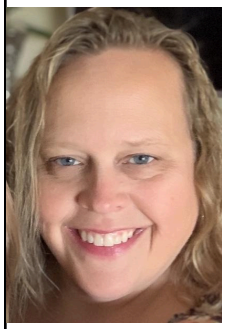
Flight of the Bumblebee: Using Acoustics to Eavesdrop on Bees and Pollination	
Michelle Oilar 	My name is Michelle Oilar. I teach 8th and 9th grade Science in a rural district in Clark County MO. I have a BS in Elementary Education, a K-9 Science Endorsement and a Reading Specialist Degree. My first 10 years of teaching were spent in 6-8th grade science in a rural Illinois school. In Clark County I have taught a combination of ELA, Science and Reading Recovery at the MS and HS level, over the last 16 years. For the past 4 years I have returned to teaching just science. My husband, daughter and I also live/work on a busy farm. Outside of school and farming I love to read, spend time with family and friends, preferable on any body of water. I soon will have extra free time as my 10th grade daughter will get her license and my chauffeuring days will end. Flight of the Bumblebee is modified for use in middle school Science classroom. This is an interdisciplinary unit that builds background knowledge and vocabulary to aid in better understanding of a complex, scientific anchor text. Curricular Focus: Life Science/Ecosystems Unit. This unit was implemented in 4 sections of heterogeneously grouped 8th graders in their Science class. My science classrooms are full inclusion with approximately 12 students with disabilities and 70% free and reduced lunch population.

Text Set Overview

ANCHOR TEXT		
Flight of the Bumblebee: Using Acoustics to Eavesdrop on Bees and Pollination		
TEXT SET LINE OF INQUIRY		
SCIENCE	**MATH**	**LITERACY**
Phenomenon: Animal populations can become endangered through a variety of factors. **What Students Figure Out:** ● The stability of populations in an ecosystem is affected by many different living and nonliving components. ● Human impact is causing declining populations.	Data Analysis Reason abstractly and quantitatively Relationship of ratios Proportional relationships between two quantities Use variables to represent real world math problems	CER - Write Arguments Cite Textual Evidence Integrate quantitative/technical info Conduct short research projects Gather info from multiple relevant resources

• Evaluate solutions for maintaining biodiversity.		

Lesson	Outcome(s)	Connections to Standards (CCSS, NGSS)
Intro		
1	Engage students' prior knowledge and create a set of questions for study.	**DCI: Disciplinary Core Idea** **LS2.C** Ecosystem Dynamics, Functioning, and Resilience **LS4.D** Biodiversity and Humans **ETS1.B** Developing Possible Solutions.
2	Students explore how changes in biodiversity can influence the availability of natural resources for humans. They study how changes in one part of an ecosystem can cause biodiversity loss in another part of the ecosystem.	**MLS EEI C** Represent and analyze quantitative relationships between dependent and independent variables. a. Write an equation to express one quantity, the dependent variable, in terms of the other quantity, the independent variable. b. Analyze the relationship between the dependent and independent variables using graphs, tables and equations and relate these representations to each other. Solve linear equations and inequalities in one Variable. **Science:** Students explore how changes in biodiversity can influence the availability of natural resources for humans. They study how changes in one part of an ecosystem can cause biodiversity loss in another part of the ecosystem. **DCI** **LS2.C** Ecosystem Dynamics, Functioning, and Resilience **LS4.D** Biodiversity and Humans

		ETS1.B Developing Possible Solutions. **CCC**: Stability and Change **SEP:** Engaging in Argument From Evidence
3	Analyze how scientific writing is organized and how the structure contributes to its meaning.	**ELA** **Missouri Learning Standard 8.R.1.B:** Determine the meaning of words and phrases as they are used in the text, including figurative, and connotative, and meanings using context, affixes, or reference materials. **Missouri Learning Standard 8.R.1.C:** Interpret visual elements of a text including those from different media and draw conclusions from them (when applicable). **Missouri Learning Standard 8.R.2.A:** Analyze how an author's choice concerning a text's organization or overall structure contributes to meaning. **Missouri Learning Standard 8.R.3.A:** Compare and contrast information presented in different mediums and analyze how the techniques unique to each medium contribute to meaning. **CCSS.ELA-Literacy.RI.8.1:** Cite textual evidence that strongly supports an analysis of what the text says explicitly as well as inferences drawn from the text. **CCSS.ELA-Literacy.RI.8.4:** Determine the meaning of words and phrases as they are used in a text, including figurative and connotative meanings; analyze the impact of specific word choices on meaning and tone, including analogies or allusions to other texts. **CCSS.ELA-Literacy.RI.8.5:** Compare and contrast the structure of two or more texts and analyze how the differing structure of each text contributes to its meaning and style. **CCSS.ELA-Literacy.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.
4	Students use mathematical formulas to conduct a simulated	SEP Engaging in Argument from Evidence

	measurement of diversity of bumblebees in an area.	DCI LS2.C Ecosystem Dynamics, Functioning, and Resilience CCC Stability and Change MP.2 Reason abstractly and quantitatively.
5	8.RI.1.A Draw conclusions, infer, and analyze by citing the textual evidence 8.RI.1.B Determine the meaning of words and phrases as they are used in the text. 8.RI.1.D Explain the central/main idea(s) of a text and analyze its development over the course of a text.	Use text and video to 8.RI.1.A Draw conclusions, infer, and analyze by citing the textual evidence 8.RI.1.B Determine the meaning of words and phrases as they are used in the text. 8.RI.1.D Explain the central/main idea(s) of a text and analyze its development over the course of a text. SEP Engaging in Argument from Evidence DCI LS2.C Ecosystem Dynamics, Functioning, and Resilience CCC Stability and Change
6	Students will explore the two basic elements, or phases, of the problem solving process. The two basic elements, or phases, of the problem solving process are establishing the criteria, and determining the constraints. ● Before you can solve a problem, you must identify what the problem is. ● Use evidence from text to identify a problem and establish criteria and constraints. ● There are many ways to solve a design problem	8.RI.1.A Draw conclusions, infer, and analyze by citing the textual evidence 8.RI.1.B Determine the meaning of words and phrases as they are used in the text. SEP Engaging in Argument from Evidence SEP Asking questions (for science) and defining problems (for engineering) DCI LS2.C Ecosystem Dynamics, Functioning, and Resilience CCC Stability and Change **ELA** **Missouri Learning Standard 8.W.2.A:** Develop argumentative writing

		by introducing and supporting a claim with clear reasons and relevant evidence; acknowledging counterclaims, and establishing relationships among claims, counterclaims, and supporting evidence. **Missouri Learning Standard 8.SL.1.B:** Delineate a speaker's argument and claims, evaluating reasoning and sufficiency of evidence in order to pose questions that connect the ideas of several speakers and respond to others' questions and comments with relevant evidence, observations, and ideas. **CCSS.ELA-Literacy.RST.6-8.1:** Cite specific textual evidence to support analysis of science and technical texts. **CCSS.ELA-Literacy.W.8.1.A-B:** Write arguments to support claims with clear reasons and relevant evidence. **CCSS.ELA-Literacy.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. **Science** While Claims, Evidence, and Reasoning is not a standard in NGSS or MLS, it is incorporated into several other standards. Information about this can be found on the NGSS website under **Science and Engineering Practices**.
7	Students will engage with the anchor text and be able to identify claims, evidence, and reasoning in scientific writing.	SEP Engaging in Argument from Evidence SEP Asking questions (for science) and defining problems (for engineering) **DCI LS2.C** Ecosystem Dynamics, Functioning, and Resilience **CCC** Stability and Change **CCSS.ELA-Literacy.RST.6-8.1:** Cite specific textual evidence to support analysis of science and technical texts.

		CCSS.ELA-Literacy.W.8.1.A-B: Write arguments to support claims with clear reasons and relevant evidence.
8	Students will evaluate possible solutions to the pollination/bee loss problem.	SEP Engaging in Argument from Evidence SEP Asking questions (for science) and defining problems (for engineering) DCI LS2.C Ecosystem Dynamics, Functioning, and Resilience CCC Stability and Change **CCSS.ELA-Literacy.RST.6-8.1:** Cite specific textual evidence to support analysis of science and technical texts. **CCSS.ELA-Literacy.W.8.1.A-B:** Write arguments to support claims with clear reasons and relevant evidence.

Introductory Claim-Evidence-Reasoning Lesson

	Key Ideas	Learning Activities
	Introduction or Review of Claim / Evidence / Reasoning (C.E.R.) A claim is a statement of belief that can be argued for or against.	Show the video clip: "Audi: My Dad's a Space Alien" car commercial. Have the students identify the claim, list three pieces of evidence, and the reasoning given behind them. ● Write those pieces on the board, then evaluate the validity of the evidence and reasoning. ● Work through material as a whole class activity.

	Claims, Reason, and Evidence are connected to each other.	Video Clip: CER (Claim, Evidence, Reasoning) in Biology: Amoeba Sisters. EdPuzzle - "BrainPop: Critical Reasoning". ● Have students either watch video individually and answer the questions, or show video to the entire class and work through questions as a whole class discussion. Define scientific reasoning in a learner-friendly way, and illuminate commonalities and differences between "everyday" language and "scientific" language. Students will conduct our scientific investigation which ends with students writing a CER over the question: Which solution made the best bubble? (See attached Lab)

Unit Lesson #1

	Key Idea	**Learning Activities**
	Engage students' prior knowledge and create a set of questions for study. .	Post the pictures from the Science Journal (Pages 2 & 3). Using the pictures or any that show different types of ecosystems ● How could you determine if ecosystems near you are healthy? ● How can people help to maintain biodiversity in your community? ● What factors should be considered before introducing new species into an area? ● Watch - Indicators of a Healthy Ecosystem
		Science Journal, Page 3 1. What are indicators of a healthy environment? 2. What is Ecological Diversity and why is it important? 3. What is happening to healthy ecosystems? 4. How confident do you feel in determining the health of the deer population? The bumblebee population? 5. Why would it be easier for you to determine deer health over bumblebee health? Explain your answer.

Unit Lesson #2

	Key Idea	Learning Activities
Engage **Exploration** **Explain** **Evaluating** **Biodiversity Loss**	Students explore how changes in biodiversity can influence the availability of natural resources for humans. They study how changes in one part of an ecosystem can cause biodiversity loss in another part of the ecosystem.	Review Science Journal from Unit 1 ● Look back at healthy/unhealthy ecosystems Phenomenon - Why Do Bees Matter Video 1:14 ● As students watch the video create Questions/thoughts and comments for further study ○ What are three things you notice? ○ What are two things you infer? ○ What is one question you have? Think, Pair, Share ● After discussing in small groups students will record in their Science Journal their ideas about different ways that bumblebees have helped humans and been negatively affected by human activities ● Share ideas with the class Define Biodiversity Slow Reveal Graph Activity: Decline of honeybees | Mathematics of Sustainability Graph Credit ● Use the Google Slides to show several graph phases of the declining hives graphs. ● For each graph students will reflect on the following questions in the Student Journal Page 4 ○ Graph 1: Predict what this graph might be showing. ○ Graph 2: What new information was added? What do you think it means? ○ Graph 3: What new information was added? What do you think it means? ○ Graph 4: In the final reveal, explain what this graph means for bumblebees, pollination and ecosystem biodiversity. ● Discuss final graphs Exit Slip - Making Sense of Today's Science

Unit Lesson #3

	Key Idea	Learning Activities
	Students Explore Text Features to aid in future comprehension.	After passing out the text and showing it on the overhead, engage students in a discussion of their thoughts, fears, concerns about a text such as this. Independently or together, write a prediction as to what the students think the text could be about. Together, read the Introduction of Anchor text. Write a prediction as to what they think the text will be about. Using highlighters, spend the 20-30 minutes interacting with the features of the text via the Scavenger Hunt. (The Text Feature Scavenger Hunt is a way to introduce students to a complex text without overwhelming them by expecting them to read it cold.)
		After the Scavenger Hunt Students will read the SUMMARY of FOTB and answer two questions as an exit slip. 1. What word is used the most in the Summary Paragraph (Paragraph 1)? 2. Explain what you think this text will be about using ONLY the Scavenger Hunt and Summary Paragraph. How do you think scientists are going to try to help bees? Use evidence from the text to elaborate on your prediction.

Unit Lesson #4

	Key Idea	Learning Activities
	Students use mathematical formulas to conduct a simulated measurement of diversity of bumblebees in an area.	Group Scenario: Disease wipes out the most dominant species in each group's sample. Groups should separate this color bean from their bean pile and recalculate how this change would affect the species richness, species abundance, and relative abundance of their sample area. Discuss as a class why an increase in the relative abundance of a species does not necessarily indicate an increase in biodiversity or ecosystem health. Directions and Student data page is located on Page 7-10 in the Student Journal. Graph paper on page 6. Complete lab with a partner. ● First display the types of beans and what bees represented.  ● Follow lab directions on page7 ○ I used pre-scooped bags of beans to save the mess and also I give them a paper plate to keep the mess down.

		• After students complete the lab exploration they should collect their data on page 8 • Record Class data either on master computer or written on the board for everyone to copy onto page 10 • Analyze individual and class data for averages to be able to compare. • Graph CLASS Bumblebee species abundance on page 6. Use a different color for each • Discuss how this lab relates to FOTB and what we have discovered so far.

Unit Lesson #5

	Key Idea	Learning Activities
		Pollination: Trading Food for Fertilization Trading Food for Fertilization Honeybees help farmers, but they don't help the environment (NPR) In groups, watch videos and answer questions (Science Journal, pages 11-12) on the importance of bees for pollinations, food and Ecosystem. The purpose is to help students develop background knowledge on the situations facing bees so they are better able to intelligently interact with the FOTB and to use the information in future problem solving activities dealing with helping the ecosystem from loss and instability.

Unit Lesson # 6

Guiding Question	How do you solve a design problem?	
	Key Idea	**Learning Activities**

	The two basic elements, or phases, of the problem solving process are establishing the criteria, and determining the constraints.	The following activity was changed and adapted from Jeanie Sneller. Have a picture on the board of different types of mouse traps/taco parties along with the question: What is the problem solving process? Engineering Mousetrap/Taco Party ● I use this image to start the lesson. You could use one or the other or one of your own. ● The Engineering Design Process: A Taco Party The Design Process: Have the students read the following article: Who Needs a Better Mousetrap? Using the article, share ideas and develop a class graphic organizer (see example) that outlines the basic elements (or phases) of the "problem solving process." Ensure that the graphic organizer is large enough to add a new row of information related to the problem the students will engage in for this learning cycle. What are the "criteria"? What are the "constraints"? ● Mousetrap/Taco Party (example or could be used to complete activity) Work in groups to solve or come brainstorm ideas "How to Build a Better Mousetrap."
	Before you can solve a problem, you must identify what the problem is.	Watch the video TEDEd Creative Constraints. ● Ask students, what are the constraints discussed in this video? ● When have you been given criteria and constraints? ● Do you ever do projects at school? ● Do your teachers tell you the criteria? What are the constraints of the project? Identifying a Problem: Provide students with a copy of the "Letter to the Scientists". Inform the students that they are scientists. After the students have read the letter, have them break up into small groups or pairs to respond to the following questions: What is the problem that the farmers are facing? Why might the farmers be facing this problem?

	Use evidence from text to identify a problem and establish criteria and constraints.	Criteria and Constraints: Break students up into small groups of 3 or 4. ● In the small groups, have the students use the information that they have been provided with to identify possible criteria and constraints of the problem that they are solving. ● For the criteria and constraints (the claims), they are to provide supporting evidence (a statement/sentence from the articles.) ● They are to create a table in their notebook to record the information.
	There are many ways to solve a design problem.	Developing Solutions: Explain to students that once a problem is understood, the next step is to develop a solution. But what are some things that we should know to help facilitate the development of a solution? Instruct the students to write down what they think the steps should be for design problems while they watch the video(s). After they have read the article, have the students respond to the following prompt on a piece of paper: What are three steps that may occur during a solution phase? After they have written their response, have them crumple up the paper and “toss” into a common area (Commit & Toss). Each student is to get one piece of paper (not their own) and, in a small group, discuss the steps identified. Add to the graphic organizer the different steps that may occur during the solution phase. Do a whole class brainstorm of possible solution pathways for the dilemma the farmers are facing. Encourage the students to draw on and think about what they have heard and read during the course of the inquiry. Once you have a list of ideas, pick ONE. Divide students into two groups. Choose one group to support the solution and the other to oppose the solution. As a group, they are to write two claims in defense of their position and provide evidence for those claims. Have each group share their claims and evidence and then discuss as a group. One possible way to share this is to have a team member from each group share the claims and evidence in a Google Doc that everyone in class can see. This document can also be displayed on the board. You can also take a vote as to which position was the strongest. You could create a Kahoot, Survey Monkey, or other type of online survey tool to get quick, anonymous results.

Unit Lesson #7

	Key Idea	Learning Activities
		Review CER components - use that review to set the purpose for reading. **** PRO TIP: Prior to the lesson number the paragraphs in the text to better help students navigate the text and allow an easier group discussion.**** With partners/groups and using the guided reading in the Student Journal 13-14 read Anchor Text: Flight of the Bumblebee. Students can read this alone or you can have them read it with a partner and discuss. Can acoustics be used to monitor bee behavior? Is it the most reliable method? ● Use Student Journal pages 15 & 16 as a guided reading After they have had time to read the text and work through it, put students into groups of 3-4. Have them focus on only the 3 CER questions under the Experimental Results in the Anchor Text pages 2-4 and page 16 in Science Journal. Give students time to discuss what they highlighted and to agree/disagree and rework their answers. Give students a way to create group answers and share them. I have used butcher paper, google slides, and Canva. Class discussion over the article and CER components Debate and agree upon CER components

Unit Lesson # 8

	Key Idea	Learning Activities
	Evaluation	Flight of the RoboBees Are Robot Bees The Future? | Planet Fix | BBC Earth Science Critiquing a Possible Solution: Individually complete the Robo-Bees assignment. It may also be helpful to print these articles so that students can look at a physical copy. Exit Slip: What are the actions you would need to take to solve a design problem? (Note, this exit slip could be completed at the end of each instructional session.)