Literacy Design Collaborative

What Factors Influence Plant Carbon Dioxide Production and Usage?

★ TASK ★ LADDER

by Erika Reeves, Kristopher C. Stevens, Peter DeWitt, Annie De Witt, Kelly M. Gaier Evans, and Kate Kucharzyk

Adapted from "Battelle Controlled Experiment Module Template" by Kelly M. Gaier Evans and Annie De Witt

This module has been developed from the Battelle Controlled Experiment Module Template to help middle school students through the scientific process of asking a question, gathering background knowledge, developing and carrying out testing, gathering data, analyzing data, and reporting on that analysis. It focuses on the writing process that follows experimentation as well as the Next Generation Science Standards related to the process of photosynthesis. The module embeds content that leads to strong understanding of factors that influence photosynthetic rate as measured by carbon dioxide concentration. However, background knowledge of the process of photosynthesis (reactants, products, location within the cell, limiting factors of photosynthesis, and the relationship between photosynthesis and cellular respiration) will either need to be taught prior to the module or incorporated in the module. Students will be able to choose how they explore this concept through a variety of perspectives:

- How carbon dioxide affects plant carbon dioxide production and usage.
- How light (quality or quantity) affects plant carbon dioxide production and usage.
- How temperature affects plant carbon dioxide production and usage.
- How water (quality or quantity) affects plant carbon dioxide production and usage.

The Battelle Controlled Experiment Module Template allows students to investigate a question they have in hopes of learning information that can better society or re-test information to help prove it in a real-world application. It has been designed to be the second module of a three-part Battelle LDC Science Collection: Data Analysis, Controlled Experimentation, and Design. The series represents a continuum of skills that build upon each other. For instance, the Design Process is predicated by the ability to test solutions in a controlled manner (i.e., carry out a controlled experiment), and the ability to carry out a controlled experiment that produces meaningful results is predicated on the ability to accurately analyze data. It is advisable, therefore, that students be relatively fluent in experimentation prior to completing the design module—and relatively fluent in data analysis before completing a Battelle Controlled Experiment Module. If your students do not yet have a sound foundation in data analysis, they should complete a Battelle Data Analysis Module first. If they are already easily analyzing data to draw conclusions, this module should be a good fit.

GRADES	DISCIPLINE	COURSE	PACING
6 - 8	Science	Life Science: Bugging Out	20hr

Section 1: What Task?

Teaching Task

Task Template BETA B - Argumentation

After researching informational texts on how plants use and produce carbon dioxide and conducting an experiment on a factor that influences that usage, write a scientific research paper in which you discuss your background research, experimental methodology, data analysis, and results and argue how a specific factor influences carbon dioxide production and usage. Support your position with evidence from your research. Identify any gaps or unanswered questions. Give one to two example/s from past or current events to illustrate and clarify your position. Include references. Include tables or charts to help convey your message to your readers.

Standards

Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects

RST.6-8.1

Cite specific textual evidence to support analysis of science and technical texts.

RST.6-8.2

Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.

RST.6-8.3

Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

RST.6-8.4

Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6—8 texts and topics.

RST.6-8.6

Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text.

RST.6-8.8

Distinguish among facts, reasoned judgment based on research findings, and speculation in a text.

RST.6-8.9

Focus

Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

WHST.6-8.4

Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST.6-8.5

With some guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on how well purpose and audience have been addressed.

WHST.6-8.7

Focus

Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

WHST.6-8.8

Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.

WHST.6-8.9

Draw evidence from informational texts to support analysis, reflection, and research.

SL.8.4

Focus

Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation.

SL.8.5

Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.

SL.8.6

Adapt speech to a variety of contexts and tasks, demonstrating command of formal English when indicated or appropriate.

WHST.6-8.1

Focus

Write arguments focused on discipline-specific content.

Ohio's New Learning Standards: Mathematics

MP.3

Construct viable arguments and critique the reasoning of others.

8.SP.1

Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association.

8.SP.4

Understand that patterns of association can also be seen in bivariate categorical data by displaying frequencies and relative frequencies in a two-way table. Construct and interpret a two-way table summarizing data on two categorical variables collected from the same subjects. Use relative frequencies calculated for rows or columns to describe possible association between the two variables.

Next Generation Science Standards

Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles.

Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue

to do so in the future.

Construct and interpret graphical displays of data to identify linear and nonlinear relationships.

Analyze displays of data to identify linear and nonlinear relationships.

Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena.

Next Generation Science Standards (NGSS Comprehensive)

MS-LS1-6.

Focus

Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.

MS-LS1-7.

Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.

MS-LS1.SEP.2.

Focus

Planning and Carrying Out Investigations - Planning and carrying out investigations in 6-8 builds on K-5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or solutions.

Texts

Text List for Carbon Dioxide .docx

Student Work Rubric - Argumentation Task - Grades 6-8

	Emerging	Approaches Expectations	Meets Expectations	Advanced
	1	2	3	4
Controlling Idea	Makes an unclear or unfocused claim.	Makes a **general** claim **that addresses the prompt**, with an **uneven focus**.	Establishes and maintains a clear claim that addresses all aspects of the prompt.	Establishes and maintains a clear, specific, and credible claim that addresses all aspects of the prompt.
Selection & Citation of Evidence	Includes minimal details from sources. Sources are used without citation.	Includes **details, examples, and/or quotations** from sources that are **relevant to the claim**. **Inconsistently** cites sources.	Includes details, examples, and/or quotations from sources that are relevant to the claim and supporting ideas. Consistently cites sources with minor formatting errors.	Includes well-chosen details, examples, and/or quotations from sources that support the claim and supporting ideas. Consistently cites sources using appropriate format.
Development / Explanation of Sources	Explanation of ideas and source material is irrelevant, incomplete, or inaccurate.	Explanation of ideas and source material is **minimal** or **contains minor errors**.	Accurately explains ideas and source material and how they support the argument.	Thoroughly and accurately explains ideas and source material, using reasoning to support and develop the argument.
Organization	Lacks an evident structure. Makes unclear connections among claim, reasons, and evidence.	**Groups ideas and uses some transitions** to connect ideas, with **some lapses in coherence or organization**.	Groups and sequences ideas to develop the controlling idea. Uses transitions to clarify the relationships among claim(s), reasons, and evidence.	Groups and sequences ideas logically to develop the controlling idea and create cohesion. Uses varied transitions to clarify the relationships among claim(s), reasons, and evidence.
Conventions	Major errors in standard English conventions interfere with the clarity of the writing. Language or tone is inappropriate.	**Errors** in standard English conventions **sometimes interfere** with the clarity of the writing. Uses language and tone that are sometimes inappropriate for the audience and purpose.	Consistently applies standard English conventions; minor errors, while noticeable, do not interfere with the clarity of the writing. Uses language and tone appropriate to the audience and purpose.	Consistently applies standard English conventions, with few errors. Demonstrates varied syntax and precise word choice. Consistently uses language and tone appropriate to the audience and purpose.
Content Understanding (Generic)	Attempts to include disciplinary content in explanation or argument but understanding of content is weak; content is irrelevant, inappropriate, or inaccurate.	Briefly notes disciplinary content relevant to the prompt; shows basic or uneven understanding of content; minor errors in explanation.	Accurately presents disciplinary content relevant to the prompt with sufficient explanations that demonstrate understanding.	Integrates relevant and accurate disciplinary content with thorough explanations that demonstrate in-depth understanding.

Background for Students

What Factors Influence Plant Carbon Dioxide Production and Usage?

You know how experiments work in school: You spend a day or two setting up a controlled experiment, then a class period performing the experiment, and that night writing up a quick lab report. Then you get a grade and move on. But have you ever wondered how scientists conduct experiments in real life? And what happens to their information and data once the experiment is complete? This module is designed to walk you through this scientific process from start to finish, working as a real scientist would. We will develop a scientific question about a relevant world topic, research past experimentation, create a unique and thoughtful experiment, analyze data, and discuss findings in order to provide advice for society.

To be successful in this module, you will need to think critically, manage your time well, and give serious thought to the experimental design process. Your culminating deliverable will be a scientific paper modeled on those written by practicing scientists every day.

Extension

The Scientific Poster skill set can be an optional extension for your project. The process of transferring the peer-reviewed-style paper to a scientific poster is a quick process and necessary if you are interested in having your students present their findings in an organized presentation setting, such as a science fair. However, the scientific poster is not the main focus of this module.

Section 2: What Skills?

Preparing for the Task

TASK ANALYSIS: Ability to review task and identify goals, benchmarks, and deliverables.

IDENTIFYING FEATURES OF A SCIENTIFIC RESEARCH PAPER: Ability to review scientific research papers and identify and explain common features.

ASKING A TESTABLE QUESTION: Ability to ask a question that can be tested using a controlled experiment to benefit society.

Reading Process

SOURCE CREDIBILITY: Ability to evaluate credibility of sources.

FINDING RELEVANT TEXTS: Ability to find texts that present research addressing similar experimental questions.

NOTE-TAKING: Ability to select important facts and pre-existing findings for use in one's own writing and experimentations.

ANALYZING INSIGHTS FROM TEXTS: Ability to analyze content from reading to be applied to one's future experimentation and future writing.

ACADEMIC INTEGRITY: Ability to identify and credit sources appropriately.

Writing a Method

RESEARCH PREVIOUS METHODS: Ability to examine previously used methods from other scientists and determine strengths and weaknesses of those methods.

IDENTIFY GOALS OF EXPERIMENT: Ability to identify the overarching goals and subgoals of an experiment to be performed.

IDENTIFY SAFETY CONCERNS: Ability to identify and list possible safety concerns and methods to maintain safety during experimentation.

DEVELOP A HYPOTHESIS: Ability to develop and justify a hypothesis about the outcome of an experiment.

WRITING THE STEPS OF AN EXPERIMENT: Ability to transform goals of experiment into a testable method (set of steps) to be used during an experiment.

WRITING A DATA COLLECTION METHOD: Ability to develop a data collection method to be used during an experimentation process.

Experimentation Process

CONDUCT EXPERIMENT AND COLLECT DATA: Ability to conduct an experiment and collect data.

Interpreting Data

REPORT DATA: Ability to accurately report findings.

DRAW CONCLUSIONS ABOUT DATA: Ability to draw conclusions, logical connections, or correlations from data sets.

DATA REPRESENTATION: Ability display data in plots, tables, and figures.

IDENTIFYING LIMITATIONS TO AN EXPERIMENT: Ability to identify and articulate known weaknesses in methods or data collection used in an experiment.

Writing a Rough Draft

OUTLINE: Ability to identify and outline the sections of a scientific report: Title, Abstract, Introduction, Methods, Results, Discussion, Acknowledgements, References.

WRITING THE METHODS: Ability to translate step-by-step methods for experimentation into paragraph form.

REPRESENTING THE RESULTS: Ability to incorporate results from experiment in forms of graphs, tables, or written explanations without speculations.

DISCUSSING/ANALYZING RESULTS: Ability to compare and contrast the results from an experiment in relation to the

DISCUSSING/ANALYZING RESULTS: Ability to compare and contrast the results from an experiment in relation to the background information on the topic.

IMPLICATIONS: Ability to identify implications of an experiment for society, limitations of the experiment, and next steps for future study.

ACKNOWLEDGEMENTS: Ability to identify major contributors to the research project.

ACADEMIC INTEGRITY: Ability to cite and credit sources appropriately.

WRITING THE INTRODUCTION: Ability to write an introduction to a scientific research paper including the research question, hypothesis, and background research.

WRITING AN ABSTRACT: Ability to write an abstract giving a brief (150-200 words) overview of the entire paper.

FORMULATING THE TITLE: Ability to formulate a title suitable for scientific work.

Revision Process

PEER REVIEW: Ability to provide meaningful feedback on a scientific research paper for a partner.

TECHNICAL WRITING REVISION: Ability to proofread and format a final paper.

FINAL DRAFT: Ability to create a final draft to broadcast results of an experiment, including all elements from original outline.

Section 3: What Instruction?

PACING	SKILL AND DEFINITION	PRODUCT AND PROMPT	SCORING GUIDE	INSTRUCTIONAL STRATEGIES
Preparing for the Task				
20 mins	**TASK ANALYSIS**: Ability to review task and identify goals, benchmarks, and deliverables.	**CONTROLLED EXPERIMENT SCIENTIFIC RESEARCH PAPER—MODULE OVERVIEW** You will receive a PDF overview of the first unit on writing controlled experimentation scientific research papers. Read the overview (knowing that this project will last many weeks, don't panic) and annotate the PDF with questions and comments. • What will you need to do? • What vocabulary is unfamiliar? • What is the pacing of the unit? • What is the product?	A mastery-level student product will: • Be annotated with questions and comments • Answer the questions from the prompt.	1. Distribute copies of this lesson in PDF. 2. Instruct students on annotating the packet.
	Standards: **CCR.W.5** : Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach. **CCR.W.1** : Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.			
	Additional Attachments: **Ex student work. module overview notes pg 2.pdf** **Ex student work. module overview notes pg 1.pdf** **ControlledExperimentLabReportUnitOverview.docx** **Controlled Experiment Lab Report Unit Overview**			

20 mins	**TASK ANALYSIS**: Ability to review task and identify goals, benchmarks, and deliverables.	**3.2.2 TASK ANALYSIS**
		As a class we will analyze the prompt for this module and break it down so we know what we're going to be learning about.
			Meets Expectations:
			• Sheet is fully filled out and student responses reflect understanding of the task.
				• Read/share important background knowledge about the unit/module with your students.
				• Explain to the class that the goal of this unit/module is to create a scientific research paper and learn more about the process scientists go through during the experimentation process. After doing all this learning they will write a scientific research paper in which you discuss your background research, methodology of experiment, data, and evaluate the results of your experiment. Support your position with evidence from the text/s.
				• Pass out Prompt Reflection Sheet and guide a class discussion about what each part of the prompt means. Use questions like:
				  ◦ What will you have to do to successfully answer this part of the prompt?
				  ◦ What do you need to learn to be able to do this?
				  ◦ What parts of this seem easy/what parts seem hard?
				• Review the reflection sheets and read them over so you have a good sense of how well each student understands the task, and provide additional feedback and support as necessary in the following days.

	Standards: **CCR.W.5** : Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.			

	CCR.R.1 : Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.			
	Additional Attachments: **Ex student work. analysis of teaching task pg 2.pdf** **Ex student work. analysis of teaching task pg 1.pdf** **Photosynthesis_A_ Controlled_Experiment_Prompt_Reflection.docx** **Surf and Turf Prompt Reflection.docx**			
25 mins	**IDENTIFYING FEATURES OF A SCIENTIFIC RESEARCH PAPER**: Ability to review scientific research papers and identify and explain common features.	**IDENTIFYING COMPONENTS AND STEPS IN THE EXPERIMENTATION PROCESS** After reviewing several controlled experiments, create a comprehensive list on a Google Doc of the components and steps in the experimentation process. Write one to two sentences explaining each component or step.	Student work that meets mastery expectations of this skill will: • Identify the sections of scientific research papers • Identify the steps/process scientists follow while writing scientific research papers • Explain each section in detail • Explain the reasons why scientists follow a specific process while performing experiments.	1. After students have reviewed and annotated the module overview sheet, explain to them that the first step will be to review scientific research papers in order to become familiar with the controlled experimentation process. 2. Provide students with the attached link to sample lab reports (teacher resources) or provide several hard-copy examples for students to review. 3. Distribute the attached graphic organizer and provide the following directions to students: ◦ Take a few minutes to review a few of the scientific research papers. ◦ Using the graphic organizer identify the different sections you find, the process the author went through to develop that section, and the purpose it serves in the report. 4. After 10-15 minutes, have students share their findings with their neighbor or table group. 5. After students have had a few moments to share, open the discussion up to the entire class. 6. Create a class list of the different components of the controlled experimentation process.
	Standards: **SL.8.4** : Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. **RST.6-8.6** : Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text.			
	Additional Attachments: **Ex student work. Looking at common experiments.pdf** **Link to Sample Scientific Writing Papers Website** **Common Experiments Graphic Organizer**			
1 hr and 30 mins	**ASKING A TESTABLE QUESTION**: Ability to ask a question that can be tested using a controlled experiment to benefit society.	**CREATING A TESTABLE EXPERIMENTAL QUESTION** Write a clearly written testable hypothesis that identifies a quantifiable independent variable that is expected to influence photosynthetic rate as measured by carbon dioxide concentration.	A master-level experimental question will: • Articulate photosynthetic rate (as measured by CO2 concentration) as the dependent variable • Articulate a clear and quantifiable independent variable that is expected to influence photosynthetic rate • Communicate the expected relationship clearly • Convey a logical hypothesis in the	**Purpose:** After observing a place, living thing, or object, scientists often have questions about what they see and make predictions about their data. A hypothesis is an educated guess about how two variables are related. (We define variables here as possible 'moving pieces' or things you change in your experiment to affect your results.) **15 minutes: Modeling** NOTE: You may use the attached presentation as a guide. 1. Review the vocabulary terms: **independent variable and dependent variable**. Differentiate between a **research question** and a **hypothesis**. 2. Distribute the attached handout to students. 3. Share some of your observations from either a shared classroom experiment, reading about an experiment, or other example. (The attached presentation examines shoes.)

			"If...then..." format • Demonstrate that the student understands that hypotheses are educated guesses and part of a multi-step process.	4. **Ask** students: How could you measure different types of shoes? List possible dependent variables: • Color of shoes • Price of shoes • Size of shoes • Brand of shoes 5. **Ask** students: What do you think causes your friends to have different types of shoes? List possible independent variables: • Where my friend lives • School my friend attends • My friend's parents' careers • Size of my friend's foot • My friend's favorite color Pick one factor and think aloud about how this could be related to types of shoes your friends own. 6. **Explain:** *I wonder if the type of neighborhood* (independent variable) *a friend lives in is related to the types of shoes he/she owns* (a dependent variable). 7. Write a sample hypothesis on the board. For example: *If a friend lives in a more affluent neighborhood, then he or she will have more expensive shoes because his family can afford them.* 8. **Explain:** *Hypotheses are "educated guesses" involving your prior experiences and ideas. When writing them, we will follow a predictable format:* ****Ask myself:* - What is my dependent variable? What is my independent variable? - How are these two variables related? How will the dependent variable change? - Why do I think the change will happen? What do I already know? ****Complete the sentence:* If _____ (independent variable), then _____(how I think the dependent variable will change) because _____(why I think the change will happen). **20 minutes: Guided Practice** 1. Provide students with approximately 20 minutes to finish the rest of the questions as a group. 2. Go over the handout examples as a class while students self-check their work. 3. Address any questions or concerns that students have about their work. 4. **Ask** students to discuss the following questions with a partner: Why is it important to write a clear hypothesis statement? What was difficult or easy about the process? How will the hypotheses you generated today relate to your work moving forward? **10 minutes: Independent Practice** Quiz (making a testable hypothesis on your own) **50 minutes: Application to photosynthesis: What factors influence plant carbon dioxide?** • 20 minutes: Define "photosynthetic rate" as the dependent variable for our project and lead a conversation to discover how that can be measured (CO_2 concentration). Demo the experimental setup. • 10 minutes: Ask students to brainstorm possible independent variables.

				• 20 minutes: Orient the students to the need to do background research to write a thoughtful hypothesis and share the resources that will be available to them.

Standards:

RST.6-8.4 : Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6—8 texts and topics.

Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles.

Additional Attachments:

- **Creating a Testable Experimental Question Presenation.pdf**
- **Writing_hypotheses Worksheet.pdf**
- **Writing_hypotheses Worksheet.pdf**
- **LCDChartforFormulatingaTestableQuestionQuiz.docx**
- **LDC Formulating a Testable Question Presentation**
- **LCDChartforFormulatingaTestableQuestion.docx**
- **Formulating a Testable Experimental Question Quiz**
- **Formulating a Testable Experimental Question Chart**

Reading Process

50 mins	**SOURCE CREDIBILITY**: Ability to evaluate credibility of sources.	**SEARCHING FOR CREDIBLE SOURCES** Complete the provided graphic organizer for at least three sources to determine their credibility. Provide an example of one strong source, one debatable source, and one weak source. Make sure you answer the question at the bottom of the page.	Student work which demonstrates mastery of this skill includes three complete Website Evaluation Checklists that: • Thoroughly evaluated at least three websites • Provided accurate analysis of websites • Completed final question evaluating credibility of websites.	1. Ask students to brainstorm a list of different websites or databases they use (or others may use) to find sources for research. Write students' ideas on the board as they share. 2. Lead a short discussion about the pros and cons of the sites they listed on the board. 3. Distribute the Website Evaluation Checklist to students. 4. Display the following website on the board: http://zapatopi.net/treeoctopus/ • This is a reliable-looking fake website for "tree octopus." It covers several topics related to the tree octopus habitat and body structure. 5. Have students give their first impression of the website's credibility and go through the checklist as a class. • A list of other possible websites can be found here: http://www.shsu.edu/lis_mah/documents/TCEA/hoaxtable.html 6. Hand out list of sites to look for resources (under student handouts). 7. Ask students to spend 20-30 minutes looking for resources that will help them with research of their testable question. Identify the resources that they expect will be helpful, those that are definitely not credible, and those that are ambiguous. • They should find at least one website that they definitely should not use because it is not credible, one of ambiguous credibility, and one that is definitely credible.

Standards:

RST.11-12.7 : Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

RST.6-8.8 : Distinguish among facts, reasoned judgment based on research findings, and speculation in a text.

Additional Attachments:

- **Website Evaluation Checklist**
- **Reliable Online Sources List**

40 mins	**FINDING RELEVANT**	**SUMMARIZING AND**	Student work that	1. Now that students know how to find credible sources, explain to

	TEXTS: Ability to find texts that present research addressing similar experimental questions.	**CITING APPROPRIATE SOURCES ON PHOTOSYNTHETIC RATE** Use notecards, Quizlet, or another electronic resource to summarize and cite (APA format) three to five credible sources that identify a quantifiable independent variable that is expected to influence photosynthetic rate as measured by CO2 concentration.	demonstrates mastery of this skill will: • Include three to five credible sources related to their research question • Include proper citations of sources in APA format (use bibme.com) • Have an effective system to track resources.	them that they need to find three to five relevant sources for the research/background section of their lab report. • Students can keep track of sources online or in hard copy as long as they organize sources so that they can locate important information and easily turn the source information into citations. 2. Remind students that they do not necessarily need every source they find, but it is better to front load available information so they do not have to do additional research later. Also, they must cite any source they use in their final lab report whether the source is or is not directly quoted, so an effective method of tracking is vital to their success. 3. Provide students time to find sources. They may use a citation generator to create citations, but they must go through and thoroughly double-check information for accuracy before using. It may be beneficial to model this process for students who have never used a citation generator before. 4. If students do not have three to five sources, they should complete the assignment for homework.
	Standards: **RST.11-12.7** : Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.			
	Additional Attachments: **Injecting Inquiry Into Photosynthesis Investigations** **Do Plants Consume or Release CO2?** **Investigating Photosynthesis: Discovering what plants need for photosynthesis**			
1 hr	**NOTE-TAKING**: Ability to select important facts and pre-existing findings for use in one's own writing and experimentations.	**CLOSE READING OF SCIENTIFIC TEXTS USING THE SCAFFOLD METHOD** Using your previously identified sources, use the Scaffold method and graphic organizer to summarize the articles. Summaries should be turned in or checked by the teacher before continuing.	Student work that demonstrates mastery of this skill will: • Include thorough and accurate responses inside the Scaffold strategy graphic organizer for chosen articles • Explain the main idea of the resources used and how each resource will help them in their scientific paper.	1. Provide students with digital or hard copies of the Scaffold strategy graphic organizer. 2. Go over the graphic organizer explaining that they will be looking for the main idea, major facts in the text, and conclusion summary of the text. This will allow them to write down any important facts and summarize the article so they can refer back to it later. 3. Let students know that while direct quotation of resources is not required, they can insert direct quotes they may want to use directly on the graphic organizer. Remind them to keep track of page numbers for any information they plan to use. 4. If time permits: Use a previous article to model the Scaffold method for the class. 5. Allow students to start working on filling out graphic organizers for the relevant, credible articles they have already identified.
	Standards: **RST.6-8.2** : Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.			
	Additional Attachments: **Ex student work. notetaking pg 2.pdf** **Ex student work. notetaking pg 1.pdf** **Research Paper Scaffold** **Example Research Paper Scaffold** **Example Student Research Paper**			
10 mins	**ANALYZING INSIGHTS FROM TEXTS**: Ability to analyze content from reading to be applied to one's future	**REFLECTION ON SUMMARIZED ARTICLES** Instructions: Fill in the empty head with the photosynthesis information	Student work that demonstrates mastery of this skill will: • Include appropriate resources aligned to	1. Ask students to take a moment to think about all of the information they just reviewed and summarized. 2. Have a short discussion about what they found, the connections the articles had to one another, and how the information they have gathered could inform their experiment.

	experimentation and future writing.	you read while filling in the scaffolding notes. You may use phrases, sketches, sentences, diagrams, etc. You may write in the space outside the head as well. OR Instructions: Empty your brain with the information you have read about photosynthesis when filling in the scaffolding notes. You may use phrases, sketches, sentences, diagrams, etc.	their question ○ Or describe more appropriate resources to be included after reflection ● Combine information gained from identified resources ● Provide a thoughtful reflection that will help frame their experiment and lab report.	3. Have students revisit the tentative hypothesis they created earlier in this module. Examine how the hypothesis stands up to what they have learned through their research. Modify as needed. 4. Ask students to write out two to three sentences on a notecard or sticky note explaining the impact their research has had on driving the direction of their question and experiment. 5. Have students turn in notecard or sticky note as an exit ticket for review.
	Standards: **SL.7.1** : Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 7 topics, texts, and issues, building on others' ideas and expressing their own clearly. **SL.6.1** : Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 6 topics, texts, and issues, building on others' ideas and expressing their own clearly. **SL.8.1** : Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly. **RST.6-8.2** : Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions. **RST.6-8.1** : Cite specific textual evidence to support analysis of science and technical texts.			
	Additional Attachments: **Ex student work. Empty your brain.pdf** **Empty your Brain Graphic Organizer - Google Docs.pdf** **Fill your Mind Empty Head Graphic Organizer - Google Docs.pdf** **VIDEO: LDC Controlled Experiment: Post Reading-Content Comprehension**			
15 mins	**ACADEMIC INTEGRITY**: Ability to identify and credit sources appropriately.	**CREATING A REFERENCE SECTION FOR SCIENTIFIC RESEARCH PAPER** Using Google Docs, create a reference page for your previously identified sources. Make sure you use proper APA format.	Student work that demonstrates mastery of this skill will: ● Have the full document titled: "*Last Name* Scientific Research Paper" ● Have a section titled: "References" ● Include APA citations for all resources expected to be used in References section.	1. Ask students to create a new document titled "*Last Name* Scientific Research Paper." 2. For now, just have them create a section titled "References." 3. Have them add any APA citations they already have to the section, or create new citations using an online citation generator. 4. Have students show you when they have references added. 5. Ongoing: As students gather more information, they should continue to add any new resources to their References page.
	Standards: **WHST.6-8.8** : Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.			
	Additional Attachments: **Citation Generator**			
Writing a Method				
40 mins	**RESEARCH PREVIOUS METHODS**: Ability to	**EVALUATING PREVIOUS METHODS**	Student work that demonstrates mastery	1. Write or display the following questions on the board: ● What was the question the scientists in the experiment were

	examine previously used methods from other scientists and determine strengths and weaknesses of those methods.	Complete the graphic organizer while analyzing the assigned lab report.	of this skill will: • Identify how scientists have tested the question in the past • Analyze the strengths and weaknesses of the experiment • Identify any problems that may need to be addressed going forward • Explain how the information gained will help inform the experiment.	attempting to answer? Did you find this information explicitly stated in the report or did you have to infer? • Did the authors provide a hypothesis for their experiment? If so, what was it? • What were some strengths and weaknesses of their experiment? Did they discuss this or did you need to infer? • How could the information from this lab help inform your own experiment? 2. Have students create a Google Doc or get out a sheet of paper to answer questions on. 3. Distribute lab (it is quite large, so a digital copy would be best). Let students know that it is a large lab and they are not required to read the whole thing. Instead have them scan it and come up with a method for finding the most important information (i.e., where can they look for the major ideas). 4. Allow students time to answer questions. 5. After approximately 15 minutes bring students together and discuss. 6. Remind students that if they plan to use this resource in their own work, they should add this resource to their reference page.
	Standards: **RST.6-8.9** : Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.			
	Additional Attachments: **Factors that Influence Photosynthetic Rate Lab Example** **Design an Experiment to Determine the Effect of Carbon Dioxide Concentration on the Rate of Photosynthesis**			

10 mins	**IDENTIFY GOALS OF EXPERIMENT**: Ability to identify the overarching goals and subgoals of an experiment to be performed.	**CHOOSING GROUPS FOR EXPERIMENTATION**
		Communicate your current position in project in order to find partner(s) with similar direction.
			Student work which demonstrates mastery of this skill will:
			• Identify the subtopic closest to their research.
				Students, until this point, were primarily working independently in order to practice skills and develop content knowledge and resources.
				
				1. Explain to students that we will be choosing groups for experimentation based on topics. Students will still create materials and lab reports independently but will work in groups during the experimentation process.
				
				2. Create a list on the board of all possible avenues students have started to take.
				• Example topics could be:
				  ◦ Impact of light intensity (lack or too much)
				  ◦ Impact of temperature
				  ◦ Lack of carbon dioxide
				  ◦ How moisture content impacts photosynthesis
				  ◦ How quality of water impacts photosynthesis
				  ◦ Impact of internal enzymes
				  ◦ Lack of minerals in soil composition
				  ◦ Etc.
				
				3. Have students write down the topics from the list that most closely align to their research and turn in.
				
				4. While students are working on next task, assign students to groups of two to three based on commonality.

	Standards: **SL.8.1** : Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly.			
15 mins	**IDENTIFY GOALS OF EXPERIMENT**: Ability to identify the overarching goals and subgoals of an	**IDENTIFY THE GOAL OF THE EXPERIMENT** On your exit ticket, write out the primary goal of the	Student work that demonstrates mastery of this skill will: • Identify one primary	1. Look back at the experiment from "Review Previous Experiments" mini-lesson. 2. Ask students to identify the experimenter's primary goal by highlighting it in yellow. Then ask where they found this information. Is

	experiment to be performed.	experiment you want to create. Additionally, write out at least two subgoals your experiment might be able to address.	goal that can be tested during the experiment • Identify at least two subgoals that the experiment will address.	the goal explicitly stated or implied by the data? 3. Have students highlight any subgoals in blue. Could the experimenter draw any conclusions other than those related to the primary goal? 4. Hold a discussion with students around the following questions: • What was the primary goal of the experiment? • Where did they find the primary goal of the experiment? • Were there any subgoals of the experiment? How did the author address these goals? • Typically in experiments only one variable is tested. How could we approach this experiment with one major goal but others in our periphery? 5. Have students identify one primary goal they would like to test and two additional goals their data might also provide information about. Example: Primary Goal: "The goal of my experiment will be to see how the time the plant spends in the sunlight affects the amount of oxygen produced." Subgoals: "My experiment could also provide information about the type of sunlight the plant prefers (overcast, direct sunlight, temperature) and the effect of carbon dioxide consumption."
	Standards: **ETS1.C:1.** : Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of the characteristics may be incorporated into the new design. (secondary to MS-PS1-6)			
1 hr	**IDENTIFY SAFETY CONCERNS**: Ability to identify and list possible safety concerns and methods to maintain safety during experimentation.	**IDENTIFY POTENTIAL HAZARDS AND SAFETY METHODS** Identify potential hazards of your controlled experiment and fill in the accompanying table to organize your hazards and safety procedures.	Student work that demonstrates mastery of this task: • Acknowledges major safety concerns in the experiment • Provides appropriate and significant detail to the hazards • Acknowledges the various settings that may exist in the experiment and the specific hazards that could exist in each setting • Includes reasoning that proves the risk to the potential hazards.	1. Review the definitions to the words "risk," "safety," "emergency safety," "preventative safety," "flammable," "corrosive," and "MSDS" and discuss how all of these terms are important to a controlled experiment. 2. Model how to identify possible hazards in different testing environments, especially in situations that involve open flame, chemicals, and/or glassware. Model this approach in the "example" chart on the attached "Controlled Experiment Safety Methods Chart" with the students (either via video or hands-on in the lab). 3. Have students consider the different materials and methods they will be using during the experiment and fill in the rest of the chart. Students can add more rows to the table if necessary.
	Additional Attachments: **Controlled Experiment Safety Methods Chart.docx**			
20 mins	**DEVELOP A HYPOTHESIS**: Ability to develop and justify a hypothesis about the outcome of an experiment.	**CREATING A HYPOTHESIS** Create appropriate, testable hypotheses for your prompts on the handout provided using the "If...then...because" format.	Student work that successfully demonstrates this skill will: • Correctly identify the dependent and independent variables in a given scenario • Include a logical hypothesis in the	**Modeling:** 1. Review the vocabulary terms: **hypothesis, independent variable, and dependent variable**. It is helpful to post these terms and their definitions on posters for reference. 2. Share some of your observations from either a shared classroom experiment, reading about an experiment, or other example. Identify the independent and dependent variables in this example. You might talk about a recent school event like the end of the marking period and discuss things that could affect an outcome like earning straight A's. Choose a topic that is already familiar to students. For additional

"If...then..." format
- Include a hypothesis that makes sense to anyone who reads it, is testable, and addresses the problem
- Include a justification of the hypothesis using prior experience and/or knowledge in a "because" clause
- Demonstrate understanding that hypotheses are educated guesses and part of a multi-step process.

examples, see the videos linked below under Teacher Resources.

3. **Ask** students: If someone wanted to improve their GPA, what might he/she consider doing? Write down students' ideas on the board. Pick one factor (e.g., amount of sleep or time spent studying) and think aloud about how this factor could be related to school performance.

4. **Explain:** *I wonder if the amount a person sleeps (an independent variable) is related to GPA (a dependent variable).* **Ask:** How do you think sleeping more might help someone perform better in school? Write down students' ideas on the board (e.g., more focused, more energy, better memory, improved mood).

5. Continue to think aloud about the relationship between the independent and dependent variables. You might think aloud and predict how the two variables are related by pulling from your background knowledge about the topic: *I remember having a student who used to fall asleep in class during lectures. After talking with Alexia, I learned that she was only getting around three to four hours of sleep per night. Alexia was earning a D in my class and wanted to improve her grade. She thought that if she stayed awake during lectures, her grade might improve. Alexia started getting more sleep at night and by the end of the semester, improved her grade to a B+.*

6. Write a sample hypothesis on the board. For example: *If students get more sleep, then they will earn high GPAs because they are more focused.*

7. **Explain:** *Hypotheses are "educated guesses" involving your prior experiences and ideas. When writing them, we will follow a predictable format:*

****Ask myself:*

- What is my independent variable? What is my dependent variable?
- How are these two variables related? How will the dependent variable change?
- Why do I think the change will happen? What do I already know?

****Complete the sentence:* If _____ (independent variable), then _____(how I think the dependent variable will change) because _____(why I think the change will happen).

Guided Practice:

1. Distribute the attached handout to students. **Note:** If you have discussed a shared-class experiment, supplement the provided examples with ones that are already familiar to students.

2. Work through the first one or two scenarios together by writing/projecting the example on the board. Or, as a practice example, consider continuing the conversation about the independent and dependent variables that you discussed as a class during the "Modeling" section of the lesson. For instance, if you discussed the relationship between sleep and grades, **ask** students: *In addition to sleep, what other factors might influence a student's academic performance?* Write down student responses on the board (e.g., study habits, amount of exercise, peer support).

3. Refer to the steps for writing a hypothesis statement (step 6 above) that you discussed earlier in the lesson as you complete the example(s) as a class.

Independent Practice:

Provide students with approximately 10 minutes to finish the rest of the questions.

Closing:

1. Go over the handout examples as a class while students self-check their work.

				2. Address any questions or concerns that students have about their work. 3. **Ask** students to discuss the following questions with a partner: *Why is it important to write a clear hypothesis statement? What was difficult or easy about the process? How will the hypotheses you generated today relate to your work moving forward?* 4. Have students share out their responses with the whole class. **Application:** Ask students to revisit the testable hypothesis they developed and revised throughout the module. Considering the examples we used today and the research you have conducted, revise and finalize your hypothesis. Adapted from: http://www.pbs.org/newshour/extra/2012/09/test-tomorrow-get-your-sleep/
	Standards: **RST.6-8.3** : Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.			
	Additional Attachments: **Ex student work. hypothesis pg 2.pdf** **Ex student work. hypothesis pg 1.pdf** **Writing Hypotheses Handout.pdf**			
40 mins	**WRITING THE STEPS OF AN EXPERIMENT**: Ability to transform goals of experiment into a testable method (set of steps) to be used during an experiment.	**WRITING OUT STEPS OF EXPERIMENT** Write out a step-by-step guide to your experimentation process on the provided graphic organizer. Also, please write out your hypothesis, and identify the independent variable, dependent variable, and control variables.	Student work that demonstrates mastery of this skill will: ● Include a plausible hypothesis written in "If...then...because" format ● Identify a correct independent variable ● Identify a correct dependent variable ● Identify multiple control variables ● Include a thoughtful list of steps on how to conduct the experiment.	**Modeling:** 1. Review the following vocabulary terms with students: hypothesis, dependent variable, independent variable, control variables. 2. Display a blank graphic organizer so that the class can see it. Introduce the following scenario (or a similar scenario that is already familiar to your students): Mr. Smith wants to know how passing out candy for correct answers impacts weekly quiz scores. **Ask** students: *How do you think passing out candy will impact students' quiz scores? Do you think students will be more or less likely to earn a high quiz score if they are given candy? Why?* Jot down student responses on the board. 3. **Model** how you would develop a possible experiment to test this scenario through a think aloud. Allow students to contribute as you think they are able, but don't get too bogged down with everyone's suggestions. The point is to show how to complete this process in about 10-12 minutes. It's not necessary for students to copy what you write. An example of a possible model is included for your reference under Teacher Resources. As you think aloud, you might stop periodically to refer to students' prior knowledge, check for student understanding, and clarify some of the following points: *The Goal.* **Explain:** I am interested in determining how candy influences quiz scores. This is the goal of my experimental design (or the "why" and purpose of my study). After completing the experiment, I will be able to analyze the data and better understand the relationship between candy and quiz scores. [You might write these variables on the board and underline "candy" and "quiz scores" to help clarify that these two variables are the focus of the experiment.] *Hypothesis.* **Explain:** I wonder how candy and quiz scores might be related. I know that a lot of students like candy, so I predict that candy will motivate students to want to perform well on their quizzes. My hypothesis for this experiment is that if students receive a piece of candy for every correct answer on their weekly quizzes, the class quiz average will go up because students will be more motivated to do well

on the quiz if they get a treat. [Make sure to point out to students that you are writing this educated guess using an "If ___ then ____ because" format that was taught in an earlier lesson.]

Independent and Dependent Variables. **Explain:** Candy is the independent variable and the class average quiz score (measured by %) is the dependent variable. We are trying to see if candy causes some kind of change in the average quiz scores of students. [If your students need more review with these terms, remind them that the independent variable causes a change in the dependent variable and that it isn't possible for the dependent variable to cause a change in the independent variable. Also remind them that some experiments have more than one dependent variable.]

Controlled Variables. **Explain:** The controlled variables, or constant variables are the following:

- What the students learn in class before the quiz
- Whether students get a study guide or not
- Day of the week the quiz is given
- How long the students have to work on the quiz
- How much the quiz affects the students' grades

If we did not hold these variables constant, it would be difficult to understand how candy affects the average student quiz score. For example, if some students were given a study guide and others were not given the study guide, we might see differences in the average quiz score. **Ask:** How might a study guide or other factors influence quiz scores? Write down student ideas on the board (i.e., improved study habits, shared information). Remind students that controlled variables are quantities that a scientist wants to stay constant.

Procedure. **Explain:** In the procedure section, we list out the steps needed to complete the experiment. By completing these steps, we will be able to test our hypothesis (if students receive a piece of candy for every correct answer on their weekly quizzes, the class quiz average will go up because students will be more motivated to do well on the quiz if they get a treat).

First, in his period one classes, Mr. Smith will tell students about the new candy policy the day before the quiz is given. Next, in his period two classes, Mr. Smith will not give students candy for correct questions on the quiz or mention the policy. On Friday, Mr. Smith will give both periods the quiz as usual. He will remind period one about the candy. Both classes will have the same 10-question multiple choice quiz. Both classes will have 20 minutes to take the quiz. The quiz will be worth 10 points in both classes. Finally, Mr. Smith will collect the quizzes, grade them, and give one piece of candy for each correct answer in period one. The last step of the procedure is when Mr. Smith will compare the class averages on the quiz.

Small Group Practice:

Distribute the blank organizer to small groups or partnerships. Provide them with the following scenario or a scenario that is related to the current unit and that is familiar to students: Ms. Wallace wants to know how giving a lunch detention as punishment each time a student is late will impact how many students are tardy to her class. Give student about 15 minutes to complete the organizer for this scenario. Leave your example on the projector so students can use it for reference.

Have a few groups share their experiment about Ms. Wallace or the topic that was provided to students. Discuss experiments using the following guide:

- What are some similarities and differences between the experiments shared?
- Do all the experiments test the same thing?
- Are there any strengths or weaknesses to the experiments?
- Is it okay that the experiments are slightly different? Why or why not?

				Extension: After showing students additional models of experimental designs, have students outline the steps of their own experiment. Provide students with a new graphic organizer and have them complete with their partners. *** Students do not need to complete the data table set up until a later mini-task.
	Standards: **WHST.6-8.2** : Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes. **RST.6-8.3** : Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.			
	Additional Attachments: **Model: Mr Smith Experimental Design Graphic Organizer** **Blank Experiment Design Graphic Organizer**			
20 mins	**WRITING THE STEPS OF AN EXPERIMENT**: Ability to transform goals of experiment into a testable method (set of steps) to be used during an experiment.	**EVALUATING EXPERIMENTAL DESIGN** Provide at least one thing you like and one suggestion/question to three groups' experimental design setups.	Student work that demonstrates mastery of this skill will: • Provide at least one positive comment on three groups' experimental design setups • Provide at least one suggestion or question on three groups' experimental design setups.	1. Ask students to display their experimental design setup on one group mate's computer. Or if they did it on hardcopy to display it on their desks. 2. Provide each student with a stack of red and blue sticky notes. 3. Explain that their job is to provide positive (hot, or red stickies) feedback on other groups' experiment setups and suggestions or questions (cold, or blue stickies) to help improve experiment. Students can put stickies on the side of the computer or paper, or on the desk. • Remind students that feedback like "good," "bad," and "cool" are not helpful. • An example of quality feedback would be "I like how you plan to test materials about both dry and wet to see how moisture content affects heating rate" or "Have you thought about a method to make sure materials have a uniform moisture content?" 4. Allow students to circulate room for approximately 10 minutes. 5. Provide students with about 5 minutes to review comments.
	Standards: **WHST.6-8.5** : With some guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on how well purpose and audience have been addressed.			
20 mins	**WRITING A DATA COLLECTION METHOD**: Ability to develop a data collection method to be used during an experimentation process.	**DEVELOP A DATA COLLECTION METHOD** Design a table to use to collect the data from your experiment.	Mastery-level student work will include a designed table: • With fitting structure allowing for complete data collection • With suitable labels (dependent and independent variables) • With fitting observation time lengths where necessary.	1. Look back at the "Steps of a Method" mini-lesson. 2. Ask students to decide on a fitting structure for their table (horizontal, vertical, matrix) for data collection. 3. Have students choose suitable labels for their experiment using their dependent and independent variables. 4. Ask students to display their table on their computer or their hard copy on their desks for feedback from another student or group. 5. Analyze the table for the appropriate experimental labels and data collection structure.
	Standards: **RST.6-8.7** : Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).			

	Additional Attachments: **Ex student work. Develop a data collecting method.pdf**			
Experimentation Process				
1 hr and 15 mins	**CONDUCT EXPERIMENT AND COLLECT DATA**: Ability to conduct an experiment and collect data.	**CARRYING OUT EXPERIMENT** Carry out your experiment following all lab protocols and accurately complete your data table.	Student work that demonstrates mastery of this skill will: • Include documentation in notes of the experimental procedure as followed and notes and explanations if the group had to make any modifications to their written experimental procedure • Include an accurate, neat, and complete data table.	If time permits create experimental kits for each group with all materials students will need to complete experiment. 1. Review all safety procedures and lab protocols with students. 2. Ask students to have one copy of their procedures and data table out on their desks. 3. Distribute lab materials to students. 4. Allow students to begin their experiments. Emphasize the use of their notebooks to record notes on the experiment including their procedures and any modifications to their methods (if modifications are required, students should take careful notes on how it was modified and explain why they made this modification). Also instruct students to record collected data on their data tables. 5. While students are working, circulate the room, checking in with students to ask and answer questions. Also check to ensure students are following safety procedures and lab protocols.
	Standards: **RST.6-8.3** : Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.			
	Additional Attachments: **Temperature and Rate of Photosynthesis - Google Docs.pdf** **Minerals (impurties) and Rate of Photosynthesis Experiment - Google Docs.pdf** **Carbon Dioxide Concentration and Rate of Photosynthesis Experiment - Google Docs.pdf** **Light Intensity and Rate of Photosynthesis Experiment - Google Docs.pdf** **Ex student work. Experimental design.pdf**			
Interpreting Data				
10 mins	**REPORT DATA**: Ability to accurately report findings.	**ORGANIZING EXPERIMENTAL DATA** Organize data collected from experiment into a class Google Spreadsheet.	Mastery-level student work will include: • New tab on spreadsheet • Collected data imported accurately into spreadsheet • Data labels.	1. Teacher creates spreadsheet for class data and shares with students. 2. Have students open spreadsheet and create new tab. 3. Import data into spreadsheet.
	Standards: **RST.6-8.7** : Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).			
25 mins	**DRAW CONCLUSIONS ABOUT DATA**: Ability to draw conclusions, logical connections, or correlations from data sets.	**DRAWING CONCLUSIONS AND MAKING CONNECTIONS ABOUT DATA** Write one paragraph drawing conclusions from your data; then write another paragraph making connections or correlations to other groups' data sets.	Student work that demonstrates mastery of this skill will: • Include a thoughtful response to what the data show • Compare their results to the hypothesis • Discuss the outcome of the experiment as	1. After students have imported their data into the the class spreadsheet, have them review their data and discuss initial reactions with their group. 2. Have students pair up with another group to compare their experiments and data. Ask them to reflect on any connections they can make. 3. Briefly provide time for students to share what they discussed as a class. 4. Prompt students to independently journal using the following prompts/questions to guide them:

			it is related to students' previously established goals • Use other groups' tables to make at least one connection or correlation between collected data.	• What are your initial reactions to your data? • Was your hypothesis confirmed or busted? Explain. • How does the outcome relate to each of your goals? Can you draw any clear conclusions about your primary goal? Your sub goals? • Look at the data sets from other groups, and use their information to make at least one connection or correlation between experiments. Please note, this should not be something to the effect of "Another experiment was very similar to ours, they found the same thing." Think bigger picture! • Did anything surprise you about your experiment or others' experiments? Why or why not? • How does the experiment relate to previous research or experiments you looked at?
	Standards: **RST.6-8.9** : Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.			
25 mins	**DATA REPRESENTATION**: Ability display data in plots, tables, and figures.	**USING GOOGLE SPREADSHEET TO CREATE GRAPHS** Create a visual representation of your graph using Google Spreadsheet.	Student work that demonstrates mastery of this skill will: • Include graphs and charts representing the best ways to display their data • Neatly display data in an easy-to-read visual.	1. Review the different types of graphs (and other ways to represent data) with students, and discuss when it is most appropriate to use each. Under student resources is a PDF overview of the different types of graphs and how to use them if students need additional support. 2. Have students open the spreadsheet with their information and make a copy to avoid confusion and students potentially deleting each others work. • Every student should make a copy and work on creating a visual. 3. Provide students with the attached links to get started on creating their visual representation. 4. Walk around the classroom and troubleshoot any issues students encounter and to ask students questions about how they plan to display their data to ensure that they are able to identify when specific graphs and charts should be used.
	Standards: **WHST.6-8.6** : Use technology, including the Internet, to produce and publish writing and present the relationships between information and ideas clearly and efficiently.			
	Additional Attachments: **Types of Graphs Help.pdf** **Video Walkthrough of using Google Spreadsheet to Create a Graph** **Directions: Creating a Graph with Google Spreadsheet Walkthrough**			
45 mins	**IDENTIFYING LIMITATIONS TO AN EXPERIMENT**: Ability to identify and articulate known weaknesses in methods or data collection used in an experiment.	**IDENTIFYING THE LIMITATIONS TO AN EXPERIMENT** Based on your completion of the experiment, answer the questions in the chart so that you can successfully analyze the limitations of the task. Then decide on the most important limitation of your study and share this limitation with the class. Finally, after listening to your peers share their limitations, work with your group/partner to decide how to communicate the	Student work that demonstrates mastery of this skill will: • Identify limitations based on the experiment • Explain the limitation thoroughly • Include a paragraph communicating the limitations of the completed study.	**Note:** A handout (**Identifying Limitations**) has been attached to help students organize their work for this mini-task. You may want to type the task in the box provided on the handout. **Instruction:** 3 minutes: Provide students with Identifying Limitations Handout and read through the task with them the first time. 10-12 minutes: Have students individually answer the questions in the chart to begin analyzing the limitations of the experiment. 5 minutes: After answering the questions, have students examine the limitations and reasoning they have identified individually with their experimental groups and to circle the one that they think is the most important/influential to the experiment.

		limitations of your study.		2-3 minutes: Give them two to three minutes to get the limitation and reasoning written on the board. If you don't have a large area of board space, you could hang a large piece of paper on the wall and have students write their limitations and reasoning on the paper using markers. Another option is to project a Powerpoint slide or Word document and ask students to take turns typing in their responses. 10 minutes: In groups of four, have students discuss all the limitations on the board and decide which two they think are the most important/influential. Teacher will circulate around the room and listen to ensure all students are engaging in the discussion asking clarifying questions as needed. 10 minutes: When the discussion is finished and the limitations have been analyzed, have each experimental group write up a paragraph summarizing what they would need to say to communicate the limitations of their study.

Standards:

MS-LS4.SEP.1. : Analyzing and Interpreting Data - Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.

MS-PS3.SEP.3.1. : Construct and interpret graphical displays of data to identify linear and nonlinear relationships. (MS-PS3-1)

MS-LS2.SEP.3.1. : Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena. (MS-LS2-2)

MS-LS2.CETS.1.1. : The use of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (MS-LS2-5)

RST.6-8.7 : Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

Additional Attachments:

Identifying Limitations to an Experiment

Writing a Rough Draft

20 mins	**OUTLINE**: Ability to identify and outline the sections of a scientific report: Title, Abstract, Introduction, Methods, Results, Discussion, Acknowledgements, References.	**CREATING A SCIENTIFIC RESEARCH PAPER OUTLINE** Create an outline of your scientific research paper, including required individual sections and a table of contents	Student work that demonstrates mastery of this skill: • Identifies the major sections of a scientific research paper (title, abstract, introduction, methods, results, discussion, acknowledgements, and references) • Includes a table of contents with all sections • Establishes a template for a scientific research paper that includes all sections.	Students should be familiar with scientific research paper sections based on exposure at this point, but may not have a firm grasp on each and every section. 1. Discuss briefly what kinds of information are included in the different sections of scientific research papers students have seen to this point. Write list on board. 2. Pass out a different sample scientific research paper to each table and ask table partners to record the different sections and compare their list to the list written on the board. 3. Have each group share out and compare and contrast the sections in each (they're almost all identical). *4. If time permits,* have a short discussion about why it is important for scientific research papers to be standardized and the role of each section. Also discuss the difference between active and passive voice. Ask students to identify where they see the passive voice in the sample scientific research papers. 5. Have students create a table of contents and lab report template they will use for their experiment (title page does not need to be completed at this point, it will be added in a future lesson).

Standards:

WHST.6-8.4 : Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

Additional Attachments:

Active vs Passive voice

Protozoan Cultures Lab Report

	Food Samples Lab Report **Sample Lab Report (No Acknowledgement Section Included)** **Sugars by Blowflies Lab Report.pdf**			

30 mins	**WRITING THE METHODS**: Ability to translate step-by-step methods for experimentation into paragraph form.	**WRITING THE METHODS AND MATERIALS SECTION OF A SCIENTIFIC RESEARCH PAPER**
		Write out the Standard Operating Procedures (SOPs) from your Experimental Design Setup into the Methods section of your scientific research paper. Make sure you write in complete sentences.
			Student work that demonstrates mastery of the skill will:
			• Summarize in complete sentences the Standard Operating Procedures (SOP) from the Experimental Design Setup in the Methods section of the lab experiment so that another student with the same background, but unfamiliar with the experiment, could perform the same experiment without additional instructions.
				1. 5 minutes: Please note and discuss the following items:
				There are several common mistakes that are often found in the Materials and Methods section of a scientific research paper.
				• (Mistake): Including every detail, like amount of time you washed hands.
				  ◦ Instead, a good guideline is to include only what is necessary for one recreating the experiment to know.
				• (Mistake): Listing all of the materials needed for the experiment at the beginning of the section.
				  ◦ Instead, the materials and equipment utilized during the experiment should be mentioned throughout the procedure as they are used. Enough detail should be included in the description of the materials so that the experiment can be reproduced.
				• (Mistake): Writing in first person, such as, First I did…
				  ◦ Instead, it is generally recommended that the Materials and Methods section be written in past tense (third person), in either active or passive voice. (Set up the equipment by…)
				2. 20-30 minutes: Students will open the Standard Operating Procedures (SOP) from the Experimental Design Setup in the Methods section of the lab experiment. Transform the bulleted items into complete sentences, keeping in mind the common mistakes as previously discussed. Remind students to use their methods outlines and experiment notes from earlier in the module.

	Additional Attachments: **Materials and Methods**			
45 mins	**REPRESENTING THE RESULTS**: Ability to incorporate results from experiment in forms of graphs, tables, or written explanations without speculations.	**CREATING RESULT IN GRAPH, TABLE, AND/OR WRITTEN FORM** Construct a graph of the results of your experiment and write a caption that expresses the data relationship contained in your hypothesis.	Student work that demonstrates mastery of the skill will: • Include a student-constructed line or bar graph correctly expressing the data collected • Include labels and/or values of collected data • Include a caption that expresses the data relationship contained in the hypothesis.	Note: Students can revisit the graph analysis from "Creating Google Spreadsheet to Create Graphs" to review the types of graphs. 1. 15 minutes: Pair students up and have one student bring up the Introduction to Describing Graphs and Table activity link (see student handout). Have the students work together to complete the four activities. 2. Walk around the classroom and troubleshoot any issues students are having. 3. 1 minute: Have students open the graph previously made on Google Spreadsheet or graph paper for their experiment. 4. 5 minutes: Have students review their previously made graph with their experimental group for consistency in the produced graph and for graph labels. Some students may need to make adjustments. 5. 5-7 minutes: Have students gather the following information about their experiment: • Start by saying exactly what the chart/graph shows and the time period, if applicable. • Describe the changes as precisely as possible. Use data and numbers from bar or line graph. • Compare the information. Talk about the difference and similarities between the data shown. • Conclude by saying what the major trends are. 6. 5 minutes: Look at examples of graph captions and model how to create a clear caption. 7. 7-10 minutes: Students work with group to create a clear and well-

				written caption to accompany their chart/graph. 8. 2 minutes: Type the final caption that expressed the data relationship contained in the hypothesis.
	Standards: **MS-LS4.SEP.1.1.** : Analyze displays of data to identify linear and nonlinear relationships. (MS-LS4-3) **MS-LS2.SEP.3.1.** : Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena. (MS-LS2-2) **MS-PS3.SEP.3.1.** : Construct and interpret graphical displays of data to identify linear and nonlinear relationships. (MS-PS3-1)			
	Additional Attachments: **Using Graphs and Charts to Illustrate Quantitative Data** **Writing about a Bar Chart** **Writing about a bar chart** **Introduction to describing graphs and tables**			
50 mins	**DISCUSSING/ANALYZING RESULTS:** Ability to compare and contrast the results from an experiment in relation to the background information on the topic.	**DISCUSSING/ANALYZING THE LABORATORY RESULTS** Provide a written statement based on your graph expressing the relationship between the independent and dependent variable according to your data. Write a paragraph(s) comparing and contrasting the similarities and differences of conclusions other experimenters have found to the similarities and differences you have found based on the expectation of your hypothesis.	Student work that demonstrates mastery of the skill will: • Include a clearly written statement based on the graph, expressing relationship between independent and dependent variables according to their data • Compare and contrast how this is similar or different than what other experimenters have found • Compare and contrast how this is similar or different than what the students have found based on the expectation of their hypothesis • Be written in paragraph form.	1. 2-3 minutes: Bring up information gathered in "Creating Result in Graph, Table, and/or Written Form" mini-task and research done in "Researching How Others Have Attempted to Answer Similar Questions" mini-task. 2. 5 minutes: Provide the following discussion paragraph from Effect of Light Intensity, Carbon Dioxide Concentration, and Leaf Temperature on Gas Exchange of Spray Carnation Plants for students to read individually and allow time to read, highlighting key details. Teacher can choose how much for students to read, based on experience or age appropriateness. A good resource for writing the discussion can be found in the discussion section from NC Writing Center. **Explain whether the data support your hypothesis** This statement is usually a good way to begin the Discussion, since you can't effectively speak about the larger scientific value of your study until you've figured out the particulars of this experiment. You might begin this part of the Discussion by explicitly stating the relationships or correlations your data indicate between the independent and dependent variables. Then you can show more clearly why you believe your hypothesis was or was not supported. For example, if you tested solubility at various temperatures, you could start this section by noting that the rates of solubility increased as the temperature increased. If your initial hypothesis surmised that temperature change would not affect solubility, you would then say something like, "The hypothesis that temperature change would not affect solubility was not supported by the data." 3. 5 minutes: Based on the modeled example, have the students work with their experimental group to create a clearly written statement based on their graph, expressing relationship between independent and dependent variables according to their data. 10-15 minutes: Have students use two Venn Diagrams—one to compare and contrast the similarities and/or differences that other experimenters have found in their experiments, and one to compare and contrast the similarities and/or differences they have found based on the expectation of their hypothesis. 4. 10 minutes: Create a clearly written paragraph of the compare and contrast results using words like "supported," "indicated," and "suggested" to evaluate your hypothesis. Students are looking for correlations between researched work and their experiment. Note: Be sure reference literature is cited here. 5. 10 minutes: Hot and cold feedback • Have one student in each group display the written statement of the relationship between the independent and dependent variables. • Have another student in each group display the compare and contrast paragraph. • Explain hot and cold feedback. • Give each student a small stack of yellow (hot) and purple (cold)

				Post-it Notes. • On the yellow Post-it Note, students will provide a comment on something that is done well. • On the purple Post-it Note, students will provide a constructive comment suggesting something that could be improved. • Students leave the Post-it Notes by the computer screen and then the group members can collect feedback and make adjustments. Possibly for homework.
	Standards: **WHST.6-8.9** : Draw evidence from informational texts to support analysis, reflection, and research. **WHST.6-8.8** : Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. **WHST.6-8.6** : Use technology, including the Internet, to produce and publish writing and present the relationships between information and ideas clearly and efficiently.			
	Additional Attachments: **Discussing-Analyzing the Laboratory Results Presentation.pptx** **Effect of Light Intensity, Carbon Dioxide Concentration, and Leaf Temperature on Gas Exchange of Spray Carnation Plants.pdf** **WarmandCoolFeedbackProtocol.pdf** **Scientific-Reports-The-Writing-Center.pdf** **UNC College of Arts and Sciences The Writing Center**			

30 mins	**IMPLICATIONS**: Ability to identify implications of an experiment for society, limitations of the experiment, and next steps for future study.	**WRITING THE IMPLICATIONS SCIENTIFIC RESEARCH PAPER SECTION**
		In the "Discussion" section of your scientific research paper, write one paragraph explaining what the next step after completing your lab should be. Your paragraph should include at least one actionable recommendation for the betterment of society or further testing.
			Student work that demonstrates mastery of this skill will:
			• Include one to two well constructed paragraphs
			• Provide at least one concise recommendation for society or further study by:
			  ○ clearly linking research with experiment
			  ○ identifying any limitations to experimentation
			  ○ establishing a need for further experimentation of societal change.
				1. Ask students to discuss with group, or journal, about what they think the next step would be to their experimentation project. Use the guiding questions below to help spur student thinking:
				• If you were to create a new experiment, or change something about the one you conducted and retest, how would it be different? What would you hope to find?
				• If you cannot think of a new or revised experiment, what tangible information did your experiment show? How can your information help improve society?
				
				2. Allow a couple minutes for students to share responses and thoughts. Emphasize this section as the "what now?" of the module. Experimentation, graphs, and a discussion are great, but point out that all that is trivial without some sort of actionable piece to take away from all the work done.
				
				3. Have students write an additional paragraph to their discussion section relating their research and experimentation to a next step that they or someone else could conduct. This paragraph could touch on an experimentation process or a societal action.

	Standards: **WHST.6-8.7** : Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.			
25 mins	**ACKNOWLEDGEMENTS**: Ability to identify major contributors to the research project.	**ACKNOWLEDGING CONTROLLED EXPERIMENT CONTRIBUTORS IN A SCIENTIFIC RESEARCH PAPER** Create a semi-formal acknowledgement paragraph to recognize/credit individuals who have helped with your project. Be sure to	Student work meets expectations if the acknowledgement paragraph: • Provides acknowledgments to people who helped with the study or preparation of the paper • Specifies the	1. 5-10 minutes: Introduce the concept of acknowledgement paragraph with teacher-provided example(s). Students will read an example acknowledgement paragraph to prepare for writing their own, being sure to note those being acknowledged are individuals who contributed a small amount of work toward the project but not significant enough to be listed as an author. 2. 3-5 minutes: Students brainstorm a list of individuals who contributed a small amount of work toward the project but not significant enough to be listed as an author. 3. 10 minutes: Students write their acknowledgment paragraph.

		specify the contributions of each individual.	contributions of the individuals noted • Uses appropriate format: semi-formal paragraph with header.	4. 5 minutes: Students do peer review, check for appropriate people being acknowledged, and confirm correct format was used.
	Standards: **RST.6-8.5** : Analyze the structure an author uses to organize a text, including how the major sections contribute to the whole and to an understanding of the topic. **WHST.6-8.4** : Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.			
	Additional Attachments: **Use 1st paragraph as a non-example** **Samples of Acknowledgement Paragraphs** **Guidelines for Writing an Acknowledgment** **Formatting APS Journal Articles :: Credits Section**			
10 mins	**ACADEMIC INTEGRITY**: Ability to cite and credit sources appropriately.	**CITING REFERENCES IN SCIENTIFIC RESEARCH PAPER USING APA FORMAT** Transfer your reference list from your tracking document to the reference section of your scientific research paper.	Student work that demonstrates mastery of this skill will: • Correctly cite three to five sources in APA format in the "Reference" section of their scientific research paper.	1. Have students get out the resource they used to keep track of citations. • Students should have been keeping track of sources in APA citations throughout the research process, so this should be a relatively straightforward step. 2. Have students transfer citations to the "Reference" created during the "Outline" mini-task. Students should review all cited references that are included in their paper and delete any that are not used. * A sample reference page is attached under student resources if students are unsure of, or have questions about formatting.
	Standards: **WHST.6-8.8** : Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.			
	Additional Attachments: **APA Reference Page Example.pdf**			
30 mins	**WRITING THE INTRODUCTION**: Ability to write an introduction to a scientific research paper including the research question, hypothesis, and background research.	**WRITING A SCIENTIFIC RESEARCH PAPER INTRODUCTION** Using the checklist and sentence starters provided, compose an introduction to your scientific research project.	An introduction to the scientific research paper that demonstrates mastery of this skill will: • State the question or problem • Present the hypothesis • Explain how the hypothesis was reached • Link the hypothesis to other research • Provide relevant background information • Include proper APA citations • Be in paragraph form.	**1. Introduction:** Explain the difference between a scientific research paper introduction and abstract (see linked PDF). • *Introduction:* Briefly introduce problem, review of research prior to testing, goals, hypothesis, and rationale for testing. • *Abstract:* Brief overview of entire project. Covers ideas such as the objective of your project, the methods you used, major findings, and recommendations. For additional information, see the Understanding and Writing an Executive Summary/Abstract mini-task. • Essentially, the introduction establishes a need and an abstract provides an overview of the entire project. **2. Direct Instruction:** Review several introductions from previously used lab reports. Lead a general discussion about these introductions. What made them compelling? What were some strengths and weaknesses? How were they similar and different? **3. Distribute Checklist** and go over sentence starters with students. Model how to write an introduction about a lab that students already completed or about a familiar example. Use a projector to post the example introduction. **4. Independent Practice:** Give students time to work on creating their introduction. They may write directly on the graphic organizer or type online. While students are working, circulate the classroom and work

				with students who are struggling to get started, and answer additional questions. **5. Closing:** Ask students to reflect on their writing process with a partner before sharing out with the whole class. What was challenging about writing their introduction? What was easy? Why?

Standards:

WHST.6-8.9 : Draw evidence from informational texts to support analysis, reflection, and research.

WHST.6-8.8 : Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.

WHST.6-8.7 : Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

WHST.6-8.4 : Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

Additional Attachments:

Introduction_Handout20151122-3-1cytvkm.docx

Lab Report Drafting Checklist and Sentence Starters

Introduction vs. Abstract.pdf

35 mins	**WRITING AN ABSTRACT**: Ability to write an abstract giving a brief (150-200 words) overview of the entire paper.	**WRITING AN ABSTRACT**
		Write a summary of the introduction and conclusion of the experiment in 150 to 200 words.
			Student work that demonstrates mastery of the skill will include:
			
			• A summary of the introduction in 150 to 200 words
			• Four to five sentences answering the following questions:
			  ○ Motivation: Why did you perform this experiment?
			  ○ Problem Statement: What are you trying to solve?
			  ○ Previous Experiments: Has this experiment been done before and by whom?
			  ○ Previous Results: What did the previous experimenters find when they did their experiment(s)?
			  ○ Your Results: What did you find when you did your experiment?
				Note: Teacher will provide several examples of abstracts for students to view.
				
				Instruction:
				
				1. 10 minutes: Have students individually read a teacher-obtained abstract looking for the five questions:
				
				• Why did they perform this experiment?
				• What did they try to solve?
				• Had this experiment been done before and by whom?
				• What did the previous experimenters find when they did their experiment(s)?
				• What did they find when they did their experiment?
				
				Have students circle or use highlighters to locate the evidence for their answers.
				
				2. 5 minutes: In a group of three to four, have students compare their answers.
				
				3. 10 minutes: In experimental groups, have students answer the questions in the **Writing an Abstract Chart Handout** on their experiment.
				
				4. 10 minutes: Have students make a Google Doc to collaborate the write-up of their abstract. Could be an in-class or homework assignment.

Standards:

RST.6-8.4 : Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6—8 texts and topics.

RST.6-8.2 : Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.

RST.6-8.9 : Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

RST.6-8.8 : Distinguish among facts, reasoned judgment based on research findings, and speculation in a text.

Additional Attachments:

	Writing an Abstract Chart Handout **Writing an Abstract**			
10 mins	**FORMULATING THE TITLE**: Ability to formulate a title suitable for scientific work.	**FORMULATING THE TITLE OF THE EXPERIMENT** Create a clearly written title that conveys the hypothesis of the experiment using the following format: The effect of ***independent variable*** on net CO2 production and use of ***aquatic plant species scientific name***.	A master-level experimental title will: • Articulate the name of the aquatic plant species (scientific name) • Articulate a clear and quantifiable independent variable that is expected to influence photosynthetic rate • Communicate the expected relationship clearly, using the following prompt: The effect of ***independent variable*** on net CO2 production and use of ***aquatic plant species scientific name.***	Note: Teacher will write the title format on the board and review the vocabulary terms genus and species as discussed in unit 1. 1. Have student(s) write down on paper or type the title format leaving the independent variable blank and aquatic plant species blank empty. 2. Have student(s) enter their independent variable into the independent variable blank. 3. Have student(s) look up the the scientific name of their aquatic plant. Enter the name into the aquatic plant species blank being sure to capitalize the first letter of the genus, leave the first letter of the species lowercase, and underlining both the genus and species in the title if handwriting and italicizing if typing.
	Standards: **WHST.6-8.4** : Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.			
Revision Process				

30 mins	**PEER REVIEW**: Ability to provide meaningful feedback on a scientific research paper for a partner.	**PEER REVIEW PROCESS FOR SCIENTIFIC RESEARCH PAPERS**
		Using the provided peer review form, provide two classmates with meaningful, actionable feedback about their scientific research paper.
			Student work that demonstrates mastery of this skill will:
			• Include complete peer review forms with relevant, helpful information for at least two classmates' scientific research papers, including:
			  ◦ at least one comment regarding something that another student has done well in each row of the peer review form
			  ◦ one suggestion for improvement in each row of the peer review form
			  ◦ an evaluation for clarity, organization, and completeness of their peer's work using a 4-point rating scale
			• Incorporate feedback from at least one other person about
				Teacher notes:
				• To model the peer review process, you will need a scientific research paper to use for whole-class instruction. You can either choose one of your stronger students' reports, pull a previously completed scientific research paper, or make up a quick mock scientific research paper. If possible, it is instructionally valuable to "plant" certain common mistakes for you to discuss during a think aloud. For example: verb-tense errors, unlabeled graphs or tables, etc.
				• You may or may not want to allow students to make edits on each others' papers in addition to completing the peer review form. There are pros and cons to having them do this. Major con: Students, inevitably, will make incorrect "corrections." Major pro: It is clearer when corrections are made in the text rather than noted on another sheet.
				• Peer review is only effective when students are very clear about the expectations for the assignment. Students who are less familiar with the requirements for each section of a research paper will benefit from a more explicit and specific peer feedback form than the one provided.
				• This mini-task assumes that students have experience with delivering feedback to peers about their writing and explaining why they decided to make particular recommendations. See the Sharing Constructive Feedback mini-task if your students need additional support with writing feedback.
				Modeling:
				1. Display and provide students with the scientific research paper for whole-class instruction. Project and complete the peer review form, but do not give students a copy of it yet.
				2. Model the peer review process:

			their own research paper.	• Read through the scientific research paper **out loud** to the students while they read along. As you read, stop and make quick notes (on the peer review form) about changes in surface-level problems, like word choice.
				• As you read the paper aloud, explain why you stop and make notes when you notice a **problem**. Some possible issues might include (although the comments that you decide to share will vary depending on your writing sample):
				  ◦ When you did not understand an idea: "*I was not sure how the author defined the research question. It would have been helpful if the author used additional details..."*
				  ◦ When there was more information you wanted to know: *"The author provided most of the materials that were included in the experiment, but a few items were missing."*
				  ◦ When you felt lost while reading: *"The graphs did not make sense to me because the author forgot to label the x and y axis."*
				• In addition, when you notice something **excellent**, name it using specific terms. Example: *"Wow! They described every step in the methods section clearly."* Other examples might include:
				  ◦ When there is sufficient information: *"I like how the author provides ample background knowledge about the research topic and question!"*
				  ◦ When there is strong organization: *"It is terrific how the author presents the data using a format that is easy to understand."*
				  ◦ When there is clear writing: *"The connection between the research question and methods section is logical and makes sense."*
				• Explain the **reviewer's role**: You want to make sure the feedback given helps the author improve his or her scientific research paper.
				• Ask the class to note 1) when they did not understand an idea, 2) what more information they would like to know, and 3) when they felt lost while listening.
				
				3. If your students could benefit from additional support, consider asking two students to model part of the peer review process in front of the class using a different section of the sample scientific report and by following the steps outlined on the Peer Review form. While the two students model, have the rest of the class listen and write down one to two questions about the peer review process.
				
				Writer's Role
				
				4 minutes: Read your paper out loud. Mark any changes on your paper as you read.
				
				2 minutes: Listen to the reader without commenting. Take notes about what you hear on the Lab Review Form.
				
				1 minute: Reflect back about what you heard them say, and ask for clarification if you need it.
				
				Reader's Role
				
				4 minutes: Listen to the writer read out loud. Take notes on the Lab Report Review Form
				
				2 minutes: Tell the writer the answer to each question from your notes.
				
				1 minute: Listen and provide clarification when asked. Give the writer your Lab Review Form notes.
				
				4. Have students share one of the questions they wrote while listening to their classmates model with a partner. Then come together as a whole class and share their questions. Some possible follow-up questions include: How are the roles of the reader and writer different during Peer Review? What does helpful feedback for a writer look like?
				
				Collaborative Practice:
				
				1. Count students off into groups of three (and if students worked in lab groups earlier, make sure they are working with different people).

				2. Provide students with a digital or hard copy of the peer review form. 3. Have students rotate papers within their new groups and begin reviewing each others' work. 4. Remind students that their forms will be collected and checked by teacher. **Closing:** Ask students to talk with a partner about the following questions: How did sharing your work with your peers benefit your writing? What is one thing you are going to change in your paper? Why? Then have students share out with the whole class.
	Standards: **SL.8.6** : Adapt speech to a variety of contexts and tasks, demonstrating command of formal English when indicated or appropriate. **SL.8.3** : Delineate a speaker's argument and specific claims, evaluating the soundness of the reasoning and relevance and sufficiency of the evidence and identifying when irrelevant evidence is introduced. **SL.8.1.D** : Acknowledge new information expressed by others, and, when warranted, qualify or justify their own views in light of the evidence presented. **SL.8.1.C** : Pose questions that connect the ideas of several speakers and respond to others' questions and comments with relevant evidence, observations, and ideas. **SL.8.1.B** : Follow rules for collegial discussions and decision-making, track progress toward specific goals and deadlines, and define individual roles as needed. **WHST.6-8.5** : With some guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on how well purpose and audience have been addressed.			
	Additional Attachments: **Additional Tips about Peer Review** **Peer_Review_for_a_Lab_Report20151016-3-m6m58u.doc**			
30 mins	**TECHNICAL WRITING REVISION**: Ability to proofread and format a final paper.	**EVALUATING REVISIONS** Revise draft to have sound spelling, capitalization, punctuation, style, and grammar. Adjust formatting as needed to provide clear, appealing text.	Student work meets expectations if the evaluating revisions sheet is completed and the final draft: • Is free from distracting surface errors • Uses formatting and style that supports purpose.	1. Briefly review selected skills that many students need to improve, including style (passive voice, precise language, etc). 2. Assign students to proofread each others' texts. 3. Have students complete the Evaluating Revisions handout individually and then share their responses with a partner. 4. Have students make corrections to their scientific research paper.
	Standards: **WHST.6-8.6** : Use technology, including the Internet, to produce and publish writing and present the relationships between information and ideas clearly and efficiently. **WHST.6-8.4** : Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.			
	Additional Attachments: **Evaluating Revisions**			
25 mins	**FINAL DRAFT**: Ability to create a final draft to broadcast results of an experiment, including all elements from original outline.	**SCIENTIFIC RESEARCH PAPER FINAL DRAFT** Students will write their final drafts using previous feedback to make necessary revisions and corrections and have paper formatted in the following order: title, abstract,	Mastery-level work will be submitted by designated deadline and will include: • Clearly written title, abstract, introduction, materials and methods, results,	Note: The final draft is a cumulation of the small mini-tasks and the majority of work has already been completed by this time. 1. 5 minutes: Have student check for items that need revision based on previous feedback (spelling, punctuation, missing parts, etc.) and make corrections. 2. 10 minutes: Have students format the digital copy of the laboratory report in the following order: title, abstract, introduction, materials and methods, results, discussion, references and literature cited in APA

	introduction, materials and methods, results, discussion, references and literature cited.	discussion, references and literature cited in APA format based on previous revisions. Final scoring will be based upon the LDC Rubric model.	format. 3. 5-10 minutes: Have student read the paper out loud to find any final mistakes. 4. 1 minute: Print paper or upload for final submission.
	Standards: **WHST.6-8.4** : Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.		
	Additional Attachments: **PhotosyntheticRateLabReportRubric (1).docx** **Photosynthetic Rate Lab Report Rubric** **Sample Lab Assignment** **Writing Lab Reports & Scientific Papers example**		

Instructional Resources

Student Handout

ControlledExperimentLabReportUnitOverview 20150922.docx

PhotosyntheticRateLabReportRubric 2015.09.22.docx

Teacher Resource

LDC Scientific Paper Checklist - Google Docs.pdf

VIDEO: LDC Controlled Experiment: Post Reading-Content Comprehension

Section 4: What Results?

Student Work Samples

Meets Expectations

- LDC Scientific Research Paper Rubric A.pdf
- LDC Scientific Research Paper Rubric B.pdf
- LDC Scientific Research Paper Sample B - Google Docs.pdf
- LDC Scientific Research Paper Sample A - Google Docs.pdf

Approaches Expectations

- LDC Scientific Research Paper Rubric J.pdf
- LDC Scientific Research Paper Sample J - Google Docs.pdf

Not Yet

- LDC Scientific Research Paper Rubric G.pdf
- LDC Scientific Research Paper Sample G - Google Docs.pdf

Teacher Reflection

Did students perform better or worse than you expected?

Students performed better than I expected on some tasks and could have improved in others. There was significant buy-in to the project which contributed to the excitement the students had while performing the experiment. The opportunity to work collaboratively with the experimental group to construct the scientific research paper allowed students to develop the skills either through writing the section for content or proofreading the section for accuracy and completion. New skills were learned by students, while other skills were further growing and developing. The organization of the mini-task layout made it simple to teach the concepts. However, much of the research on the topic is done on a high level and scaffolding is necessary to assist the students in understanding what they are reading.

Were there parts of the rubric that all students seemed to do well on?

Students seemed to do well on all portions of the rubric where there was concrete information to be provided. They were able to accurately address the materials and methods sections, clearly represent their data, and even write a clear abstract overviewing the essentials from their experiment.

Were there parts of the rubric that all students struggled with?

Students struggled, at times, with collecting and using appropriate sources to provide a clear direction for experimentation. It felt like they all had ideas about what they wanted to do, but ideas were largely independent of information gathered. They also struggled with evaluating and analyzing data. They drew conclusions based on what they saw, but did not necessarily use specific evidence to support conclusions.

If you were to re-teach this module, which parts of your instructional ladder would you definitely keep and what parts would you consider replacing or modifying?

The experimentation and data collection were the engaging parts of the module. Writing the different sections of the paper often required a shift in perspectives. Formulating a testable question mini-task could be used in any science class to develop the writing of a solid testable hypothesis.

Anything else that comes to mind that you would change for next time?

I would add a second day for experimental testing. This allows for kinks to be worked out if the original testing does not provide results. In addition, this gives the students an opportunity to make adjustments to their experiment. They could use the day one or day two data for their paper. I also would give more time for peer review.

Middle school teachers could use this module to teach the scientific research paper process, but have the product be a scientific poster instead of a paper.

Motivational Ideas:

I sparked interest in a few ways. First, I told the students their work would be published. We printed and bound the final copies of the research papers and had the students come up with a journal title. Second, I allowed the students to create a cafe atmosphere on scheduled days (not every day) where significant writing would occur. They came up with cafe expectations as a class, and parents provided supplies for hot chocolate, tea, and lemonade. This motivated students to complete in-class work or prepare outside work for the next day. I exchanged their completed work for a cup of choice beverage.

All Attachments

- **Text List for Carbon Dioxide .docx : https://s.ldc.org/u/1oox5peo48gx166twd7dzcm8v**
- **LDC Scientific Research Paper Rubric A.pdf : https://s.ldc.org/u/6rwbhwkhroxigg3f0obw8evdk**
- **LDC Scientific Research Paper Rubric B.pdf : https://s.ldc.org/u/aoowuyjzi3a8tcvaarq8rh87v**
- **LDC Scientific Research Paper Sample B - Google Docs.pdf : https://s.ldc.org/u/85c1jyvm31jbqj4w1jsxiczly**
- **LDC Scientific Research Paper Sample A - Google Docs.pdf : https://s.ldc.org/u/4imq1f2mrqb3md1jbjqdltc3z**
- **LDC Scientific Research Paper Rubric J.pdf : https://s.ldc.org/u/bgn0mx95t3dhbeh1ocsi5lfso**
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- **PhotosyntheticRateLabReportRubric 2015.09.22.docx : https://s.ldc.org/u/3rold379a3twmytija40ssg8n**
- **LDC Scientific Paper Checklist - Google Docs.pdf : https://s.ldc.org/u/9486hjjhrn5r1969mac0s33z1**
- **VIDEO: LDC Controlled Experiment: Post Reading-Content Comprehension : https://s.ldc.org/u/dcvs5hthchrwq3od8nwklornq**