson-Billings (1994),[1] recognizes the importance of including students' cultural references in all aspects of learning and is characterized by positive perspectives on parents and families, communication of high expectations, learning within the context of culture, student-centered and culturally mediated instruction, reshaping the curriculum, and the teacher as facilitator. Extending this stance, culturally sustaining pedagogy (Paris, 2012)[2] calls for approaches that not only respond to or are relevant to young people's cultural experiences and practices but also actively support them in sustaining the cultural and linguistic competence of their communities while simultaneously providing access to dominant cultural competence. In practice, game-changing strategies include facilitating learning experiences that honor informal language and respectfully scaffold it to formal language; offering students choice in problems to investigate; inviting students to bring community-rooted problems that create "windows and mirrors" by allowing learners to see their own and peers' identities in mathematics; combating Eurocentrism by correctly attributing the historical development of key mathematical ideas and honoring algorithms, processes, and problem-solving strategies from diverse cultures; and helping students see mathematics as a useful tool for solving authentic, personally meaningful problems and for analyzing and addressing injustices.

Learning Outcomes

Develop mathematical habits of mind, such as engaging in sense making; communicating effectively verbally, in writing, and using graphical displays; justifying conclusions; and critiquing their own work and the work of their peers.

Suggested Pacing

One 45-minute day

Prerequisite Skills

This section has no prerequisite skills.

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[1] Ladson-Billings, G. (1994). *The dreamkeepers: Successful teachers in African American education*. Jossey-Bass Publishing.

[2] Paris, D. (2012). Culturally sustaining pedagogy: A needed change in stance, terminology, and practice. *Educational Researcher, 41*(3), 93–97.

Materials and Technology

- Cultural Authenticity[3]
- What Is Culturally Sustaining Pedagogy?[4]

Facilitation Notes

This section is an important start to setting the tone and expectations for this course. Students should feel a sense of belonging and purpose in the course.

Framing (15 minutes)

What do we mean by "culture?"

- Invite students to have a discussion with an elbow partner about what they think of when they hear the word *culture*.
- Share some definitions found online. For example, Merriam-Webster defines culture as "the customary beliefs, social forms, and material traits of a racial, religious, or social group" or "the set of shared attitudes, values, goals, and practices that characterizes an institution or organization."[5]
- Introduce the idea of creating a particular culture in this class. Ask students what they would want the classroom culture to be (e.g., respectful, supportive, inclusive, inquisitive).
- Share some parts of your own cultural background.
- Engage students in a discussion about the value of sustaining and exploring cultures. Use the following guiding questions as needed.
    - Why is it important to sustain aspects of our cultures?
    - What do you gain by learning about your own culture?
    - What do you gain by learning about someone else's culture?
    - What defines your culture (e.g., ancestry, heritage, age, interests)?

[3] Reading Rockets. (2015). *Cultural authenticity* [Video]. YouTube.

[4] Institute of Education Sciences. (n.d.). *What is culturally sustaining pedagogy?* [Infographic] Regional Educational Laboratory Program.

[5] https://www.merriam-webster.com/dictionary/culture

Activity (30 minutes)

Windows and Mirrors

- In 1990, Rudine Sims Bishop from Ohio State University wrote an article for the journal *Perspectives: Using and Choosing Books for the Classroom*. In "Mirrors, Windows, and Sliding Glass Doors,"[6] she discussed the analogy of windows and mirrors for students in children's books.

  > *Books are sometimes windows, offering views of worlds that may be real or imagined, familiar or strange. These windows are also sliding glass doors, and readers have only to walk through in imagination to become part of whatever world has been created or recreated by the author. When lighting conditions are just right, however, a window can also be a mirror.* (Bishop, 1990, p. ix)

- Ask:
  - In books you read, reels you watch, or movies you stream, do you see mirrors of yourself? Do you see windows into the lives of others? How does each impact your connection to the media?
- On a blank sheet of paper, ask students to draw images or write phrases that represent a mirror of themselves. Then on another piece of paper, ask them to draw images or write phrases of a window into a world that is different from their own. They might be something students have seen or read about, or they can think of a person they know.
- Give students time to mingle with their classmates. Their first task is to find someone who has something in common with themselves—look at their mirrors. Once students have formed pairs or small groups, have them discuss similarities and differences in what they created as their mirrors.
- Look for any students who did not find anyone with a commonality. Help them find someone with at least one common trait, maybe having the same hair color. Ask their permission to call on them during the debrief to share how not finding another student with a common trait feels. Students may not be willing to share and that should be respected.
- Next, have students find classmates who provide a window into a different culture. Again, have them create pairs or small groups. Allow time for students to share something about themselves that is different from their partner or group mates.

[6] Bishop, R. S. (1990). Mirrors, windows, and sliding glass doors. *Perspectives, 6*(3), ix-xi.

- Debrief questions:
  - What did it feel like to find people who have things in common with you (sense of belonging)?
  - If anyone struggled to find commonality with others, would you be willing to share how that sense of isolation felt? Can anyone relate to feeling isolated in another context?
  - Share something you learned about someone who was a window for you.
- Summarize this activity by emphasizing to students the value of finding community with people with whom they share things but also learn from those who are different.
  - *In this class, we will look for windows and mirrors in the context that we explore and learn about.*

Setting a Foundation

Section 4: Metacognition

Overview

In this section, students will define ***metacognition***, the awareness or analysis of one's own learning and thinking processes. Psychologist John Flavell coined the term *metacognition* to refer to the process that can be described as "thinking about thinking." Students will access tools that promote metacognition and practice metacognitive strategies.

Learning Outcomes

Develop mathematical habits of mind, such as engaging in sense making; communicating effectively verbally, in writing, and using graphical displays; justifying conclusions; and critiquing their own work and the work of their peers.

Suggested Pacing

🕔 One 45-minute day

Prerequisite Skills

This section has no prerequisite skills.

Materials and Technology

- Thinking About Thinking: Problem-Solving Tool[1]
- Thinking About Thinking: Self-Reflection Tool[2]
- Towers of Hanoi puzzle[3]
- Computer or tablet for each student

Facilitation Notes

- Prompt pairs of students to consider strategies they have used when playing board games, video games, sports, and gaming apps.

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[1] Charles A. Dana Center and Agile Mind, Inc. (n.d.). *Thinking about thinking: Problem-solving tool.* Learning and the Adolescent Mind.

[2] Charles A. Dana Center and Agile Mind, Inc. (n.d.). *Thinking about thinking: Self-reflection tool.* Learning and the Adolescent Mind.

[3] Charles A. Dana Center and Agile Mind, Inc. (n.d.). *Classroom tools: Tower of Hanoi*. Learning and the Adolescent Mind.

- Have student pairs discuss a game experience and the strategies involved. Afterward, invite pairs to share their discussions with the class. Use the following questions to focus discussion on strategy.
    - *What kinds of strategies do you use?*
    - *Do you ever have to change your strategy? How do you know?*
    - *Do you ever reflect on the strategies you used?*
    - *What do you do if a strategy doesn't work?*
- Ask a student to come to the board to play a game of tic-tac-toe with you. As you play, think aloud about your strategy. For each move, provide an oral rationale or show the strategy you are using. Have the student do the same.
- Define ***metacognition***. It is likely a new word for students. Point out the prefix, *meta-*, and the root, *cognition*. Discuss the definitions of the prefix and root as shown on the student activity sheet.
- Have students think of any other words or uses of *meta* or *cognition*. Based on what they have learned on this page, ask:
    - *What would meta-communication mean?*
- Explain that metacognition is an important element of self-regulation. An awareness of one's thinking processes, or metacognition, is an important skill and strategy within the larger self-regulatory framework.
- Provide an example or two of metacognition from your own experience or make some up. For example:

    Suppose two of your friends ask you for advice. Pat wants to spend a substantial amount of money to buy a video game. Cameron says this is a bad idea, that the money should be saved or spent on something more useful. Your friends ask you to decide who has the better idea. *Hmm,* you think. *If I say Pat should spend the money on the video game, I'll make Pat happy, and I'll get to play the game with Pat . . . but that will make Cameron mad because I'm disagreeing with Cameron's opinion. On the other hand, if I say the money should be saved or spent for something more useful, Cameron will be happy with my support, but Pat will be mad at me.*
- Let students know that they will engage in some problem solving to practice thinking about their own thinking.
- Share the Towers of Hanoi puzzle with students.
- Present the rules of the game. Do not illustrate any possible moves for the students.

- Let students work on the Towers of Hanoi in small groups of 2 or 3 students.
- Initially, give groups no more than a few moments to work on the problem. Make sure to stop the groups before any one group reaches a solution. At this point, you are only giving groups a chance to understand the problem and the animation.
- To promote additional reflection, ask about their strategies so far.
    - *How did you start the task?*
    - *What has worked so far?*
    - *What hasn't worked? Has that taught you anything about the puzzle?*
    - *What will you do if you get stuck?*
- Give groups about 30 minutes to try to solve the Towers of Hanoi. Point out that the animation has a feature that allows them to choose simpler versions of the problem with fewer rings. Remind students that their ultimate goal is to move all 5 rings, but a strategy they may choose to use is to solve simpler versions of the problem first.
- As students solve the puzzle, the captions prompt them to consider if they can solve it in fewer moves—this is intentional. If students ask you if they have the minimum number of moves, push them to explain why they think they have found the optimal solution. This will push their thinking and reflection about the problem-solving experience.
- If students solve the puzzle with 5 rings in 31 moves, they have found the minimum number of moves for a Towers of Hanoi with 5 rings. Challenge these students to extend their thinking. Ask:
    - *How many moves would it take to move 6 rings?*
    - *How many moves would it take to move 7 rings?*
    - *Can you find a pattern?*

    If a group solves the puzzle in more than the minimum number of moves, challenge them to reduce the number of moves. This will allow students who have not yet solved the puzzle to have additional time to think and work.
- As students begin to solve the Towers of Hanoi, ask them to explain their strategy to another student. Some students will stumble upon a solution, but they will struggle to communicate their solution. Students may not be used to thinking about why they are doing something during problem solving.
- Share the Thinking About Thinking: Problem-Solving Tool. Ask if they used any of these questions organically as they worked on the Towers of Hanoi puzzle.

- Present the Three-Bucket Problem. Encourage students to use the prompts on the Problem-Solving Tool as they work on this task.
- Have students read the problem. Demonstrate a few moves using the animation for the class. Point out that the dividing lines on each container are to help monitor progress; they are not measurements. Each time students pour, it will either fill the container they are pouring into or empty the container they are pouring from.
- Have students work in small groups to develop a plan. At this point in their work, students should not be using the simulation online. They should record their plan on their activity sheets. Give students time to work with the simulation activity online only after they have a written plan.
- As students work at the computer in their groups, the captions will prompt them to monitor and evaluate their work. They should use the activity sheet to record their reflections about these strategies as they solve the problem. This activity will take at least 30 minutes.
- **Solution**: Pour from the 8-quart bucket to fill the 5-quart bucket. Pour from the 5-quart bucket to the 3-quart bucket. There should now be 3 quarts in the 8-quart bucket, 2 quarts in the 5-quart bucket, and 3 quarts in the 3-quart bucket. Pour from the 3-quart bucket to the 8-quart bucket. Pour from the 5-quart bucket to fill the 3-quart bucket. This will leave 2 quarts in the 3-quart bucket. Now pour from the 8-quart bucket back into the 5-quart bucket. There should now be 1 quart in the 8-quart bucket, 5 quarts in the 5-quart bucket, and 2 quarts in the 3-quart bucket. Pour from the 5-quart bucket into the 3-quart bucket. There are now 4 quarts in the 5-quart bucket. Now pour from the 3-quart bucket into the 8-quart bucket. There should be 2 buckets with 4 quarts each!
- Debrief and discuss the process that students used to solve the Three-Bucket Problem. Use the questions to guide the discussion. Students might believe that when they try hard and still struggle, it is a sign that they are not smart. Help students understand that sometimes their effort is not effective. Reinforce the idea that by using metacognitive strategies and setting goals, their efforts can become more effective.
- Have students use the Self-Reflection Tool to reflect on their problem-solving experiences. Explain that this tool is a way for them to reflect on their learning and apply that learning to new situations. Students do not need to write something for every prompt in the table, but encourage them to use the tool to process the experience and to think about how they can learn from it.

Setting a Foundation

Section 5: Team Building

Overview

This section helps students collaborate with classmates while learning how everyday information is transformed into data. Through two complementary activities—one that creates a visual snapshot of class interests and another that allows students to move around the classroom and sort fun personal facts—learners practice observing, comparing, and communicating patterns in ways that feel social rather than strictly academic. Along the way, they experience the basics of data collection and grouping, consider how categories are defined, and notice variability across the group. The emphasis is on belonging and collaboration, yet students also begin to think critically about how data are represented, interpreted, and communicated, and how choices in categorization shape meaning. By the end of the section, students will have strengthened comfort in peer dialogue, built shared norms for discussion, and laid a clear foundation for the course's work in ISQR.

Learning Outcomes

Develop mathematical habits of mind, such as engaging in sense making; communicating effectively verbally, in writing, and using graphical displays; justifying conclusions; and critiquing their own work and the work of their peers.

Suggested Pacing

🕔 One 45-minute day

Prerequisite Skills

This section has no prerequisite skills.

Materials and Technology

- Large paper, whiteboard, or poster with pre-labeled *x*-axis categories
- Emoji stickers (or sticky notes that students can draw emojis on)
- Markers
- One index card per student

Facilitation Notes

Activity 1: Class Preferences Snapshot (Sticker Voting)

- Prepare and display 4-category posters for each question. Suggested questions:
  - *What is the best streaming service (e.g., Netflix, Hulu, Disney+, YouTube)?*
  - *What do you consider to be an ideal Friday night (e.g., gaming, hanging out, movies, sleeping)?*
  - *Which would you rather have for a year (e.g., free gas, free coffee, free concert tickets, free clothes)?*
  - *If you could instantly master one skill, what would it be (e.g., play an instrument, code an app, speak another language, bake like a pro)?*
- Introduce the activity.
  - *Today, we're going to learn a little bit about one another in a fun way and create a visual display of our class's preferences. This activity will also help us see how diverse or similar our interests are. Along the way, we'll also notice some patterns in the choices we make as a group. There's no right or wrong answer here. Just pick what's true for you.*
  - Explain the process:

    I'll read a question, and you'll place your sticker in the category that matches your choice. Once we're done, we'll step back and see what patterns we notice.
- Conduct voting.
  - Give each student one emoji sticker per question.
  - As each question is read aloud, students place their sticker in the matching category.
  - Encourage light conversation as students vote so they naturally compare choices.
  - Pause for quick observation. Ask:
    - *"What do you notice so far? Any surprises?"*
  - Invite 1 or 2 students to share.
- Guide observation and discussion.
  - Have students view the full "graph" (the sticker displays).

  - Use the following prompts.
    - *Which category stands out as the most popular? How can you tell?*
    - *Did anything surprise you about these results?*
    - *If we had a bigger class, do you think the graph would look the same?*
    - *Which option had the least votes? Why do you think that is?*
    - *How would this graph look if we turned it into percentages?*
- Optional math extension:
  - Count each category's votes.
  - Convert counts to percentages.
  - Create a quick mini-infographic on scrap paper.
- Wrap-up
  - Invite groups to share one interesting pattern they found.
  - Highlight how representation, interpretation, and categorization shape meaning and reveal variability.

Activity 2: The Greatest Data Swap

- Share fact prompts for students (examples).
  - Number facts:
    - *Hours you're on your phone each day*
    - *Number of playlists in your music app*
    - *Number of hairstyles/colors you've had*
    - *How many TikToks/Reels you watch before bed*
    - *Number of siblings/cousins you see regularly*
  - Category facts:
    - *Favorite fast food spot*
    - *Go-to late-night study snack*
    - *Best social media app*
    - *Comfort TV show/series*

- *Dream vacation destination*

Card Creation

- Ask students to write their name, one "number fact," and one "category fact" on the card.

Find Your Match

- Call out one of the facts (e.g., favorite fast food).
- Have students physically group themselves based on their answers.
- Observation questions:
  - *Which group is largest? Smallest?*
  - *Did any group have an unusual or unique answer?*
- Discussion prompts:
  - *Which group had the most people?*
  - *Which had the fewest?*
  - *Did any group surprise you?*
  - *If we did this activity with students from another school, do you think the results would be similar?*

Group Sort

- Call out one of the facts (e.g., favorite fast food).
- Have students physically group themselves based on their answers.
- Observation questions:
  - *Which group is largest? Smallest?*
  - *Did any group have an unusual or unique answer?*
- Discussion prompts:
  - *Which group had the most people?*
  - *Which had the fewest?*
  - *Did any group surprise you?*
  - *If we did this activity with students from another school, do you think the results would be similar?*

Debrief

- Discuss what students learned about classmates.
- Highlight the variety of responses and any “outliers.”
- Optional: Invite a student to propose how to show the results as a chart or graph.

Closing the Section

- Reinforce that these activities build belonging while introducing core ideas in data collection, categorization, representation, and variability.
- Preview that future lessons will formalize these ideas using the language and tools of statistics and quantitative reasoning.

Setting a Foundation

Section 6: The Data Cycle

Overview

This section introduces students to the ***data cycle*** as a systematic framework for investigating questions with data, using the relatable context of factors that influence exam performance. Students begin by generating their own questions about what might predict test scores. Then they explore whether more sleep leads to better performance by working through each stage of the data cycle: formulating questions, collecting or assembling data, analyzing the data, and interpreting and summarizing conclusions. Through guided analysis of secondary data about sleep and exam scores using Common Online Data Analysis Platform (CODAP), students learn to identify variables and units, check data for errors, create appropriate visualizations such as scatterplots, interpret patterns and outliers, and critically evaluate whether observed relationships suggest causation or simply correlation. The section culminates in a mini-project where students apply the complete data cycle to a health topic of their choice (e.g., sleep habits, nutrition, physical activity) by formulating their own research questions, collecting primary data through surveys or finding relevant secondary data, organizing and analyzing them using statistical tools and visualizations, and presenting findings that acknowledge limitations and broader implications.

Learning Outcomes

- Develop mathematical habits of mind, such as engaging in sense making; communicating effectively verbally, in writing, and using graphical displays; justifying conclusions; and critiquing their own work and the work of their peers.
- Select and use available technology, as appropriate, for the situation.
- Employ systematic problem-solving processes, including the statistical problem-solving process (i.e., formulating questions that can be answered by data, collecting or assembling data, analyzing the data, and interpreting and summarizing conclusions).
- Use authentic data to investigate real-world problems.
- Construct and interpret univariate and multivariable data visualizations, including but not limited to histograms and scatterplots.

Suggested Pacing

🕔 One 45-minute day

Prerequisite Skills

- Interpreting scatterplots
- Using spreadsheets

Materials and Technology

- Computer access

Facilitation Notes

Engage (15 minutes)

The goal of the Engage activity is for students to connect with a relatable question about exam performance and to begin thinking about what factors might influence outcomes in their own lives.

- Present the opening context: Exam performance is influenced by multiple factors, not just study time. Small, deliberate changes in sleep, practice, feedback, and stress management can make a measurable difference.
- Ask students:
  - *What are some questions you have about predicted exam performance?*
- Give them 2–3 minutes to think individually. Ask them to share with a partner and then with the whole class.
- Record student questions visibly (e.g., whiteboard, chart paper, shared document). Listen for questions that suggest causal relationships, not just simple descriptions. Do not evaluate questions at this stage. The goal is to generate curiosity and surface prior assumptions about what influences performance.
- Tell students that to answer questions like these, a systematic way to work with data is needed.

Deep Dive (30 minutes)

- Present the data cycle visual, explaining how the process is helpful in making sense of data: formulate questions, collect or assemble data, analyze data, and interpret and summarize conclusions.
- Ask:
  - *What stands out to you about the data cycle process?*

- Allow students to process the framework in their own words.
- Emphasize that the cycle is iterative, not linear. Real investigations often loop back to earlier steps.
- **Step 1: Formulate questions.**
    - The question is provided (*Does more sleep lead to better exam performance?*), but ask students why it is a good question to investigate with data.
    - Connect back to questions that students generated in the Engage activity.
- **Step 2: Collect or assemble data.**
    - Introduce the distinction between primary data (the data you collected yourself) and secondary data (the data someone else collected).
    - Explain that for this investigation, they will use secondary data from a student survey.
    - Ask:
        - *What type of sample is this?*
    - Guide students to recognize that the sample is observational data from one class.
    - In order to plant seeds for later discussion about generalizability, ask:
        - *Does our class data represent everyone in our school/state/nation?"*
- **Step 3: Analyze the data.**
    - Have students identify the variables (sleep hours, exam score) and their units (hours, points).
    - Ask students to check the data for missing values or potential errors. (In this case, the data appears complete.)
    - Ask:
        - *Which type of graphical display would best show the relationship between sleep and exam score? Why?*
    - Guide students toward a scatterplot, if needed.
    - Introduce or review CODAP. Walk through creating a scatterplot: Click "Graph," drag “Sleep Hours” to the horizontal axis, and drag “Exam Score” to the vertical axis.
    - Give students time to create their own scatterplots.

- Ask:
  - *Do you see a trend in the scatterplot (positive, negative, or no clear pattern)? What evidence supports your claim?*
- Guide students to observe that there is no clear pattern. Exam scores ranged widely regardless of the number of hours of sleep the students got.
- Ask:
  - *Are there points that stand out to you? What might explain them?* Help students notice outliers (e.g., two students performed very high despite only getting 4 hours of sleep).
- Introduce the concept of confounding variables. Ask:
  - *What variables not shown in your graph might confound the relationship between sleep and exam performance*?
- Guide students to recognize that without a clear pattern, we cannot claim causation. Even if there were a pattern, observational data alone do not prove causation because of confounding variables.

- **Step 5: Interpret and summarize conclusions.**
  - Ask:
    - *Now it's time to communicate the results. Based on this observational data, can you conclude that more sleep causes higher scores? Why or why not? What evidence would you need to make a stronger causal claim?*
  - Students should recognize that the scatterplot does not show any pattern. Points look random, and there is no clear trend. Without a trend, we cannot say that more sleep causes higher scores. Other factors could be involved (e.g., study quality, attendance, stress, prior knowledge), and self-reported sleep might be inaccurate.
  - Emphasize that acknowledging limitations is a strength, not a weakness.

Student Mini-Project (90 minutes)

Students will follow the data cycle to investigate a health topic (e.g., sleep habits, nutrition, physical activity, screen time).

- Students choose a topic that interests them and decide what questions they want to investigate. Circulate and help students refine vague questions into specific, investigable ones.
- Help them design clear, measurable survey questions. Ask meaningful questions that provide measurable responses.
- Students should use analytical tools that they have previously learned to explore, organize, and create representations of their data.

Setting a Foundation

Section 6: The Data Cycle

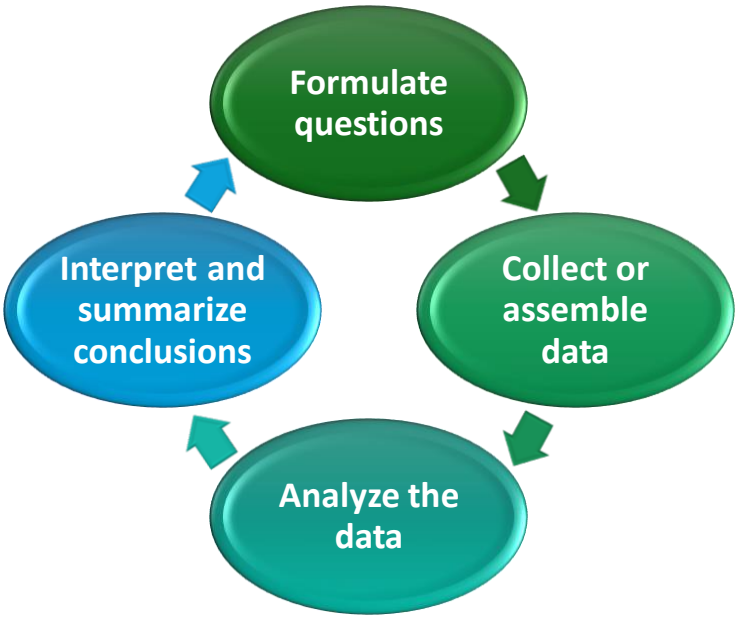
Engage

Exam performance is rarely determined by study time alone. Attendance, quality sleep, targeted practice with feedback, and stress management can impact outcomes. Small, deliberate changes in any one of these factors can make a measurable difference, but studying without rest or feedback can boost confidence more than scores.

1. What are some questions you have about predicted exam performance?

Deep Dive

To answer your questions, you will need to examine data. Often, to fully analyze data, you need to go through the ***data cycle***. The data cycle is a helpful process that gives an organized approach to making sense of data. The first step of the data cycle is to formulate questions, which you just did regarding exam performance. Are there any questions you would add to your list? Once you have formulated questions, the next step is to gather data. Then, you can analyze that data and communicate the results. Take a look at the image to visualize the data cycle.



1. What stands out to you about the data cycle process?

One question you may have asked above is whether getting more sleep leads to better performance on exams. Let's explore this question further using the data cycle. The second step of the data cycle is to collect or assemble data. For example, if you have questions about the typical commute time for students at your school, you will need to survey students to collect the data. When you collect the data yourself, it is known as ***primary data***. Other times, the data have already been collected and are available to use and analyze. These data are called ***secondary data***. To answer the question related to sleep and exam performance, you will use secondary data.

The Common Online Data Analysis Platform (CODAP) is a tool that makes analyzing data a simpler process. The "ISQR Student Exam Data" table shows student data in multiple columns. Take a minute to explore the dataset.

1. What are the variables and units for this dataset? Identify two of each.

2. The third step of the data cycle is to analyze the data. In the spreadsheet, do you notice any missing values or potential errors?

3. Go back to our question related to sleep time and exam performance. Which type of graphical display would best show the relationship between sleep and exam score? Why?

4. Use CODAP to create a scatterplot with “Sleep Hours” on the horizontal axis and “Exam Score” on the vertical axis. You can do this by clicking “Graph” at the top left of the screen and then dragging each variable to the appropriate axis in the graph.

5. Do you see a trend in the scatterplot (positive, negative, or no clear pattern)? What evidence supports your claim?

6. Are there points that stand out to you? What might explain them?

7. What variables not shown in your graph might confound the relationship between sleep and exam performance?

8. Now it’s time to communicate the results. Based on this observational data, can you conclude that more sleep causes higher scores? Why or why not? What evidence would you need to make a stronger causal claim?

Student Mini-Project

Imagine you serve on a youth advisory board that is helping your city examine health topics such as sleep habits, stress, nutrition, or physical activity. Community groups make strong claims about what works. How can you use data to verify whether their recommendations would truly make a difference?

Once you select a topic of interest, you will follow the data cycle to develop your own research questions, collect relevant data, and organize and analyze them using a spreadsheet. You will apply the analytical tools you have previously used to interpret patterns, trends, and relationships within the data. You will then present your findings.

Step 1: Formulate questions.

Choose a topic that interests you and decide what questions you want to investigate.

- Write a few possible questions that you want to explore.

Step 2: Collect or assemble data.

Once you have selected your topic, you will collect either primary or secondary data.

- Primary data: Create a survey to collect firsthand data from your peers, family, or community. Ask meaningful questions that provide measurable responses.
- Secondary data: Research publicly available datasets relevant to your topic. Look for information from credible sources such as government reports, research studies, or industry reports.

Step 3: Analyze the data.

Using the analytical tools you have previously learned, explore, organize, and create representations of your data to help answer your research questions by asking:

- What statistical measures will best summarize your data? Consider calculating measures such as mean, median, mode, and range.
- How can you compare different categories or groups within your dataset?
- Which graphical depictions of data will best help you answer your questions?
- Does your data show any patterns or trends over time? What might be causing these changes?

Step 4: Interpret and summarize conclusions.

Analyze the findings from your data investigation and write a summary communicating your findings.

- Identify key takeaways and summarize what the data suggest about your chosen topic.
- Think about how your analysis applies to real-world situations and what broader implications your conclusions may have.

Finally, reflect on the challenges and successes of your data investigation.

- Consider what aspects of data collection and analysis were most difficult and what strategies helped you to interpret the information effectively.
- Are there any remaining questions you may have that were not answered by the data?
- Are there any confounding variables to consider in future data analysis?
- Think of how your project could be improved or expanded with additional data or further analysis.
- Evaluate how this experience has shaped your understanding of the power of data in decision making.

Setting a Foundation

Section 7: Data Ethics

Overview

This section equips students to reason about ethical data practices through real-world scenarios and a school-based case. Students define what *ethical* means in the context of data, and weigh benefits and potential harms. They examine how purpose, consent, privacy, data minimization, fairness, transparency, and security shape responsible data collection and use. Through the fitness app example, students explore how anonymous location data can become identifiable and consider mitigation strategies. In the school access scenario, they practice designing clear categories, choosing anonymous/aggregated reporting, planning opt-in consent, and deciding retention and access, all while attending to equity and avoiding stigma. The lesson emphasizes communicating results responsibly, acknowledging limitations, and elevating student voice in survey design and implementation.

Learning Outcomes

- Discuss the ethical issues around the collection and management of data, data privacy, and informed consent, and identify potential ethical issues in specific contextual situations.
- Identify types of bias and potential sources of bias in data collection.

Suggested Pacing

🕔 Three 45-minute days

Prerequisite Skills

There are no prerequisite skills for this section.

Materials and Technology

- “Would You Share That?” scenario cards

Facilitation Notes

Engage (30 minutes)

- For this activity, place students into groups. Give each group a card from the "Would You Share That?" scenarios page. Give each student a chance to read the prompt. Then give a few minutes for groups to discuss the prompt and to ensure that each group member understands the scenario. Walk around and listen for questions, but at this point, do not take questions aloud for the class to hear. Before moving forward with the activity, have each group designate a note taker and a reporter. (You may also wish to designate a timekeeper, if necessary.)
- When all groups are ready and roles have been assigned, present the following prompts.
    - *Would you be comfortable with your data being used this way? Why or why not?*
    - *Who benefits from collecting these data? Who might be harmed?*
    - *What questions should be asked before collecting or using these data?*
- Give groups some time to think of responses for each prompt. The note taker should write down their group's responses, making sure that the reporter is able to use the notes for a whole class share out. At the end of each share out, the reporter should check with their group to make sure that any major areas of discussion were not missed.
- After each group presents, allow a couple of minutes for clarifying questions from the class. This time is not for students to debate what they have heard, but time for clarifying the group's responses to the prompts.
- As reporters from each group share their responses, highlight any major themes that emerge (e.g., consent, bias, transparency, power). Keep a record of those themes to discuss later with the whole class.
- After all groups have shared, ask the whole class what kinds of themes they noticed. Make a running list of any major takeaways and compare them to the list that you generated.

Investigation (30 minutes)

- Have students use their Student Pages to write their own ideas of what it means to be ethical in data collection. If students need prompting, ask:
  - *What are some responsible ways to collect data?*
  - *Who is responsible for protecting people's personal data?*
  - *Can a data collection practice be legal but unethical?*
  - *Can a data collection practice be ethical but still seem unfair?*
- Once students have created their own definitions for ethical data collection, have them share with a partner. Partners should help make sure that definitions are clear and give good guidance for how data should be collected.
- Students are now able to answer the remaining questions in their Student Pages.

Check Your Understanding (75 minutes)

- Have students answer the remaining questions on their own.
- Asking good questions and thinking critically about ethics will be foundational for this course. Take time to read students' responses and be prepared to have a full class discussion.

Setting a Foundation

Section 7: Data Ethics

Would You Share That?

Scenario List

A fitness app installed on your phone shares user location data with advertisers.	A school uses your performance on past exams to predict future success.	A social media platform uses facial recognition to tag people in photos posted on a social media app.
A college uses historical data to predict which applicants are most likely to graduate and prioritizes them in admissions decisions.	A clothing store uses your purchase history to send personalized ads to your phone.	A city police department uses historical crime data to predict where crimes are likely to occur and increases police presence in those areas.
Students at your school are required to complete a health and wellness survey. The results are shared with an outside organization to improve student services.	A career exploration app uses your grades, interests, and personality quiz to recommend a career.	A college uses your social media history in its admissions decision.
Your school uses digital ID cards that track when you enter and leave campus.	Your English teacher uses an AI tool to give feedback on essays. The tool stores and uses your writing to improve its performance.	A civics class uses a mock voting platform to simulate elections. Students log in using their school ID.

Setting a Foundation

Section 7: Data Ethics

Engage

Read a prompt from the "Would You Share That?" scenarios page and discuss it with your group. Before moving forward with the activity, designate a note taker and a reporter, and if necessary, a timekeeper.

Investigation

1. Use your own words and experience to define what it means to be ethical in data collection.

You will use data to solve problems throughout this course. As you have seen previously, some of the data will have already been collected—these are called *secondary data*. Some of the data will be collected by you and your peers—these are called *primary data*. Answer the following questions as you think about ethics in data collection.

2. How might data ethics affect the way we analyze or interpret data in this course?

3. Why is it important to think about ethics *before* we start working with data?

4. How can ethical responsibility help us become better problem solvers and decision makers?

A fitness app's anonymous location data for each of its subscribers were sold to third parties to improve city planning and advertisement targeting.

5. What would you want to know before sharing your data?

6. What could make "anonymous" location data identifiable?

Deep Dive

Suppose your school is collecting data on which students have access to learning tools, such as laptops, tablets, or calculators.

1. Why collect these data at all? What specific decisions might they inform?

2. Could the school meet the goals of collecting these data without collecting personal or identifiable information? How?

3. How can the categories be made clear and easy to answer?

4. How should students be informed about the purpose, who will see the data, and how it will be used?

5. What information would make you comfortable in participating?

6. Who benefits from collecting these data, and who might be harmed?

7. How could the school reduce mistakes or bias?

8. How would you like these questions to be presented?

Check Your Understanding

1. In your own words, describe what it means for a music streaming platform to be ethical in collecting data from its users.

2. The platform wants to study teenagers' listening habits. Give an example of how it could use primary data and how it could use secondary data.

3. Imagine you are a user of this platform. List three questions you would want answered before you agree to let your data be shared with the company.

4. Write two example survey questions that could be asked to students related to music streaming and study habits.

Setting a Foundation

Section 8: What's in a Query

Overview

This section engages students in investigating the environmental impact of artificial intelligence by examining the hidden costs of everyday AI interactions. Beginning with a hands-on activity in which students craft their own AI queries and collect class data on query length, they discover that the way they phrase questions to AI tools affects energy consumption. Students then analyze a real-world claim that the average ChatGPT query uses as much energy as a little over one second of boiling water by exploring what constitutes an "average" query and how factors (such as prompt length, conversation history, and model type) influence computational demands. Through calculating measures of center and variability, creating data visualizations, and building statistical models to estimate energy use and carbon emissions at scale, students practice quantitative reasoning while grappling with questions of digital sustainability and responsible technology use. The section culminates in critical evaluation of media claims, discussion of limitations and assumptions in their models, and student-driven action projects, ranging from creating infographics to writing policy briefs. By the end of this section, students will have strengthened their ability to collect and analyze authentic data, model real-world phenomena, interpret and communicate statistical findings, and think critically about the broader implications of technology choices in their daily lives.

Learning Outcomes

- Develop mathematical habits of mind, such as engaging in sense making; communicating effectively verbally, in writing, and using graphical displays; justifying conclusions; and critiquing their own work and the work of their peers.
- Select and use available technology as appropriate for the situation.
- Interpret and compare measures of center and measures of variability, and evaluate claims based on such summaries.
- Calculate (using technology) and use appropriate measures of center and variability to summarize data and to compare data distributions.

Suggested Pacing

🕔 Three 45-minute days

Prerequisite Skills

There are no prerequisite skills for this section.

Materials and Technology

- Computer access
- Spreadsheet software
- *Optional:* Resource "Mean, Mode, and Median"

Facilitation Notes

Engage (25 minutes)

- Give students examples of an open-ended question that is specific enough to need explanation (e.g., "Why do some countries have higher life expectancies than others?"). They must use AI (e.g., ChatGPT, Copilot, Gemini) to get an answer that they are satisfied with.
- Students will record their questions and the total number of words in the final question. Record each student's word count for the class to see—you now have a student-created dataset.

Analysis (45 minutes)

Give students a few minutes to explore the following context.

> In July 2025, OpenAI CEO Sam Altman claimed an "average ChatGPT query uses energy equal to about what an oven would use in a little over one second."[1] However, experts say the claim lacks key context, like what an "average" query even is. What is an average query? In 2025, the average length of a ChatGPT query was approximately 23 words.[2]

- Allow students to answer the analysis questions on their student pages. Use the resource "Mean, Mode, and Median," if needed.
- Students can use calculators, spreadsheets, or other online tools to find the mean absolute deviation and standard deviation. One available tool is here: https://dcmpdatatools.utdanacenter.org/eda_quantitative/
    - One available tool can be found here: https://dcmpdatatools.utdanacenter.org/eda_quantitative/

[1] Chao, Z. (2025, July 2). How much energy does your AI prompt use? It depends. ScienceNews.

[2] Elad, B. (2025). ChatGPT statistics 2026: Usage figures, subscription trends & industry reach. SQ Magazine.

  - Note that in order to add their own data, students will need to choose "Your Own" from the "Enter Data" dropdown list.

- Students should have calculated the 5-number summary in previous math courses, but make sure they understand the following statistics before moving on.
  - Minimum: The lowest value in the data set
  - Q1: The median of the lower half of the data (25^{th} percentile)
  - Median: The middle value of the data (50^{th} percentile)
  - Q3: The median of the upper half of the data (75^{th} percentile)
  - Maximum: The highest value in the data set
- Students can continue to use technology to create the boxplot and histogram.

Deep Dive (65 minutes)

- Have students read the prompt in their Student Pages.

  A 2025 article from *TechRadar* breaks down how extra words in AI prompts, such as "please" and "thank you," increase the number of tokens the model must process—requiring more computation, more electricity, and more cooling, especially when scaled across millions of users. "Obviously, there's an energy cost when using ChatGPT, which has massive AI-powered servers that run the whole operation. But as these tools thrive in popularity, are most of us even aware that one simple message, or one AI-generated meme, is impacting the planet?"[3]

- Explain that when you interact with an AI model (like ChatGPT) and issue a sequence of queries, the energy cost is incurred for each query and response pair, not just the final one. Every time you send a query, the model runs through its inference pipeline by:
  - loading the model in memory (already running in most cases),
  - processing your input (including context window and history), and
  - generating a response token by token.
- Each inference run consumes energy proportional to:

[3] Disotto, J.-A. (2025, April 17). ChatGPT spends "tens of millions of dollars" on people saying "please" and "thank you," but Sam Altman says it's worth it. TechRadar.

  - length of your prompt (including any retained conversation history that is fed back with each query),
  - length of the model's response, and
  - size of the model and hardware efficiency.

- Students will complete the table based on their class data from the Engage activity. Here is an example:
  - Formula:
    - *Energy per query = (query tokens + response tokens) × (energy per token)*
    - *Assume 0.5 J per token. Round tokens to the nearest whole number.*

Query #	Query Words	Query Tokens	Response Words	Response Tokens	Total Tokens	Estimated Energy (J)
1	15	20	80	107	127	63.5
2	25	33	100	133	166	83
3	12	16	50	67	83	41.5
Total	52	69	230	307	376	188

- Students can compute how much energy their query used from the Engage activity.
- You can use the information below to prompt a class discussion.
  - Reasoning models, which explain their answers step by step, use significantly more energy than direct-answer models. One study estimated that answering 600,000 questions with a large reasoning model could emit as much CO_2 as a round-trip flight from London to New York. Electricity prices are climbing more than twice as fast as inflation and "power-hungry AI data centers are one factor that is driving those high prices."[4]
- You can prompt students' thinking with additional questions:
  - *What are the benefits of AI that might justify its energy use?*
  - *How does AI energy use compare to other technologies (e.g., cars, airplanes, streaming video)?*
  - *Should companies be required to disclose energy and emissions data?*

[4] Horsley, S. (2025). *Electricity prices are climbing more than twice as fast as inflation*. NPR.

  - *What could be done to make AI more sustainable?*

- As students explore complex issues like this one, it is important to help them recognize how math and data help us understand the world, and can lead us to action. Students can choose assessment activities to complete:
  - Create visualizations (e.g., graphs, infographics) to share their learning.
  - Write an op-ed explaining the cost/benefit of AI.
  - Design a classroom/school/community campaign for efficient AI querying.
  - Write a one-page policy recommendation for governments or companies to use AI responsibly.

Setting a Foundation

Section 8: What's in a Query

Engage

Use an AI tool to generate a response to an open-ended question. You can phrase your question however you think is best. You can revise your question and ask again, if necessary, but be sure that it is clear enough to get a helpful answer.

1. What is your question?

2. Did you revise the question? If so, how did you revise it?

3. Once you are satisfied with the answer, record how many words you used in your last question.

Analysis

In July 2025, OpenAI CEO Sam Altman claimed an "average ChatGPT query uses energy equal to about what an oven would use in a little over one second."[1] However, experts say the claim lacks key context, like what an "average" query even is. What is an average query? In 2025, the average length of a ChatGPT query was approximately 23 words.[2]

1. Do the results from your class data represent everyone in the school? The state? The nation? Explain your answer.

2. For the class data, find the mean, mode, median, and range.

3. Use technology to find the mean absolute deviation and standard deviation. What do they tell you?

4. Use technology to find the 5-number summary (minimum, Q1, median, Q3, maximum).

5. Create a boxplot of the data.

6. Show the data in a histogram.

[1] Chao, Z. (2025, July 2). How much energy does your AI prompt use? It depends. ScienceNews.

[2] Elad, B. (2025). ChatGPT statistics 2026: Usage figures, subscription trends & industry reach. SQ Magazine.

Deep Dive

> A 2025 article from *TechRadar* breaks down how extra words in AI prompts, such as "please" and "thank you," increase the number of tokens the model must process—requiring more computation, more electricity, and more cooling, especially when scaled across millions of users. "Obviously, there's an energy cost when using ChatGPT, which has massive AI-powered servers that run the whole operation. But as these tools thrive in popularity, are most of us even aware that one simple message, or one AI-generated meme, is impacting the planet?"[3]

Below is a step-by-step method and formula you can use to better understand energy usage.

- Number of tokens (words ≈ 0.75 times tokens) for each query
- Number of tokens in each response
- Approximate energy per token

Large Language Models (LLMs) consume about 0.3–1 joule (J) per token at inference time. Use the data from the Engage activity to estimate energy usage.

- Energy per query = (query tokens + response tokens) × (energy per token)
- Assume 0.5 J per token. Round tokens to the nearest whole number

Query #	Query Words	Query Tokens	Response Words	Response Tokens	Total Tokens	Estimated Energy (J)

[3] Disotto, J.-A. (2025, April 17). *ChatGPT spends "tens of millions of dollars" on people saying "please" and "thank you," but Sam Altman says it's worth it*. TechRadar.

Appendix 1A: List of Personal Questions[1]

- How many brothers or sisters do you have (if any)?
- What's your favorite food?
- Do you have a pet and, if so, what kind is it and what's its name and age?
- Who is your best friend?
- Who is your favorite relative?
- What month is your birthday?
- What are your favorite TV shows?
- What's your favorite ice cream flavor?
- What subject did you enjoy most at school?
- What was your easiest subject at school?
- What kind of car do you drive?
- What car would you want to own?
- What's your favorite book?
- If money were no object, where would you spend your next vacation?
- What did you like most about school?
- What gives you the most satisfaction from being a teacher?
- Did you always want to be a teacher and, if not, what other jobs have you had since college?
- If you could live anywhere in the world, where would it be and why?
- Whom do you admire most—someone living today or someone in history?
- If you could change one thing about yourself, what would it be?
- What one thing do you like most about yourself?
- What's the best thing that's happened to you in the past month/week?
- What's your favorite time of year?

[1] Special thanks to our Development Team members for contributing ideas for these questions.

- What kind of music do you listen to?
- What's your favorite song?
- What kind of pizza do you prefer?
- Do you like sports and, if so, which one and why?
- Which sports hero do you most admire and why?
- What's the worst vacation memory you have?
- If you won the lottery tomorrow, what would be the first thing you'd do?
- What qualities do you admire most in your best friend?
- Did you have a favorite toy when you were a child and, if so, what was it?
- What's the one thing you own that you treasure the most?

Appendix 1B: My Story Example

It had been at least 20 years since I'd been in a classroom environment, so I was understandably nervous about going back to school to pursue my Ph.D. My degree is in Educational Psychology and I discovered (only after I'd registered and was totally committed to the program) that each semester, I had to take at least one statistics course.

I'd never taken a statistics class before (and it was years since I'd done math), but it sounded fun and I knew it was going to be essential to my success in my new field. If I wanted to graduate, then there was no way I could avoid stats!

The first day of my first statistics class, the instructor walked in, turned on the projector, and began going through his slides. It all sounded like a foreign language to me. I looked around to see if anyone else looked as terrified as I felt, but everyone just had their heads down, taking notes.

I seriously questioned whether going back to school had been a good idea. I tried to take good notes, but because I didn't know what I was supposed to be doing, what information was most important, or how I was supposed to understand what the instructor was talking about, I felt completely lost. When the instructor was done, he simply shut off the projector, gathered his papers, and left the room. I didn't know any of the other students, and they seemed to know what they were doing. For the first time in my life, I felt completely helpless—and hopeless—but it was really important to me to get my degree.

After the shock subsided, I told myself I was going to pass that darned statistics class. I just needed to figure out how I was going to do it, especially since I wanted to do well on the first exam so I wouldn't fall behind. I also knew that doing poorly would be a blow to my self-confidence.

As luck would have it, one of my other courses was called Human Learning, and the assigned textbook was interesting. In fact, it's been the only book I've ever kept from my time at college; I still refer to it today. There were chapters that talked about things like self-regulated learning, goal setting, and lots of psychological terms like "attributions" and "self-efficacy." So, before doing anything else, I dug into that book.

I learned a lot of interesting things, such as success in college has very little to do with luck and a lot to do with effort and persistence. I couldn't do anything about the way the statistics instructor taught us—that was out of my control. But I knew that when I put my mind to it, when I carved out the time and really worked hard, I could get a passing grade.

One of the best discoveries about how the brain works is that our brains are "plastic." We used to think that intelligence was fixed and that you were either born smart—or you weren't. But that's been proven by scientists to be completely wrong. In fact, we can set ourselves up for success by thinking more positively, finding reasons for doing whatever we find hard, and adopting some key learning strategies. This knowledge helped convince me that my inability to get statistics was only temporary.

I made a choice then and there that I was going to ace that course . . . and that's exactly what I did.

Everything I learned that helped me be successful in my statistics courses and throughout my studies are things that you will have a chance to experience during this course. In a moment, you'll be able to see what those topics are when we go through the syllabus together and to talk about them in your small groups.

Let me end with the highlights of what I did to succeed at statistics:

- I made a **conscious choice** that I would not be a victim—just because the instructor was difficult didn't mean I would give up at the first hurdle! I determined instead to be a champion. I would succeed because it was my life and my career that was at stake, and I wasn't going to let anyone spoil that for me.
- I set some **ambitious goals** for myself, which meant a certain amount of sacrifice in terms of the time I dedicated to learning the material for this statistics course. I just kept my eye on the big picture: This course was just a small part of what was really important to me.
- I also figured out how to **work smarter** as well as harder. I learned what successful students do that unsuccessful students don't do—in particular, how to be a good learning advocate for myself. I went to see the instructor and the teaching assistant in office hours when I couldn't understand something; I faced on my challenges immediately, rather than letting them build up; I talked to other students who found statistics a lot easier than I did and asked if I could study with them; and I organized study groups and learned how to run them effectively so they didn't deteriorate into social events where no work got done.
- Perhaps the most important thing I learned was that **I wasn't alone.** Everyone looked as if they knew what they were doing, but we were all terrified. As I became friends with some of the other students, we found it helped to talk things through, ask each other questions, and actively take control of our learning.

I can't say I ever loved statistics—just like I'd never really warmed up to math when I took it in high school—but I knew it was an important means to an end for me, so that made it important for me to succeed. It's a bit like being at work: Sometimes you have to work with someone you don't especially like, but you know that you need to get along with that colleague in order to succeed at something that is important—like your job or the chance of getting promoted.

Statistics helped me get my degree and gave me a sense that although it's not a subject that I find easy or enjoyable, it's something I can be good at when I really try. That's the kind of experience I want for you and why we have designed this course to help you pass your math courses—not just the one you're currently registered for, but all the others you may need to take to get you through college and into the career you want.

Appendix 1C: Student Information Sheet

Personal

Full Name: _____

Current Address: _____

_____

_____

Ways to contact you (complete as applicable):

- Home phone: _____
- Cell phone: _____
- Work phone (give best hours to reach): _____
- Email: _____
- Other: _____

Do you work? Yes / No

- If Yes: Full time or Part-Time? _____
- How many hours? _____

What do you want to do after high school? _____

_____

_____

_____

_____

Course Specific

List the courses in which you are enrolled in this semester.

_____

What are you most hoping to gain from this course?

_____

_____

What grade do you intend to earn in this course? _____

What challenges could prevent you from earning your goal grade in this course?

_____

_____