BRIGHT-CS

DATA, DATA BO BETA

Data Science Project | Grade 6 | 3 – 5 Weeks

PROJECT OVERVIEW

FINAL PRODUCT
Students answer their own research questions by analyzing a publicly available data set and create a presentation of their findings.

TIMEFRAME
3-5 weeks

AGE GROUP
Grades 6-8

DRIVING QUESTION
"How can we explore data sets to answer interesting questions?"

PROJECT DESCRIPTION
Why "Data, Data Bo Beta"?

Emerging at the intersection of computer science (CS), statistics and business, **data science** is not only a rapidly growing field, but a natural CS entry point for curious young people. Driven by their own questions, with just the mathematical concepts they've already learned by sixth grade, students can use widely available software to glean intriguing insights hidden inside the reams of data collected on everything from sports, to music, to social media usage, and beyond.

HOW DOES THIS PROJECT DEVELOP INDEPENDENT LEARNERS IN STEM+CS?

All learners depend on adults at first. To persist in STEM+CS, they must "learn how to learn." Experiences that develop the habits of mind needed to take charge of one's own learning are less often provided to culturally and linguistically diverse students (Hammond, 2015). This project helps educators put all students on-course to becoming independent learners in STEM+CS.

LEADS TO A MEANINGFUL PRODUCT

The first step to independence is engagement. Disconnected exercises that don't culminate in a real-life product are less likely to inspire thoughtful participation than lessons where students apply knowledge and skills to make something meaningful. The more likely they are to use the final product in their own lives, the more motivated they'll be to finish. And, when the product uses coding, they'll end up with authentic proof that "I can" do computer science. The resulting sense of efficacy can inspire even more engagement.

ALLOWS FOR PRODUCTIVE STRUGGLE

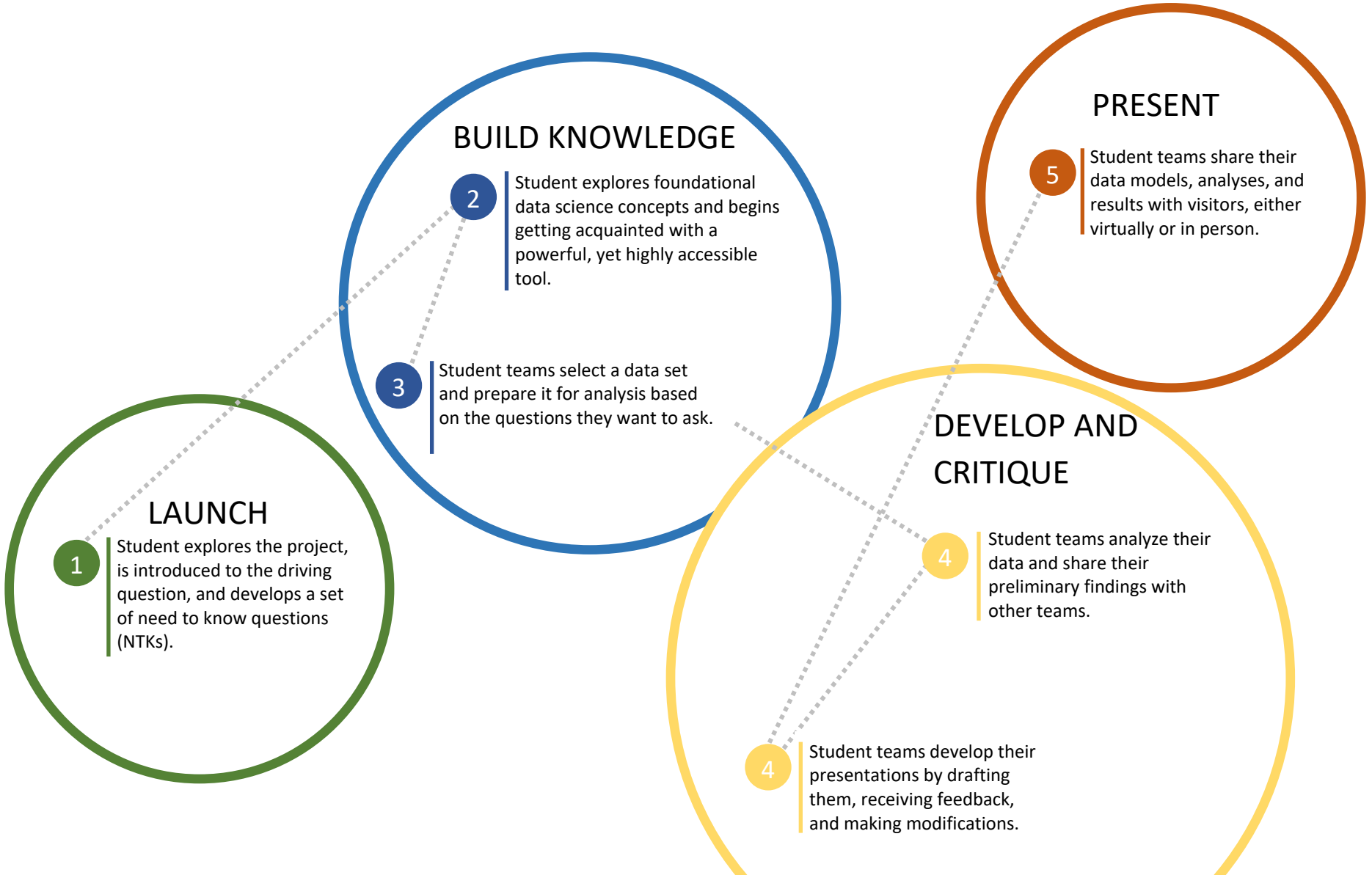
Independent learners have developed strategies for tackling new challenges (Hammond, 2015). How? They tell us that in STEM+CS, the process of trial and error is key (Yamaguchi et al., 2021a). Unlike mindless application of teacher procedures, struggling to figure out mistakes ("bugs"), or make improvements themselves helps them not only see what strategies work, but really understand why. Of course, productive struggle takes time. A good project is paced to include multiple chances to make, reflect on, and resolve errors--from prototyping and debugging, to user-testing one's product and iterating, to practicing and honing a final presentation.

HELPS EDUCATORS CREATE CONDITIONS FOR SUCCESS

Struggling with challenges on its own is not enough to produce learning. Dependent learners are prone to drop back and let peers take over; even independent learners may shy from making valuable errors when others are watching (Yamaguchi et al., 2021a & 2021b). Educators create the conditions for success by providing the right inputs, feedback and encouragement to help students embrace difficulties and break through. From strategically placing cognitive burden on students, to methods of building positive attitudes about mistakes, to providing prompts that let students get *themselves* unstuck, the "teaching tips" in this document help set up learners for mastering challenging tasks--the experience likeliest to make an impact on their future independence.

PROJECT PATH AND MILESTONES

The Data, Data Bo Beta project begins with a launch and ends when students formally reflect on their experience after presenting their final products. A bird's eye view of the project's path and milestones is provided below and visually summarizes how students will navigate from start to finish. A more in-depth presentation of student tasks follows on the next page.



PROJECT MILESTONES AND STEPPING STONES

Milestone #1: Student explores the project, is introduced to the driving question, and develops a set of need to know questions (NTKs).

Milestone #2: Student explores foundational data science concepts and begins getting acquainted with a powerful, yet highly accessible tool.

ENTRY EVENT	PREVIEW THE PROJECT	EXPLORE THE DRIVING QUESTION	WHAT IS DATA SCIENCE?	GETTING ACQUAINTED WITH EXCEL
Student learns what data science is and how they can use it to study phenomena that interest them and make novel discoveries.	Student is introduced to expectations for the final product: selecting a data set, defining a set of questions to ask, analyzing the data, and presenting their findings.	Student explores the question, "How can we explore data sets to answer interesting questions?" takes a brief survey [to support a later discussion about data], and develops a set of need to know questions (NTKs).	Student rounds out the NTKs and leverages them to discuss baseline data science skills.	Student gets acquainted with the data science functionality of Excel by exploring a test data set.

Milestone #3: Student teams select a data set and prepare it for analysis based on the questions they want to ask.

Milestone #4: Student teams analyze their data and share their preliminary findings with other teams.

IDEATE AND EVALUATE	PRE-PROCESS DATA	ANALYZE THE DATA	CRITIQUE DATA ANALYSIS	PLAN FOR FUTURE WORK
Student teams brainstorm which data set they want to perform analysis on and the four questions they want to ask.	Student teams will prepare and clean the data for analysis.	Student teams work together to analyze the data set they chose and develop preliminary answers to their questions.	Team members rotate to review the questions asked along with preliminary results and provide feedback.	Student teams perform additional analysis based on input from other teams. They also identify a new data set to explore and key questions.

Milestone #4: Student teams develop their presentations by drafting them, receiving feedback, and making modifications.

Milestone #5: Student teams share their data models, analyses, and results with visitors, either virtually or in person.

DRAFT AND PRACTICE	INCORPORATE FEEDBACK	PREPARE	PRESENT	REFLECT
Student teams draft their presentations and practice in front of other teams.	Student improves their presentations based on feedback received by other teams and present to visitors to gain more feedback.	Student teams incorporate feedback received from visitors and make final preparations for presenting their projects.	Student teams present their data models and results to experts either virtually or in person.	Student and teacher reflect on their original NTKs and their current understandings.

LAUNCH – introduce students to the project and get them excited about it.

BUILD KNOWLEDGE – provide the baseline knowledge, activate the baseline skill necessary to complete the project, and allow students to build their plan.

DEVELOP AND CRITIQUE – allow students to implement their plan and provide opportunities for them to receive feedback from their peers.

PRESENT – allow students to develop and deliver presentations for an audience outside of their teacher/peers.

GETTING STARTED

Where

This project is appropriate for any setting, from a core STEM class, to an elective course in computing, to a homeroom, extracurricular club, or camp. Educators do not need to be experts in computing to lead it. All of the content knowledge and skills necessary to complete the project are outlined in linked PowerPoint presentations and other resources that are freely available on the web. We do, however, recommend that educators take time to familiarize themselves with these resources, and even attempt to complete the project on their own first. The experience of creating one's own computing product can provide valuable insight for supporting students through the process.

Who

Student recruitment is an important consideration for educators seeking to engage diverse students in this project, particularly when planning to teach it as part of an elective course, club, camp, or other setting outside a core STEM class. Relying on interested students to identify themselves may result in missing out on some who could develop an interest if only for the right kinds of outreach. Effective recruitment methods include: 1) asking influential adults (such as parents of, and school staff popular among, culturally and linguistically diverse students) to personally invite students to participate; 2) organizing recruitment sessions to show students a finished exemplar of the final product they will create; and 3) asking attendees to bring a friend to the sessions with them.

It's also worth considering how to ensure a diversity of prior CS skills and experiences among your students. Research suggests that among culturally and linguistically diverse students, both dependent and independent learners find it helpful to work with like peers at different levels of skill (Yamaguchi et al., 2021b). That's because peers with more skill allow students to seek support and experience perspectives on the material beyond what their teacher can provide alone; peers with less skill offer students the opportunity to build confidence by explaining the material to others. Since there may be few culturally/linguistically diverse students in any given grade level, and particularly few diverse students of the same gender, it could be worth recruiting across different grade levels--even different schools--to create a cohort where diverse students can find a number of peers like them who also bring different skills and experiences to the table.

When and What

After recruiting a cohort of diverse students, survey them to see which potential meeting times work best (assuming you are teaching the project as part of an extracurricular club or camp). Then secure the necessary hardware. While all of the software recommended for this project is freely available on the web, students will need access to individual, internet-enabled devices (preferably laptops) during each session of the class, club, or camp. Consider what existing devices may already be available to students, whether through school issue, computer labs, local public libraries, or other facilities.

END STATE

More than completing a final product, this project is about helping students develop the academic, cognitive, and social-emotional tools they need to take charge of and propel their own learning in STEM+CS. But what does that really look like? How can you tell which students haven't yet had experiences to develop those tools, in order to better support them? And what does it look like when you've done your job to coach them towards greater independence?

BASED ON RESEARCH (Hammond, 2015; Yamaguchi et al., 2021a):

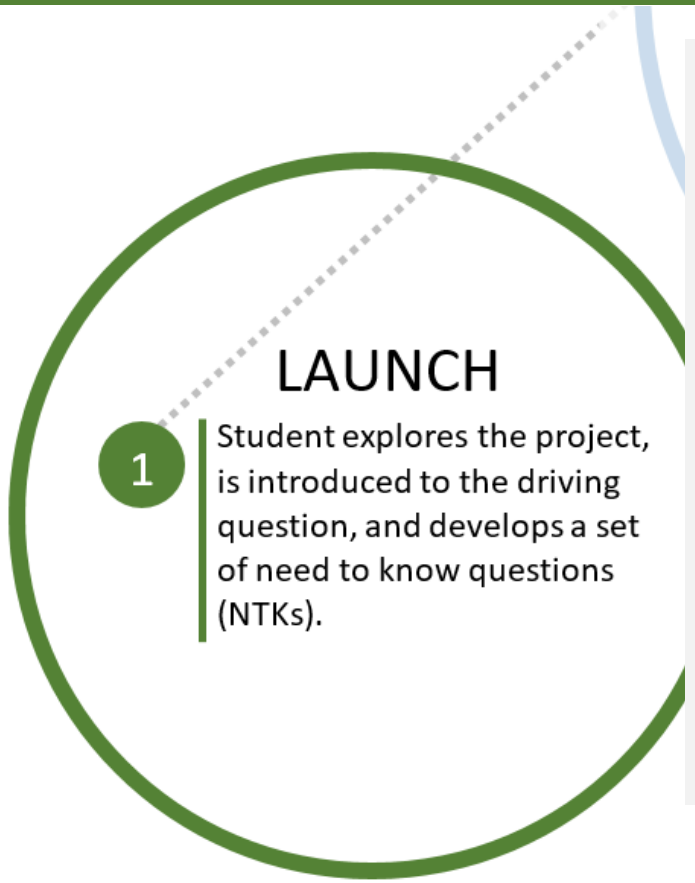
Dependent learners...		**Independent learners...**
• **Often think mastery means being able to name and remember procedures for completing a task** (i.e., rote learning) • **May engage when asked to reproduce teacher-modeled skills/knowledge with minimal cognitive effort** (e.g., answering simple recall questions, copying a teacher's steps) • **Stop engaging when challenged to "figure out" new content themselves** Zaretta Hammond (2015) calls this "depend[ing] on the teacher to carry most of the cognitive load of a task."	***Acquiring new skills and knowledge***	• **Usually appreciate that mastery means knowing *why or how* "it works"** (i.e., conceptual understanding) • **Often prefer to jump in and "figure out" new skills/knowledge after minimal instruction** (e.g., through trial and error). Hammond (2015) calls this "rel[ying] on teacher to carry some of the cognitive load temporarily."
• **Tend to engage less on aspects of their project that challenge them to develop new skills in STEM+CS** (e.g., coding) **than in aspects where they already have skill** (e.g., visual presentation) • **When working in groups, sometimes avoid performing tasks requiring new STEM+CS skills**, allowing others to carry the cognitive load • **Sometimes declare their work "finished" before it reaches their original goal**, when further improvements would require pursuing skills or knowledge beyond those provided by teacher	***Managing independent work time***	• **Tend to spend more time on aspects of their project that require new skills in STEM+CS** • **Are likelier to continue working on their products when there are still improvements to be made,** even if those improvements require pursuing skills or knowledge beyond those provided by teacher
• **When running into challenges in their work, are more likely to get "unstuck" by receiving help from a teacher** than to use any other strategies	***Getting "unstuck"***	• **Are less likely than dependent learners to ask their teacher for help and more likely to try other strategies for getting "unstuck,"** such as creating a plan of attack, rereading materials provided, conducting their own research, tackling easy parts first, or using trial and error

MILESTONE #1: LAUNCHING INQUIRY

As the entryway into Data, Data Bo Beta!, this milestone is designed to fuel the interests, excitement, and creative curiosities of students and provide the support they need to be ready for and invested in the process ahead of them. Specifically in Milestone #1, students begin having foundational discussions and participating in activities that will set them on a path to answer the driving question:

"How can we explore data sets to answer interesting questions?"

Milestone #1 ignites an inquiry cycle that will ultimately be shaped by students' own creative curiosities and directed by an evolving list of need to know (NTK) questions that they must define and address in order to make progress. Since NTKs can help students be more mindful about the concept or ideas, they will explore, it is important to encourage this process and help students to see the value in it. This might include anticipating students' questions in advance and structuring the lesson accordingly. It might also mean being flexible to NTKs as they arise and ensuring that students have a safe space to tap into and explore their curiosity. For this project, Data, Data Bo Beta, students' NTKs may relate to the role of a data scientist, the data analysis process, and data analysis tools in the context of data set they are interested in exploring. Although you may be able to predict a large majority of NTKs in advance, students will likely venture into unanticipated territory, generating questions that are unique, unexpected, and novel. Helping students value this **creative curiosity** and understand how to channel it would be a significant outcome of this project.



STEPPING STONES

ENTRY EVENT

Student learns what data science is and how they can use it to study phenomena that interests them and make novel discoveries.

PREVIEW THE PROJECT

Student is introduced to expectations for the final product: selecting a data set, defining a set of questions to ask, analyzing the data, and presenting their findings.

THE DRIVING QUESTION

Student explores the question, "How can we explore data sets to answer interesting questions?", takes a brief survey [to support a later discussion about data], and develops a set of need to know questions (NTKs).

RESOURCES

PROJECT SUPPORT

- Slide Deck: Milestone 1

ARTICLES

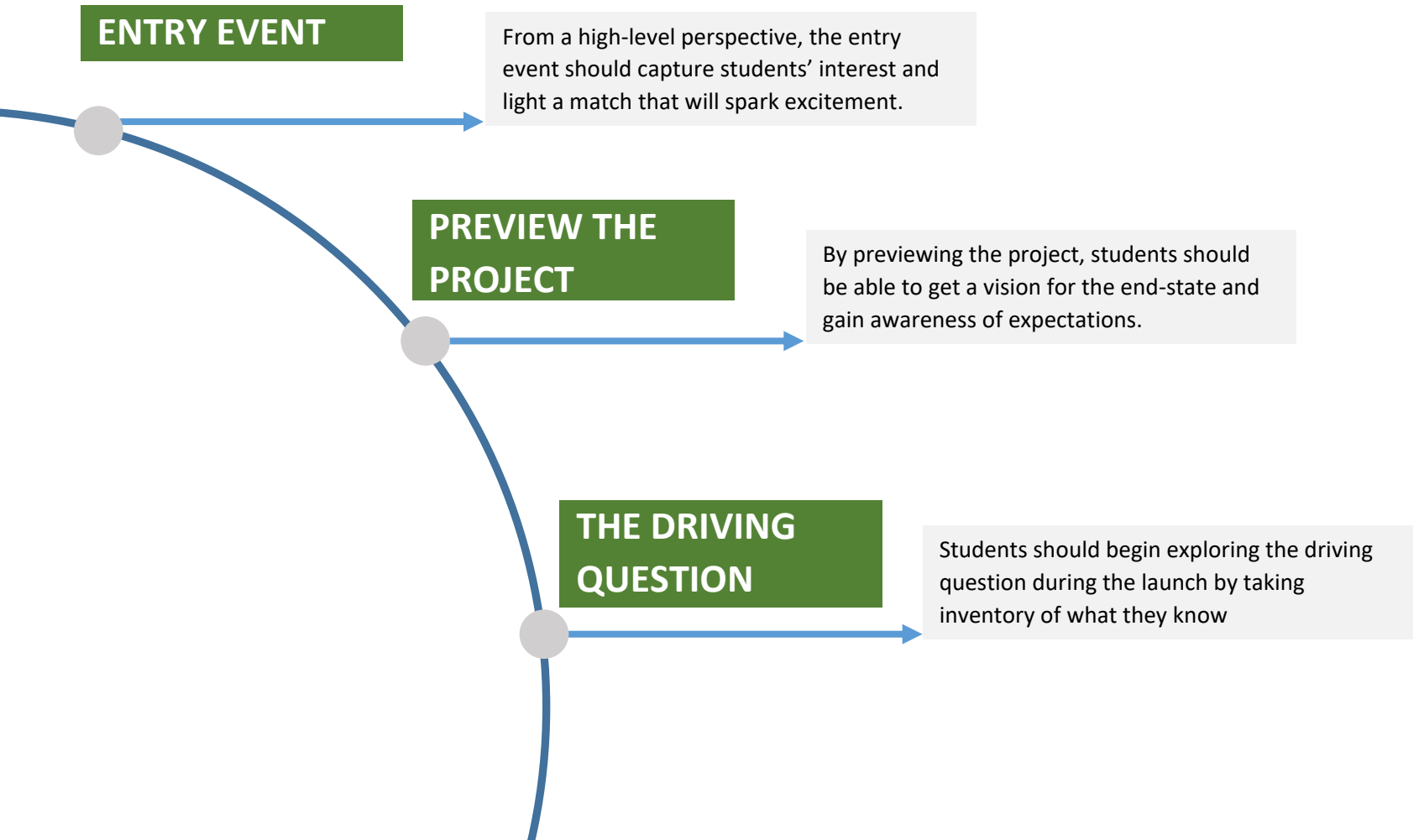
- Skills Needed For Data Scientists
- Introduction to Data Science
- The Data Science Education Revolution
- Freakonomics: K-12 Data Literacy
- Data Science in a Box
- Using Data in the Classroom
- Resources to Teach and Learn Data Science in High School

VIDEOS

- Data Science in 5 Minutes
- 5 Reasons Why I Love Being a Data Scientist
- What Kind of Math Do You Need to Be a Data Scientist?
- How I Would Learn Data Science (If I Had to Start Over)
- The Most Important Skills for Data Scientists

DESIGNING AND EXECUTING THE LAUNCH

Designed and executed carefully, Milestone #1 provides an opportunity to pique students' curiosity, encourage discussion, and help participants start building confidence that they are capable of success in open-ended problem solving in general and data science in particular. The accompanying slide deck provides one way to execute the launch; the text below provides more context about what each component of the launch is to accomplish. In general, the key is to introduce and emphasize the decision-making, planning, and end-product development process in an engaging way. The remainder of this document provides more detailed insight into the launch components, desired outcomes, and insight into how you might implement each *component* to achieve critical *outcomes*.



NEED TO KNOW (NTK) PREPERATION

By developing, exploring, and tracking their NTKs during this project, students will not only be more mindful of their curiosities but they will also see how questions evolve and resolve as time goes on. Understanding how to navigate this process is a valuable skill and nurturing this skill will be helpful to students in this project and beyond.

The NTK process is essential to the project. It helps students activate their prior knowledge and be more mindful of the questions they have as a way to guide how they explore the driving question. Given the nature of this project, students are likely to have high-level NTKs about data science and data analysis in Milestone #1. Potential questions are listed below.

GENERAL DATA SCIENCE QUESTIONS

- What do data scientists do?
- Is data science 'hard' and if so how?
- What data analysis processes are used in data science?
- What skills do you need to be a data scientist? What can you do to develop those skills (e.g., training, education, etc.)?

DATA SCIENCE QUESTIONS SPECIFIC TO THIS PROJECT

- Are there different types of data?
- What kind of data will we be analyzing?
- What kinds of questions should we be asking (to motivate data analysis)?
- What tools will we be using to do data analysis?
- Will we be doing any coding?
- Will we be picking the data sets?
- Will we have to do anything to the data sets prior to analysis?

SAMPLE LAUNCH: STUDENT VIEW

LESSON LAUNCH

THE ENTRY EVENT

A key aspect of the electronic age is the ability to capture and store large amounts of data. Hidden in that data: answers about critical patterns, outliers, and average phenomena that can help us gain a better understanding of the world around us and the people in it. Data science helps us unearth the answers to those questions and, in a cycle, helps us to shape new questions and continue to explore. These skills are not only exciting, they can also be quite lucrative! This project is designed to help you start learning about data science and acquiring/strengthening those critical, foundational skills.

Quick Tip!

From the start of your first lesson, students will begin assessing their interest level in what you'll teach and the work you'll ask them to do. This often influences how much effort they put in later, or even--if the experience is optional (as with an afterschool or summer program)--whether they return for the next session. So it's important to consider how you'll ensure that students leave Milestone 1 excited to come back and roll up their sleeves.

INVESTIGATE

PREVIEW PROJECT EXPECTATIONS

Your project is to select a data set, pose integral questions, identify the answers to those questions via data analysis, and then present your findings. Over the course of the project, you will become deeply acquainted with the data science process. Your final product will be (1) a discussion of your process from start to finish, (2) your findings and their implications, (3) and a presentation that captures both. The audience for your final presentation will be a group of visitors. However, you will present to your peers in the interim to get practice and feedback.

After exploring the specifications and expectations for the project (via the Student Planning Sheet and the Rubric) you will complete an activity based on the **This Session Will Be a Success If…** framework to start thinking about what you would like to learn/accomplish as a result of this project.

Build interest in the final product

The more meaningful the final product to students, the more likely they are to stay engaged. For both dependent *and* independent learners, a meaningful product is one that feels relevant to their lives. Do they have a personal use for it? As early as possible, make sure that students are clear on what their final product could look like and help them to imagine how the product could be useful to them right here where they live, right now at this age.

INVESTIGATE (CONT'D)

EXPLORING THE DRIVING QUESTION

"How can we explore data sets to answer interesting questions?"

INITIATING THE NEED TO KNOW PROCESS

Drawing from the discussions you've just had, let's organize our shared knowledge. What is your perception of the data analysis process? What do you need to learn in order to carry out that process? What questions do you have about what you need to have or know in order to complete the process?

Additionally, professionals who leverage data to ask and answer critical questions are called data scientists. Have you heard of this occupation before? What do you think you need to know or learn in order to be a "real" data scientists?

SYNTHESIZE AND REFLECT

CLOSING THE LAUNCH

Review the Student Planning Sheet and use the appropriate space to write down each of the key decisions you and your partner made about which data set you want to explore, the questions you want to ask, and an overview of the reasons why you made your choices (so you can review them later).

Once you and your partner have discussed your options and identified a preliminary plan, provide your instructor with the following:

- The make-up of your team (student names)
- The data set you will explore
- Your initial list of questions

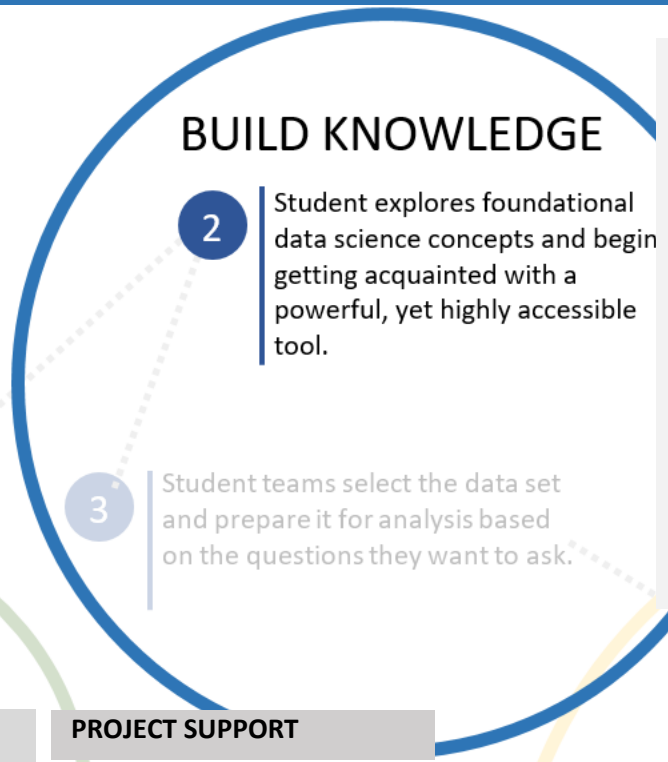
Pair students with intention and build relationships

The minute students learn they'll be working in pairs, they start worrying about who their partner will be. In STEM especially, it's important for girls and culturally/linguistically diverse students to have the chance to work alongside others like them, which may reduce stressors like stereotype threat and more. This could mean allowing students to choose partners who they already know, but it could also mean assigning pairs and giving tasks that build trust between partners early in the process. Positive working relationships with others in the class can not only support students to begin taking academic risks in front of their peers, but can also become an important reason for students to keep showing up to class.

MILESTONE #2: DATA SCIENCE INTRODUCTION

This milestone immerses students in the role of a data scientist, helps students explore key skills/approaches they will need in the rest of the project, and aims to expand awareness of data science - as a career - in a way that is both tangible and appealing. In addition, it provides baseline exposure to the use of Microsoft Excel as a tool for data science. Overall, this milestone is designed to stoke interest for students and to help them use tools that are at their fingertips to explore data science now and in the future.

Understanding basic ideas about data collection, storage, and analysis are critical to data science. The goal of this milestone is to help students learn about each and apply baseline skills in a hands-on way that allows them to build the appropriate knowledge, make mistakes, ask questions, gain exposure/familiarity, and ultimately be prepared to conduct data activities independently (in both the short- and long-term).



STEPPING STONES

WHAT IS DATA SCIENCE?

Students round out the NTKs and leverage them to discuss baseline data science knowledge and skills.

GETTING ACQUAINTED WITH MICROSOFT EXCEL

Student gets acquainted with the data science functionality of Excel by exploring a test data set.

RESOURCES

PROJECT SUPPORT

- Slides: What is Data Science
- Slides: Getting Acquainted with Microsoft Excel

VIDEOS

- Introduction to Data Science
- Resources for Teaching K-12 Statistics
- Data Analytics In Excel - Full Course
- Microsoft Excel Tutorial for Beginners: Full Course
- A Day In the Life of a Data Scientist
- Business Intelligence Analyst Career Video

ARTICLES

- Ways to Represent Data - 6th Grade
- Excel for Data Science?
- Occupational Outlook: Data Scientists
- Skills Needed For Data Scientists
- Careers in Data Science

ACTIVITIES

- Jot Thoughts
- KWHL Chart
- K.I.M.S.
- Fist To Five
- Tell Me Everything
- GUS Method
- What? So What? Now What?

STEPPING STONES TO DATA SCIENCE INTRODUCTION

Build students' muscle for independent research

Independent learners tell us that one strategy they use for tackling challenges in their work is to conduct research. But to track down the knowledge or skills they need, students must learn to articulate what their specific questions are (*What now?* doesn't count!), then practice searching out answers among the endless resources available online. Give students a chance to flex this muscle by offering the linked texts and videos as a starting place to explore their NTKs. Then, in the likely case they still have unanswered questions, encourage them to go further by asking your own questions to spur reasoning about what to do next (e.g., "What search terms might you try?"). This can produce greater independence in the long run than simply telling them what steps you'd take or, worse, what the answers are.

	1. WHAT IS DATA SCIENCE?
Standards	CCSS.ELA-LITERACY.L.6.4; CCSS.ELA-LITERACY.SL.6.1.C; CCSS.ELA-LITERACY.SL.6.1.D; CCSS.MATH.CONTENT.6.SP.A.2;
Accompanying Slides	• Slides: What is Data Science
Students will be able to....	Expand/address their list of NTKs by discussing basic ideas about data science (both as a process and a career) and identifying key terms/concepts they will need to either (1) define or (2) get more information about in order to move forward (leveraging the K.I.M.S. approach).
Ideas for activities	• Help students understand the world of data science and provide the baseline, tool-independent knowledge necessary to conceptualize the data science process via an interactive presentation that encourages group discussion via questions. The discussion should begin with a review of the NTKs (to keep them front of mind) and focus on the following: ○ **Creative curiosity** and NTKs are important as students navigate the project. ○ Data science is a process of leveraging pieces of information as clues that can answer larger questions about patterns, correlations, outliers, and averages (among other things). ○ There are many tools that are used in Data Science. Excel is one of many but it is powerful and probably already installed on the computers students use. ○ Data Scientists use a variety of skills; discussing these skills can help students prepare for the project and discussing their earning potential can help to engender interest in the profession. Towards the end of this discussion, review students' NTKs and specifically identify which ones have been covered to date and how. Ask students to choose one unanswered NTK and try to research the answer to it. • **Suggestion**: have students keep track of new words and concepts they learn during this process for later reflection leveraging the K.I.M.S. approach.
Reflection and Synthesis Prompts	• What aspects of data science are interesting to you? • What responsibilities and tasks of a data scientist fit your skills and interests? Why? • What aspects of data science appear to be the most difficult? Easiest?

Formative Assessment Ideas	● Fist To Five ● Tell Me Everything ● Leveraging the GUS Method, have students explain, in their own words, what they think creative curiosity is, why it's important, and whether/when they have used it in other contexts.
Suggestions for Feedback and Support	● Leveraging the K.I.M.S. approach, have a flowing dialog with students about the new vocabulary the've been exposed to and ideas they've learned as a result of the "**WHAT IS DATA SCIENCE?**" module. ○ Have students discuss how they feel about working on an open-ended project, where the answers are not known in advance with the attention of heightening their confidence in the process.

STEPPING STONES TO DATA SCIENCE INTRODUCTION

Resist carrying all of the cognitive burden for students

As educators, it's tempting to break new skills into steps we can model while students follow along. But this can lead students to reproduce our steps passively with little mental effort, limiting their understanding and eliminating a chance to develop habits of mind for tackling new challenges independently. Instead, explain the Excel functions in the slide deck by projecting the dataset "Calculus Test Scores" and applying them as students watch--*without* letting them copy you. Run through all the functions in five minutes or less, then set students loose in pairs to try using the functions on the dataset you generated with the class survey in Milestone #1. Give them a copy of the slides for reference, and if they ask for help recreating the processes you modeled, encourage them to consult the relevant slides and embedded Support links in order to try by themselves first.

	2. PRE-PROCESS DATA
Standards	CCSS.ELA-LITERACY.L.6.4; CCSS.ELA-LITERACY.SL.6.1.C; CCSS.ELA-LITERACY.SL.6.1.D; CCSS.MATH.CONTENT.6.SP.A.2; CCSS.MATH.CONTENT.6.EE.B.6; CCSS.ELA-LITERACY.WHST.6-8.8
Accompanying Slides	• Slides: Getting Acquainted with Microsoft Excel
Students will be able to....	Continue to actively resolve NTKs and apply baseline data science knowledge leveraging Microsoft Excel. In effect, Excel will be used to apply the concepts introduced in the "**WHAT IS DATA SCIENCE?**" module in an actual analytic environment.

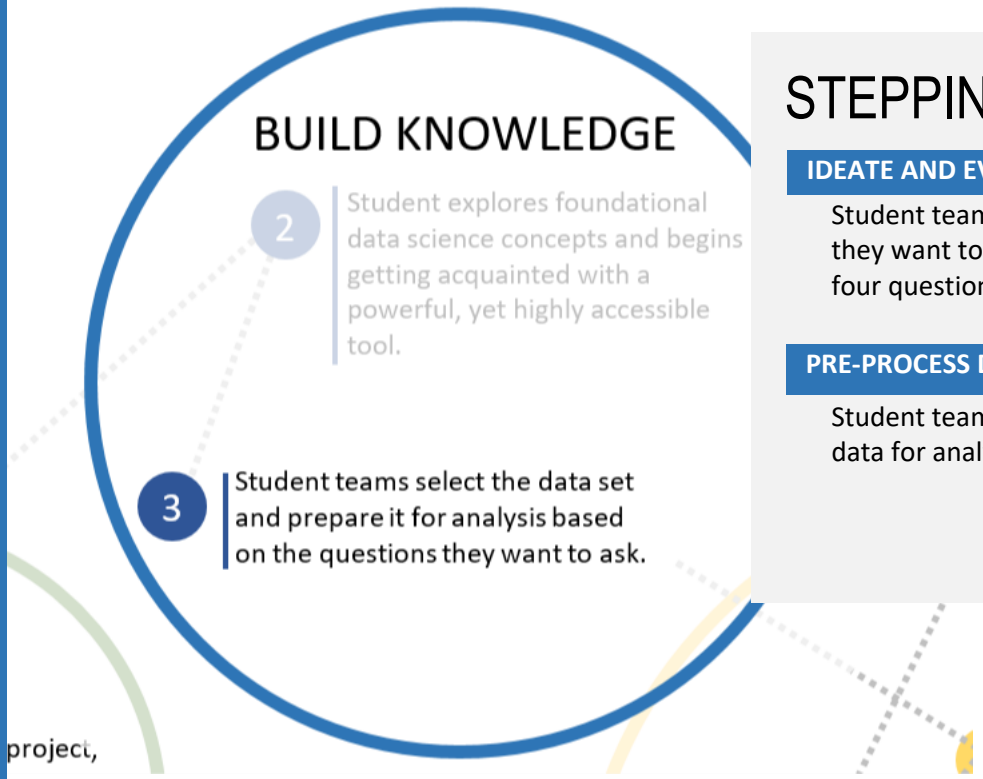
Ideas for activities	• Actively/iteratively discuss and apply key data science concepts by having students start Microsoft Excel, load the data set they contributed to in Milestone #1, and walk-through its analysis. Use the context of the "**WHAT IS DATA SCIENCE?**" module to introduce this topic as follows:
	  ○ Discuss that Excel is one of many tools that can be used for data science, provide an overview of its pros and cons.
	  ○ Discuss other types of tools used for data science/analytics to provide an awareness of what professionals are using.

Reflection and Synthesis Prompts	• What factors about Microsoft Excel are hard to grasp? • What are your impressions of the Excel environment? Is it easy to use? Hard? • Does working in Excel change your opinion of the kind of data you want to analyze? If so, why?
Formative Assessment Ideas	• Ask students a question about a data set and have them tell you the process they would need to complete in Excel to answer the question. • What? So What? Now What?
Suggestions for Feedback and Support	• Make sure students are following the lesson and understand the important concepts they'll need in order to begin analyzing data for their project in Milestone 3. • Have students revisit their NTKs at this juncture, discuss what they have recently been able to answer, and what they still need to know. • Leverage the KWL worksheet to further review what has been learned so far and figure out how it can be applied toward the project.

MILESTONE #3: IDEATION AND DATA PREPARATION

This milestone immerses students in the data selection and formatting processes that are necessary precursors for data analysis.

Given that this is a team activity that thrives on creativity, collaboration and ideation are inherent parts of this milestone as well, and will allow students to exercise and strengthen soft skills in the process.



STEPPING STONES

IDEATE AND EVALUATE

Student teams brainstorm which data set they want to perform analysis on and the four questions they want to ask.

PRE-PROCESS DATA

Student teams will prepare and clean the data for analysis.

RESOURCES

PROJECT SUPPORT

- Project Specifications
- Data Set Overview

VIDEOS

- Data Preprocessing: Steps and Considerations
- Excel Crash Course - Data Cleaning in Excel
- Pre-Modeling: Data Preprocessing and Feature Exploration in Python (advanced)

ACTIVITIES

- Think-Pair-Share
- Exit Tickets
- Points of Most Significance
- Two Stars and a Wish

STEPPING STONES TO IDEATION AND DATA PREPARATION

Set expectations for partner work

When partners bring different levels of independence to their work, it's common for more independent learners to take over the cognitive burden, while dependent ones sit back or focus on aspects of the project that don't require them to practice the new skills it seeks to teach. Now is the time not only to set expectations that partners share the work equally, with each student getting the chance to attempt new STEM skills (particularly coding) individually--but also to emphasize why it's important. Use the Project Rubric provided in Milestone 1 to lead a class discussion where students develop "pair work norms" to ensure *each* partner gets to demonstrate *all* of the competencies outlined in the rubric.

	1. IDEATE AND EVALUATE
Standards	CCSS.ELA-LITERACY.CCRA.SL.1; CCSS.ELA-LITERACY.SL.6.1.A; CCSS.ELA-LITERACY.SL.6.1.B; CCSS.ELA-LITERACY.SL.6.1.C; CCSS.ELA-LITERACY.SL.6.1.D; CCSS.ELA-LITERACY.WHST.6-8.2.D; CCSS.ELA-LITERACY.WHST.6-8.7; CCSS.ELA-LITERACY.WHST.6-8.8; CCSS.MATH.CONTENT.6.SP.A.2; CCSS.MATH.CONTENT.6.EE.B.6; NGSS.MS-ETS1-1; NGSS.MS-ETS1-2;
Students will be able to....	Begin finalizing the process of selecting what data set they will work with, the rationale for their selection, and the questions they want to answer.
Ideas for activities	• Provide students with the project specifications and an overview of the available data sets. • Allow students to connect with their partner briefly to determine if they want to choose a different data set and have them make a final selection. • Next, have students work independently to revisit the questions they planned to ask early in the project; have them update the list then reconvene with their partner to identify a final list of four questions they would like to answer given the data set they selected. Leverage the Think-Pair-Share framework for this activity.
Reflection and Synthesis Prompts	• Did you and/or your teammate change your mind about the data set you wanted to work with after doing the data science exercise? If so, why? • How did you and your teammate decide which questions to ask? • How, if at all, did your question list evolve over time and what contributed to the evolution.
Formative Assessment Ideas	Apply an Exit Ticket idea with the goal of understanding how students are processing their experience so far.

Suggestions for Feedback and Support	• Have students share their decisions for the following and talk them through how, if at all, their plans should be modified:
	  ○ the raw data set they plan to use in the project,
	  ○ The questions they plan to answer via data analysis, and
	  ○ their hypothesis for the results of their data analysis.

STEPPING STONES TO IDEATION AND DATA PREPARATION

Pose students' questions and problems back to the class

As students begin tackling more technical aspects of their project, it's likely they'll have questions or run into problems. A key skill of independent learners is being able to get themselves "unstuck" using strategies besides just asking the teacher how. Take this opportunity to add to students' strategies for getting unstuck, by challenging the whole class to reason through ways to resolve individual pairs' questions or problems. As students discuss, make observations about the problem or ask your own questions to prompt student thinking about the underlying concepts. This approach also has the added benefit of helping to normalize experiences of difficulty as a regular part of the learning process.

	2. PRE-PROCESS DATA
Standards	CCSS.ELA-LITERACY.CCRA.SL.1; CCSS.ELA-LITERACY.SL.6.1.A; CCSS.ELA-LITERACY.SL.6.1.B; CCSS.ELA-LITERACY.SL.6.1.C; CCSS.ELA-LITERACY.SL.6.1.D; CCSS.ELA-LITERACY.SL.6.4; CCSS.ELA-LITERACY.WHST.6-8.2.D; CCSS.ELA-LITERACY.WHST.6-8.5; CCSS.ELA-LITERACY.WHST.6-8.8; CCSS.MATH.CONTENT.6.SP.A.2; CCSS.MATH.CONTENT.6.EE.B.6; NGSS.MS-ETS1-1; NGSS.MS-ETS1-2;
Students will be able to....	Clean, format, and prepare the selected data set for analysis.

Ideas for activities	• Have students review the data set and discuss how, if at all, they need to pre-process the data in advance of the analysis step.
	• Have students present the following to the class in a class-wide discussion:
	  ○ Which data set they selected and why
	  ○ The questions they plan to ask
	  ○ The extent to which they have to pre-process the data and their plan for completing that step.

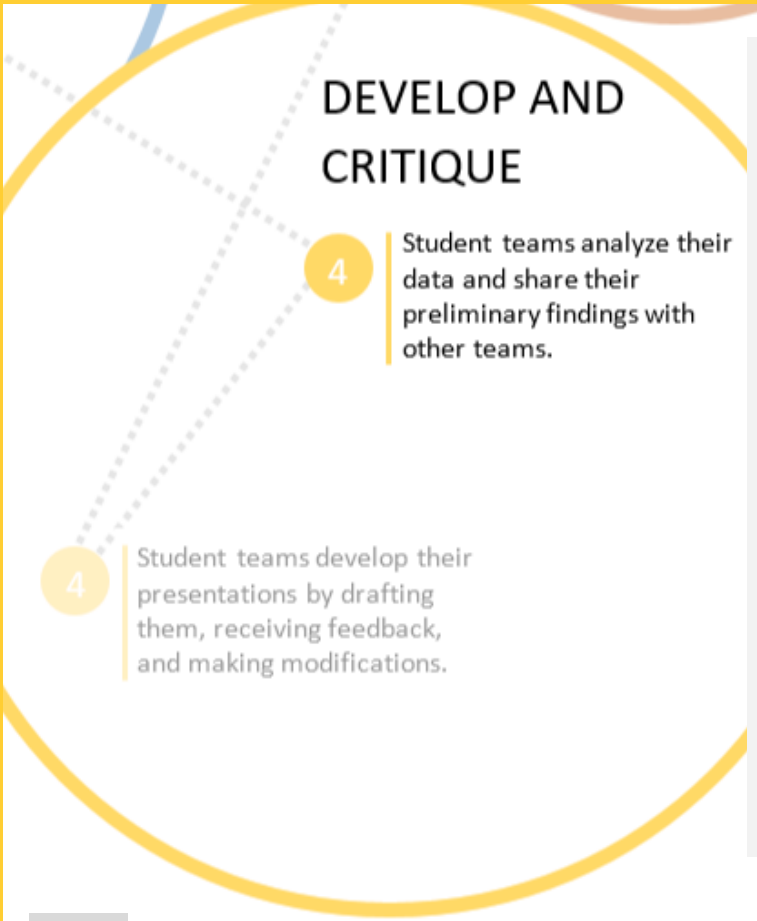
Reflection and Synthesis Prompts	• Revisit your NTKs:
	  ○ How many have you been able to answer so far?
	  ○ Do you need to do more research to round out any of the answers you have so far?
	  ○ Of the NTKs that have not been answered, when do you think you will be able to answer them?
	  ○ Are any of the NTKs beyond the scope of this project?
	• Leverage the points of most significance framework to help students bring key aspects about the process to date front of mind.

Formative Assessment Ideas	• Ask students to discuss the need to pre-process data in advance of data analysis. • Have students submit an overview of the skills they think they've learned since the start of the project and those they think they've improved since the beginning of the project. • Have students also anticipate what other skills they may learn/strengthen in the rest of the project. • Apply one or both of Leverage the two stars and a wish approach to assess how students are characterizing their progress made to date and the opportunities they have for improving. • Have students complete the tweet up exercise and submit their results.

Suggestions for Feedback and Support	● If students have trouble understanding the need to clean data, have them review the video "Excel Crash Course - Data Cleaning in Excel" (this is addressed starting at timestamp **2:29** and ends at timestamp **3:56**; the rest of the video can also be used to show students cleaning techniques.)

MILESTONE #4: DATA ANALYSIS

The goal of this milestone is to have students apply the data science and analytic skills they developed/refined in Milestone #2 and the questions and pre-processing they developed/accomplished at the end of Milestone #3 toward data analysis in Microsoft Excel.



STEPPING STONES

ANALYZE THE DATA

Student teams work together to analyze the data and develop preliminary answers to their questions.

CRITIQUE DATA ANALYSIS

Team members rotate to see what data their classmates are working on and their preliminary results in order to provide feedback. Teams will then reconvene and continue to refine their analyses based on input.

PLAN FOR FUTURE WORK

After completing analysis for this project, students will identify a data set and questions to explore in the future.

RESOURCES

POTENTIAL DATA SOURCES

- Bureau of Justice Statistics
- Centers for Disease Control and Prevention (CDC)
- Data.gov
- National Aeronautics and Space Administration (NASA)
- National Center for Education Statistics
- National Center for Health Statistics (NCHS)
- National Oceanic and Atmospheric Administration (NOAA)
- US Census Bureau
- US Department of Education - Data Express
- The World Bank

ACTIVITIES

- Know-Need To Know
- 3-2-1
- Two Stars and a Wish
- Plus, Minus, Interesting

Provide strategic support so students feel a sense of mastery

Experiences of success in overcoming challenges, or "mastery experiences," are critical to developing confidence--a key quality of independent learners. But students may attribute success to their teacher's help rather than their own efforts, if given the wrong types of support. At this stage of the project, students are especially likely to run into challenges (like managing large data sets, dealing with missing data, etc.), so it's important for teachers to provide support that preserves students' chance to experience personal success. When they ask you for help with these challenges, resist the urge to give them solutions. Instead--along with questions or observations to prompt their thinking as described in Milestone 3 (Teaching Tip #2)--provide encouragement that "you can do it," based on specific evidence of the student's past success (for example, in their work on Milestone 2). In the end, they will be more likely to feel they resolved their challenges "themselves"--and can do so again in the future.

	1. ANALYZE THE DATA
Standards	CCSS.ELA-LITERACY.CCRA.SL.1; CCSS.ELA-LITERACY.L.6.4; CCSS.ELA-LITERACY.SL.6.1.A; CCSS.ELA-LITERACY.SL.6.1.B; CCSS.ELA-LITERACY.SL.6.1.C; CCSS.ELA-LITERACY.SL.6.1.D; ; CCSS.ELA-LITERACY.WHST.6-8.2.D; CCSS.ELA-LITERACY.WHST.6-8.7; CCSS.ELA-LITERACY.WHST.6-8.8; CCSS.MATH.CONTENT.6.SP.A.2; CCSS.MATH.CONTENT.6.EE.B.6; NGSS.MS-ETS1-2; NGSS.MS-ETS1-3; NGSS.MS-ETS1-4
Students will be able to....	Perform data analysis on a data set of their choosing.
Ideas for activities	• Based on their experience in Milestone #3, have students create to-do lists or checklists to help them organize and keep track of their analysis process. • Have students share, orally or in writing, their goals for each work day, what they accomplished, and next steps and help them to identify if they need to make any changes to their plans.
Reflection and Synthesis Prompts	• What did you find interesting about the data analysis process? • What do you like about data science? • What surprised you about the analysis process and the answers you discovered?
Formative Assessment Ideas	Leverage the **3-2-1** Exit Ticket to understand how well students can summarize their experiences and what those summaries are.
Suggestions for Feedback and Support	Review teams' work plans and provide suggestions for how they need to integrate missing steps, correct course, or re-prioritize the order of steps.

Make it normal to have errors and misunderstandings

Both dependent and independent learners can be reluctant to make errors or reveal misunderstandings, especially in front of their peers. But the success of peer critiques hinges on their willingness to do so. It's your task to make "presenters" comfortable talking about their team's work--*especially* any problems they still have--and to make "rotators" comfortable asking questions of other teams without worrying about "sounding dumb." After explaining the roles of presenter and rotator, try reducing students' anxiety about making their mistakes public by talking about an experience in school or at work where *you* made mistakes. Explain how you resolved them, highlighting any ways you solicited feedback from others or asked people questions in the process. Encourage students to see mistakes as part of learning, and their peers as potential resources to help resolve their errors and misunderstandings while they still have time before final grades are assigned.

	2. CRITIQUE DATA ANALYSIS
Standards	CCSS.ELA-LITERACY.CCRA.SL.1; CCSS.ELA-LITERACY.CCRA.W.3; CCSS.ELA-LITERACY.SL.6.1.A; CCSS.ELA-LITERACY.SL.6.1.B; CCSS.ELA-LITERACY.SL.6.1.C; CCSS.ELA-LITERACY.SL.6.1.D; CCSS.ELA-LITERACY.SL.6.4; CCSS.ELA-LITERACY.WHST.6-8.2.D; CCSS.ELA-LITERACY.WHST.6-8.5; CCSS.ELA-LITERACY.WHST.6-8.8; CCSS.MATH.CONTENT.6.SP.A.2; CCSS.MATH.CONTENT.6.EE.B.6; NGSS.MS-ETS1-1; NGSS.MS-ETS1-3; NGSS.MS-ETS1-4
Students will be able to....	• Provide critiques to other team members about how to improve their analyses, field critiques from other teams, and modify their analyses accordingly. • Students will begin next steps for further data exploration.
Ideas for activities	• Allow each team to select one person to rotate and one person stay in place to present the data analyses approach and record the critique. • Once the critiques have been completed, allow teams to reconvene and discuss the results of the critiques as well as their plans for modifications.
Reflection and Synthesis Prompts	• For the **rotator**: what aspects, if any, of the project you critiqued would you like to also implement into your analysis? • For **presenter**: what was difficult about receiving the critiques; what was helpful? • For the **teams**: what aspects of the critiques sparked new ideas? What had you (potentially) thought about already (but decided against)? • What impact will the critique have on your analysis and/or the approach you take moving forward? • Do you think data scientists go through this critique/modify process? If yes, why? If not, why not?
Formative Assessment Ideas	• Have students indicate what they learned from the critiques and how, if at all, the feedback impacted their choices.
Suggestions for Feedback and Support	• Leverage the Two Stars and a Wish framework to help students expand the impact of the critiques they receive.

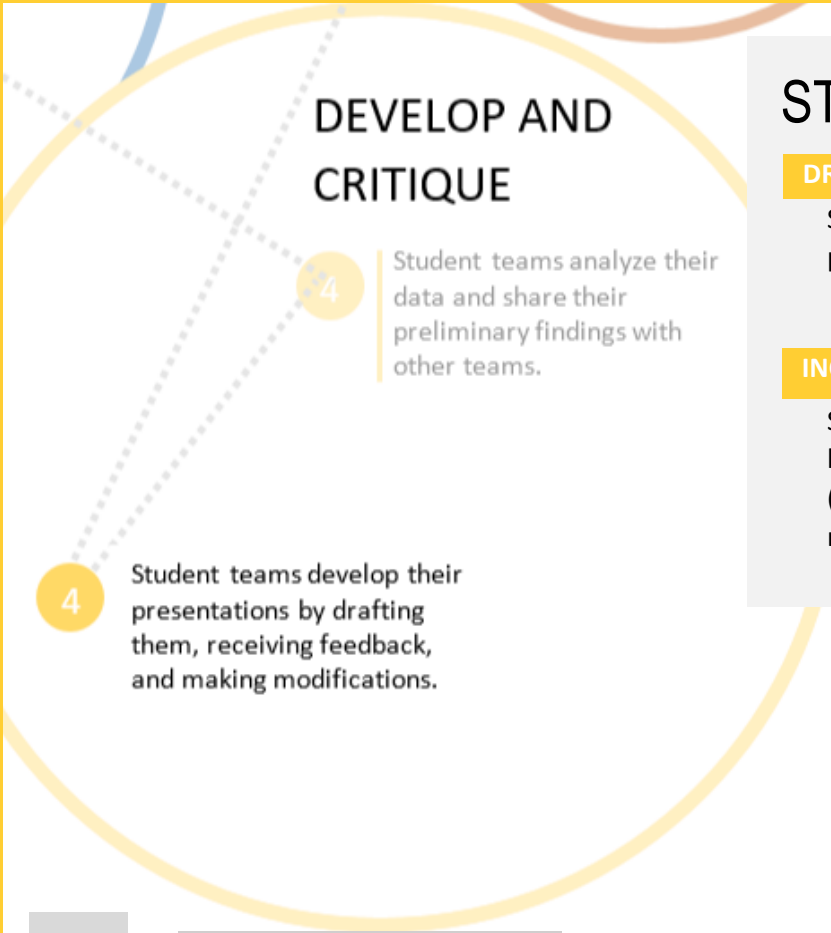
Push students who need more of a challenge

Succeeding at tasks that feel easy doesn't increase students' confidence. For students who speed through their data analysis without much struggle, this Stepping Stone is especially crucial. It adds a new layer of challenge by pushing students 1) to undertake the novel task of searching for another data set on their own, as well as 2) to synthesize their learning up to this point into a new plan of attack for analysis. Consider introducing this Stepping Stone before all groups have finished analysis of their original data set, to allow those who finish early to move on. That way more students will experience the appropriate level of challenge to feel a true sense of mastery by the end of the project.

	3. PLAN FOR FUTURE WORK
Standards	CCSS.ELA-LITERACY.CCRA.SL.1; CCSS.ELA-LITERACY.SL.6.1.A; CCSS.ELA-LITERACY.SL.6.1.B; CCSS.ELA-LITERACY.SL.6.1.C; CCSS.ELA-LITERACY.SL.6.1.D; CCSS.ELA-LITERACY.WHST.6-8.2.D; CCSS.ELA-LITERACY.WHST.6-8.7; CCSS.ELA-LITERACY.WHST.6-8.8; CCSS.MATH.CONTENT.6.SP.A.2; CCSS.MATH.CONTENT.6.EE.B.6; NGSS.MS-ETS1-1; NGSS.MS-ETS1-2;
Students will be able to....	Identify concrete plans for conducting the data analysis process on a new data set.
Ideas for activities	• Allow students to either select one of the data sets provided or search for a new data set. To support the latter process, leverage the list of potential data sources included in the '**POTENTIAL DATA SOURCES'** portion of the **'RESOURCES'** at the beginning of this milestone. • Allow students to generate a list of to-dos and NTKs for analyzing a new data set. The to-dos and NTKs should take their experience to date, observation of other teams' approaches, and feedback from their peers into consideration. The goal is to put students in the position where the exploration of a new data set is within reach and they have the basic tools and confidence needed to explore on their own.
Reflection and Synthesis Prompts	• How did your experiences so far factor into the data set you chose and your plan for moving forward? • What experiences/knowledge did you gain during the project that will help to make analyzing a future data set easier or, potentially, harder? • What challenges do you anticipate in exploring the new data set? • Do you have enough information to explore the new data set on your own (outside of this class/workshop/etc.)? If not, what do you feel you are missing? • Will you continue to use Microsoft Excel for data analysis or will you try other tools?
Formative Assessment Ideas	Allow teams to critique plans for future data analysis and offer suggestions for improvement.
Suggestions for Feedback and Support	Leverage the Plus, Minus, Interesting exercise to get a handle on how students absorbed the process so far. This exercise can provide an opportunity for you to help them correct some of the minus thinking.

MILESTONE #4: REPORT DEVELOPMENT

The goal of this milestone is to have students draft and finalize their presentations iteratively and improve them based on feedback from their peers (both internal and external to their classroom).



STEPPING STONES

DRAFT AND PRACTICE

Student teams draft their presentations and practice in front of other teams.

INCORPORATE FEEDBACK

Student teams improve their presentations based on feedback received by other teams (optional) and present to visitors to gain more feedback.

RESOURCES

VIDEOS

[Schooled by Kids: Presentation Skills, Part 1]

ACTIVITIES

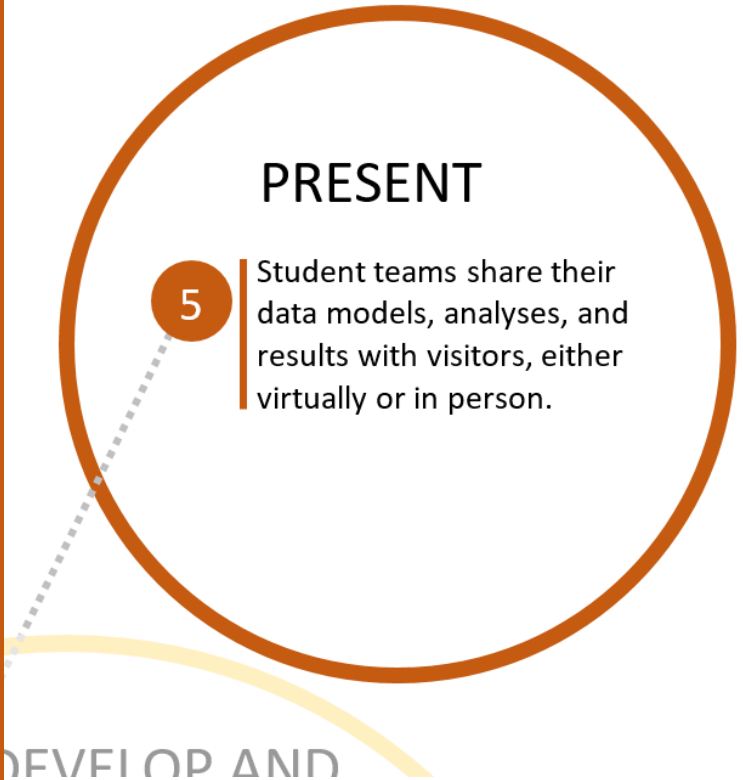
[Presentation Rubric for Evaluation]
[Presentation Overview]
[Feedback Assessment Form]
[3-2-1]

	1. **DRAFT AND PRACTICE**
Standards	CCSS.ELA-LITERACY.CCRA.SL.1; CCSS.ELA-LITERACY.CCRA.W.3; CCSS.ELA-LITERACY.L.6.4; CCSS.ELA-LITERACY.RI.6.1; CCSS.ELA-LITERACY.SL.6.1.A; CCSS.ELA-LITERACY.SL.6.1.B; CCSS.ELA-LITERACY.SL.6.1.C; CCSS.ELA-LITERACY.SL.6.1.D; CCSS.ELA-LITERACY.SL.6.4; CCSS.ELA-LITERACY.WHST.6-8.2.B; CCSS.ELA-LITERACY.WHST.6-8.2.D; CCSS.ELA-LITERACY.WHST.6-8.4; CCSS.ELA-LITERACY.WHST.6-8.5; CCSS.ELA-LITERACY.WHST.6-8.6; CCSS.ELA-LITERACY.WHST.6-8.8; CCSS.MATH.CONTENT.6.SP.A.2; CCSS.MATH.CONTENT.6.EE.B.6; NGSS.MS-ETS1-1; NGSS.MS-ETS1-4
Students will be able to....	• Summarize the process they have taken to select, pre-process, and analyze the initial data set they chose. • Present the four questions they asked about the data and the results they discovered. • Present a draft presentation to other team members for initial review/critique.
Ideas for activities	• Work together to identify what the components of the presentation should be. • Provide a Presentation Overview for the structure of the presentation and allow students to begin ideating. • Have the students develop their presentations. • Have a practice session where students present and receive feedback from other teams.
Reflection and Synthesis Prompts	• What did you enjoy about developing your presentation? • How has watching other teams present improved your presentation? • What presentation skills have you learned or refined as a result of this process? • What presentation skills should we discuss in a mini-workshop?
Formative Assessment Ideas	Provide students with a **Presentation Rubric** that they will use to both critique other teams and self-assess.
Suggestions for Feedback and Support	• For students who need additional support in understanding how to give effective talks, share the following link: • Schooled by Kids: Presentation Skills, Part 1

	2. INCORPORATE FEEDBACK
Standards	CCSS.ELA-LITERACY.CCRA.SL.1; CCSS.ELA-LITERACY.SL.6.1.A; CCSS.ELA-LITERACY.SL.6.1.B; CCSS.ELA-LITERACY.SL.6.1.C; CCSS.ELA-LITERACY.SL.6.1.D; CCSS.ELA-LITERACY.SL.6.4; CCSS.ELA-LITERACY.WHST.6-8.2.B; CCSS.ELA-LITERACY.WHST.6-8.2.D; CCSS.ELA-LITERACY.WHST.6-8.4; CCSS.ELA-LITERACY.WHST.6-8.5; CCSS.ELA-LITERACY.WHST.6-8.6; CCSS.ELA-LITERACY.WHST.6-8.8; CCSS.MATH.CONTENT.6.SP.A.2; CCSS.MATH.CONTENT.6.EE.B.6; NGSS.MS-ETS1-1; NGSS.MS-ETS1-3; NGSS.MS-ETS1-4
Students will be able to....	• Synthesize feedback from other teams and the instructor into the directives necessary to improve their presentation, to identify what feedback they will keep, what they will disregard, why they chose to do either, and (if they chose to accept the feedback) how they updated their presentations accordingly.
Ideas for activities	• Have students use the Feedback Assessment Form that includes columns for feedback received, whether they plan to keep or reject it, and (if kept) how they modified their presentation accordingly. • **Optional**: Have students who are not in the class (but roughly the same age) sit for a practice presentation and offer critiques. This should be done once students have received their first round of critiques from other teams and had a chance to make adjustments.
Reflection and Synthesis Prompts	• **What was the best or most interesting piece of feedback your team received?** • **How did that feedback impact your project?** • **Was there any feedback you received earlier, that you did not incorporate, that you heard again in later critiques? If so, how did you address that?**
Formative Assessment Ideas	• Leverage the **3-2-1** Exit Ticket to understand how well students can summarize their experiences developing/refining their presentations and what those summaries are.
Suggestions for Feedback and Support	• **It would be helpful for feedback to be recorded or written for students to keep with them while they work. The Feedback Assessment Form may be helpful in this way.**

MILESTONE #5: FINAL PRESENTATION

The goal of this milestone is to have students present their work to an audience and receive feedback.



STEPPING STONES

PREPARE

Student teams make final preparations for their projects.

PRESENT

Student teams present their analysis process and results to visitors either virtually or in person.

REFLECT

Students and teacher reflect on their original NTKs, their current understanding, and lessons learned.

RESOURCES

TOOLS

- Establishing Norms
- Standard Operating Procedure
- Presentation Rubric
- What, So What
- Plus, Minus, Interesting
- 3-2-1 Bridge
- I Used to Think – Now I Think

STEPPING STONES TO FINAL PRESENTATION

	1. **PREPARE**
Standards	CCSS.ELA-LITERACY.CCRA.SL.1; CCSS.ELA-LITERACY.CCRA.W.3; CCSS.ELA-LITERACY.L.6.4; CCSS.ELA-LITERACY.RI.6.1; CCSS.ELA-LITERACY.SL.6.1.A; CCSS.ELA-LITERACY.SL.6.1.B; CCSS.ELA-LITERACY.SL.6.1.C; CCSS.ELA-LITERACY.SL.6.1.D; CCSS.ELA-LITERACY.SL.6.4; CCSS.ELA-LITERACY.WHST.6-8.2.B; CCSS.ELA-LITERACY.WHST.6-8.2.D; CCSS.ELA-LITERACY.WHST.6-8.4; CCSS.ELA-LITERACY.WHST.6-8.5; CCSS.ELA-LITERACY.WHST.6-8.6; CCSS.ELA-LITERACY.WHST.6-8.8; CCSS.MATH.CONTENT.6.SP.A.2; CCSS.MATH.CONTENT.6.EE.B.6;
Students will be able to....	Finalize their presentations and p**repare to share** their **data analysis** approach, process, and **solution.**
Decision points	● When and where will students share their presentations? ● How will the presentation space be set up? ● What roles will individual groups/students play in the overall event for setup and takedown, as well as any other necessary tasks. ● **Note**: if you would like to engage students in the decision-making process, consider leveraging the Establishing Norms and Standard Operating Procedure frameworks.
Ideas for activities	● Film practice runs for students to self-assess. ● Have students self-assess based on the **Presentation Rubric**.
Logistics	● Create a guest list and send out invitations. ● Identify non-participant support to manage tech support, tend to guests, and/or troubleshoot when potential issues arise. ● **Decide how the audience will be invited, greeted, and** seated/placed **at the venue.** Deciding whether to invite o**ther guests**, **such as administrators and other classes**, is also an important **consideration.**

STEPPING STONES TO FINAL PRESENTATION

	2. **PRESENT**
Standards	CCSS.ELA-LITERACY.CCRA.SL.1; CCSS.ELA-LITERACY.RI.6.1; CCSS.ELA-LITERACY.SL.6.1.A; CCSS.ELA-LITERACY.SL.6.1.B; CCSS.ELA-LITERACY.SL.6.1.C; CCSS.ELA-LITERACY.SL.6.1.D; CCSS.ELA-LITERACY.SL.6.4; CCSS.ELA-LITERACY.WHST.6-8.2.B; CCSS.ELA-LITERACY.WHST.6-8.2.D; CCSS.ELA-LITERACY.WHST.6-8.4; CCSS.ELA-LITERACY.WHST.6-8.6; CCSS.ELA-LITERACY.WHST.6-8.8; CCSS.MATH.CONTENT.6.SP.A.2; CCSS.MATH.CONTENT.6.EE.B.6;
Students will be able to....	• Present their data analysis process, questions explored, and results to an audience **to share what they have discovered.**
Decision points	• Depending on audience, some presentations may be virtual. Filming final presentations ahead of time would serve as a back-up for unanticipated absences and issues. • How will students present: one group at a time or simultaneously while stakeholders move around? • What will students do when they are not presenting? • How can the experience be structured so that visitors can give meaningful feedback on the teams' approach/presentations.
Ideas for activities	• In-person or virtual presentations.
Logistics	• If you serve as the host of the event, it may be necessary to prepare a program. You also may need to step in when/if students cannot present for some reason. Enlisting the help of another adult will help to ensure the event runs smoothly. • Outline the process for setup and take-down.

	3. **REFLECT**
Standards	CCSS.ELA-LITERACY.CCRA.SL.1; CCSS.ELA-LITERACY.CCRA.W.3; CCSS.ELA-LITERACY.RI.6.1; CCSS.ELA-LITERACY.SL.6.1.A; CCSS.ELA-LITERACY.SL.6.1.B; CCSS.ELA-LITERACY.SL.6.1.C; CCSS.ELA-LITERACY.SL.6.1.D; CCSS.ELA-LITERACY.WHST.6-8.2.D; CCSS.MATH.CONTENT.6.SP.A.2;
Students will be able to....	**Reflect with the teacher on the project and their original NTKs through collaborative discussions and writing.** A key focus of this activity will be to help students understand how much they have advanced since Milestone #1.
Ideas for Reflection on Work Product and Process	● Allow students to develop **individual written reflection** and then confer with their team to round out their recollection of key activities. Once everyone has submitted his or her reflection, **follow the written activity up with a whole-group discussion on the project.** ● Leverage the following the **Plus, Minus, Interesting** worksheet to support these discussions/writings: ● Do the **What, So What?** exercise to frame the discussion of how the knowledge and experience gained as a result of the project will be leveraged in the future and explicitly state the next steps. ● Deliberately and strategically encourage students to continue with the project by suggesting that they work with a second data set/questions in their own time as an independent study.
Reflection on Presentation	Discuss how the presentations evolved over time and how the event with visitors went, overall.
Formative Assessment Ideas	Allow teams to critique plans for future data analysis and offer suggestions for improvement.
Ideas for Reflection on NTKs and Key Knowledge	● **Individually revisit NTKs and write about what they have learned, what they have yet to discover, and a plan for addressing the latter.** ● Leverage the following frameworks to support reflection: ○ **3-2-1 Bridge** ○ **I Used to Think – Now I Think** ● Provide reflective prompts for discussion including: ○ **I was surprised when** I learned/understood that**...** ○ **I'm still wondering about...**

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