IMPLEMENTING INQUIRY-BASED LEARNING INTO A HIGH SCHOOL SCIENCE CLASSROOM TO IMPROVE STUDENT ENGAGEMENT AND LEARNING OUTCOMES

by

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A capstone project submitted in partial fulfillment of the requirements for the degree of Master of Arts in Teaching.

Hamline University

Saint Paul, Minnesota

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PROJECT DESCRIPTION

This project was designed as a result of researching the question, *how can inquiry-based teaching models promote learning in a high school biology class?* After reflecting on experiences as a student and a teacher, and extensively reviewing the literature available on inquiry-based learning, the Next Generation Science Standards, and student engagement and learning outcomes, the following project was developed.

This project is a curriculum designed for a 10th grade general biology course in a rural Minnesota high school. It is a 10 day animal behavior unit designed to be delivered in 1 hour class sessions. This unit serves as a bridge between an ecology unit and an evolution unit. The goal of the curriculum was to implement inquiry-based learning practices to fulfill the 2019 Minnesota state science standards, which align with the Next Generation Science Standards.

The curriculum follows the formatting of the Understanding by Design (UbD) framework. Understanding by Design involves a backward planning model, which starts by defining classroom outcomes. In this curriculum, outcomes were determined using the 2019 Minnesota state science standards. Following classroom outcomes, assessments are designed, and lastly a learning plan and academic activities. The lessons are formatted using the UbD lesson plan model.

TABLE OF CONTENTS

REFERENCES

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Appendix A

Animal Behavior Unit Timeline

Day 1
- Guppy lab intro/ethogram/discussion/preparation
- Jamboard
- Prep Packet

Day 2
- Prep Packet
- Design guppy lab
- Conduct guppy lab

Day 3
- Collect guppy data
- Begin writing intro section of paper
- Begin writing methods section of paper

Day 4
- Collect guppy data
- Research methods activity

Day 5
- Collect guppy data
- Cricket lab intro

Day 6
- Collect guppy data
- Cricket lab

Day 7
- Collect guppy data
- Create & Present CER in small groups

Day 8
- Collect guppy data
- Mate selection lab

Day 9
- Collect guppy data
- Mate selection lab

Day 10
- Collect guppy data
- Finish guppy lab report

Appendix B

Title: Animal Behavior: Lesson 1 (3 Days)
Topic: Habitat Selection & Guppy Lab
Subject/Course: Biology Kingdoms **Grade: 10**

Stage 1 - Desired Results

State Aligned Standards:
9L.2.2.1.1 Use a computational model to support or revise an evidence-based explanation for factors that have ecological and economic impacts on different sized ecosystems, including factors caused by the practices of various human groups.** (P: 5, CC: 3, CI: LS2) Examples of ecological impacts might include changes in the carrying capacity, species numbers and/or types of organisms present in an environment. Examples of human practices that can have positive or negative impacts, such as stream restoration versus deforestation as an ecological example. Examples of computational models may include online simulations of population dynamics, population ecology, or population growth.

9L.3.1.1.1 Develop and use a model to illustrate the levels of organization of interacting systems and how that translates into specific functions in multicellular organisms. (P: 2, CC: 6, CI: LS1) Emphasis is on specific functions at the organ system level such as nutrient uptake, water delivery, and organism movement in response to neural stimuli. Examples of models may include real (e.g. fish, birds, insects, etc.) or imaginary organisms with attention to the various structures and systems that assist the organism in performing necessary life functions.

Understandings:
- Students will understand how biotic and abiotic factors interact in an ecosystem to support life.
- Students will understand how an animal's habitat supports its behaviors needed for survival.

Essential Questions:
- What is the difference between a habitat and an ecosystem?
- What behaviors does a habitat support?
- What components of a habitat support life?
- How can a fish survive in a closed-bottle ecosystem?

Students will know…
- The definitions of the words: ecosystem, habitat, abiotic, biotic
- what makes a habitat
- how habitats support animal behavior necessary to survival and reproduction

Students will be able to…
- identify the key features of a habitat
- identify the behaviors of a guppy and how their habitat supports those behaviors
- design a closed-bottle habitat that will support the life of a fish

Stage 2 - Assessment Evidence

Performance Tasks:
- Students will design and build their own guppy habitats to sustain life for 3 weeks.
- Students will collect data looking at their water quality and the behavior of the fish to measure the success of their habitat. They will write an explanation for each characteristic of their habitat (oxygen content, plant use, type of water, food source, etc.) and submit it before being able to build their habitat.

Other Evidence:
- Students will write a short, 2-3 page report using scientific literature format. Students will reflect on their learning and the outcome of their labs in the discussion portion of their paper.

Stage 3 - Learning Plan

Learning Activities

Day 1

- Lab Preparation Jamboard
- Fish ethogram video with timer
- Guppy *(Poecilia reticulata*) Habitat Lab Preparation

Day 2

- Guppy (*Poecilia reticulata*) Habitat Lab Preparation
    - Design lab
    - Build habitat

Day 3

- Collect guppy lab data
- Guppy Lab Report

Materials Available

- Let me know if there is something else you'd be interested in having in your habitat. Either you can bring it in, or I'll see what I can do.

Guppy

Container
2L Bottle

Water
Pond Water
Lake Water
River Water
Tap Water

Plants
Elodea
Hornwort
Anacharis

Algae Pads

Other animals
Snails

Sediment
Fertilizer
Pebbles
Rocks
Sand
Dirt

Guppy (*Poecilia reticulata*) Habitat Lab Preparation

1. Observe the fish video for 3 minutes. Make a list of the behaviors that you see below. https://www.youtube.com/watch?v=SusQyYcRMvk

2. Define each behavior above
3. Come up with an abbreviation for each.
    a. Ex. Eating (E), Resting (R)
4. Fill out your Ethogram with the behaviors that you identified.
5. Watch the next 5 minutes of the fish video and fill out the ethogram for ONE of the fish. https://www.youtube.com/watch?v=SusQyYcRMvk

Name of Observer: Study Species: Goldfish Study Animal: Details of environment:						
	Types of Behaviors					
Time						
0:00						
0:15						
0:30						
0:45						
1:00						
1:15						
1:30						

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4:45						
5:00						
Total						

Project Objective: To put together a suitable habitat (ecosystem) that will allow one guppy to survive to the end of the school year and beyond. You will be making observations of your ecosystem for the next three weeks and recording data to be used in your write up for this lab. The ecosystem in this experiment will be closed, meaning that once you set up your ecosystem, the bottle cap will remain on for the remainder of the experiment. In other words you will not take off the cap to add any food, water, etc.

6. What do you need to research before building your habitat?

7. What does your habitat need to have to support your guppy's physical and behavioral needs? You will need to do some research for this section. Make a list below and include links to your sources.

Get in your Groups

8. Write your research question.
    a. Hint - this will include specifics about the habitat you decide to build

9. Write a hypothesis. (What do you think the answer to your question will be?)

10. Design your habitat.

Available Materials - Let me know if there is something else you'd be interested in having in your habitat. Either you can bring it in, or I'll see what I can do.

Container	**Water**	**Plants/Algae**	**Sediment**
2L Bottle	Pond Water	Elodea	Fertilizer
	Lake Water	Hornwort	Pebbles
Other animals	River Water	Anacharis	Rocks
Snails	Tap Water	Algae Pads	Sand
			Dirt

    a. What materials will you use?
    b. For each material, explain why you chose that item and how it will meet your fish's physical and behavioral needs.
        i. *Hint - The more you write here, the less you will need to write for your lab report. You'll just be able to copy and paste this section into your paper.*

c. What are your controlled variables? (The variables that will not change)

d. What are your uncontrollable variables? (The variables that could affect your experiment, but you cannot control)

11. What type of data will you collect? (How will you measure the success of your habitat for your fish?)
    a. Make your data table below.

12. Draw and label your setup below. (Feel free to draw on a piece of paper. Include a photo of your drawing here, or submit a picture to the Google Classroom assignment).

Guppy Lab Report

You will be writing a formal lab report following the standard formatting of scientific literature. Your report will be written in a similar format to the article we read called, “Weather-Dependent Foraging Behavior of Some Birds Wintering in a Deciduous Woodland.”

Your paper will include:

- Introduction: Introduce the goal of the experiment, including your research question and hypothesis.
- Methods: Explain what you did, including the materials you used, why you used them, and how you measured the success of your habitat.
- Results: Include your data table and describe the changes you observed in your habitat as well as how long your fish lived.
- Discussion: Describe what the results mean. Was your habitat successful? What was the possible cause of your fish’s death? If your fish is still living, talk about how long you think it could live in its habitat and why it has been successful.
- Summary: A brief paragraph summarizing everything you’ve covered in your report.
- Literature Cited: Cite the sources you used for your research in the paper in the intro and methods section (to support why you chose each source).

Formatting Guidelines:

- 11 or 12 size font
- Double spaced
- 2-3 pages
- Headings for each section of your paper (Intro, methods, etc.)
- In-text citations and proper citations in your literature cited section

Guppy Lab Rubric:

	1	2	3	4
Intro	Does not explain goal of project, include research question, or hypothesis.	Poorly explains goal of project, includes research question, and hypothesis.	Adequately explains goal of project, includes research question, and hypothesis.	Excellently explains goal of project, includes research question, and hypothesis.
Methods	Does not explain why each material was chosen, cites sources, or how habitat success was measured.	Poorly explains why each material was chosen, cites sources, and how habitat success was measured.	Adequately explains why each material was chosen, cites sources, and how habitat success was measured.	Excellently explains why each material was chosen, cites sources, and how habitat success was measured.
Results	Poorly organized data table, does not describe results of experiment.	Organized data table, poorly describes results of experiment.	Organized data table, adequately describes results of experiment.	Well organized data table, excellently describes results of experiment.
Discussion	Poorly describes meaning of results.	Somewhat describes meaning of results.	Adequately describes meaning of results.	Excellently describes meaning of results.
Conclusion	Does not summarize paper.	Poorly summarizes paper.	Adequately summarizes paper.	Excellently summarizes paper.

Appendix C

Title: Animal Behavior: Lesson 2 (1 Day)
Topic: Research Methods and Application of Animal Behavior
Subject/Course: Biology Kingdoms **Grade: 10**

Stage 1 - Desired Results

State Aligned Standards:
4.1.1 Students will be able to engage in argument from evidence for the explanations the students construct, defend and revise their interpretations when presented with new evidence, critically evaluate the scientific arguments of others, and present counter arguments.

Understandings:	Essential Questions:
● Why different research methods are used in different situations. ● The ethical concerns of research using animals.	● How is animal behavior researched? ● What are the pros and cons of observational, experimental, and comparative research methods? ● When is it appropriate to use a specific research method?
Students will know… ● The definitions of the words: ethology, comparative methods, observational methods, experimental methods ● The differences between observational, experimental, and comparative research methods.	Students will be able to… ● Compare and contrast research methods in the field of animal behavior ● Determine what research method is best fit to test a specific hypothesis

Stage 2 - Assessment Evidence

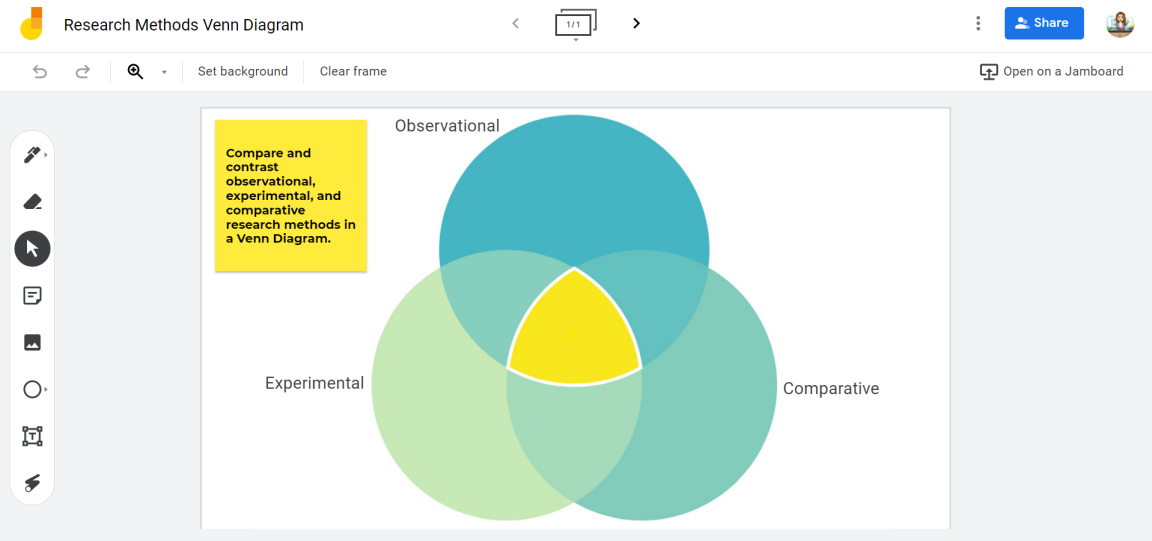
Performance Tasks:	Other Evidence:
● Class discussion and Jamboard participation ● Jamboard discussion tool	● Venn Diagram Jamboard

Stage 3 - Learning Plan

Learning Activities
Day 4

- Collect guppy ecosystem data - 5 minutes
- Think-pair-share discussion about opening question: What are some ways we can study and/or research animal behavior? (Have students share ideas on Jamboard in whole-class discussion) - 15 minutes
    - Follow-up question: How could we categorize these different methods? Students sort answers in Jamboard Venn diagram
    - Follow-up question: Why would you choose to use each method?
- Watch research video clips and discuss research methods presentation - 25 minutes
    - What are some pros and cons to these methods?
- Students refine Jamboard Venn diagram with table partners - 5 minutes
- Animal research ethics discussion - 10 minutes
    - What are some things that need to be considered when using animals in research?

Animal Behavior Research Methods Jamboard



Research Method Presentation

Appendix D

Title: Animal Behavior: Lesson 3 (2 Days)
Topic: Cricket Lab
Subject/Course: Biology Kingdoms **Grade: 10**

Stage 1 - Desired Results

State Aligned Standards:
9L.4.1.1.3 Evaluate the evidence supporting claims that changes in environmental conditions may result in (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species (P: 7, CC: 2, CI: LS4) Emphasis is on determining cause and effect relationships for (1) how changes to the environment such as deforestation, fishing, application of fertilizers, drought, flood, and (2) the rate of change of the environment affect distribution or disappearance of traits in species.

9L.3.1.1.1 Develop and use a model to illustrate the levels of organization of interacting systems and how that translates into specific functions in multicellular organisms. (P: 2, CC: 6, CI: LS1) Emphasis is on specific functions at the organ system level such as nutrient uptake, water delivery, and organism movement in response to neural stimuli. Examples of models may include real (e.g. fish, birds, insects, etc.) or imaginary organisms with attention to the various structures and systems that assist the organism in performing necessary life functions.

Understandings: ● Students will understand how to create and test a hypothesis based on a research question. ● Students will understand the difference between learned and innate behaviors.	Essential Questions: ● What are some observable cricket behaviors? ● What behaviors are learned and innate? ● How can I develop an experiment to learn more about a cricket's behavior?
Students will know… ● The definitions of the words: instinct, innate behavior, learned behavior ● The difference between an innate and a learned behavior. ● That some behaviors are a combination of instinct and learned behaviors.	Students will be able to… ● Write and test a hypothesis ● Support a claim using evidence and reasoning ● Communicate ideas to peers ● Compare and contrast innate and learned behaviors

Stage 2 - Assessment Evidence

Performance Tasks: ● Claim, Evidence, Reasoning virtual poster presentation ● Assessed against rubric below	Other Evidence: ● Students will draw a conclusion based on evidence ● Students will support a claim in a small group virtual poster presentation

Stage 3 - Learning Plan

Learning Activities
Day 5
- Collect guppy lab data
- Cricket lab preparation
    - Students are broken into groups of 3-5 students determined by teacher
    - Students watch crickets interact and complete an ethogram
    - Discuss components of a research question as a class

- Small groups choose behavior they want to research and design a research question.
- Teacher checks groups' questions as they finish them.

Day 6

- Collect guppy lab data
- Cricket Lab
  - Students design an experiment to test their hypotheses based on their research question and create data table - 15 minutes
  - Students build and conduct their experiments. Students repeat multiple trials to obtain significant results. - 25 minutes
  - Students organize results and draw final experimental design and write the introduction and methods section of their paper - 10 minutes

Day 7

- Collect guppy lab data
- CER
  - Students write a claim answering their research question using their results
  - Students write reasoning and design a virtual poster to communicate their findings with their classmates - 30 minutes
- Present virtual CER posters - 30 minutes
  - Classmates ask questions following each presentation and groups evaluate ways they could improve or build upon their experiment.

Day 10

- Collect guppy lab data - 5 minutes
- Compile guppy lab data and add to results section of lab report - 5 minutes
- Discuss the rubric and discussion section of a lab report - 10 minutes
- Students write discussion section of lab report and complete revise any sections that need to be updated - 30 minutes
- Student unit review survey - 10 minutes

Cricket Lab Preparation

1. Observe your crickets for 5 minutes. Make a list of the behaviors that you see below.

2. Define each behavior above
3. Come up with an abbreviation for each.
    a. Ex. Eating (E), Resting (R)
4. Fill out your Ethogram with the behaviors that you identified.
5. Observe your crickets and fill out the ethogram for 15 minutes.

Name of Observer:
Study Species: Study Animal:
Details of environment:

	Types of Behaviors									
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Total										

6. What behavior would you like to research? Create a research question for your experiment.

7. What do you need to research before creating your experiment?

8. Research more about crickets, and write your notes below.

Cricket Lab Experiment

1. Write your research questions.
    a. Example: Do crickets prefer to eat fruits or vegetables?

2. Why did you choose this research question?

3. Write a hypothesis. (What do you think the answer to your question will be?)

4. Design your experiment.
    a. How are you going to test your hypothesis? What research method are you using (comparative, experimental, observational)?

    b. What materials will you use?

c. What is your independent variable? (The variable you are changing)

d. What is your dependent variable? (The variable you are measuring)

e. What are your controlled variables? (The variables will not change)

f. What are your uncontrollable variables? (The variables that could affect your experiment, but you cannot control)

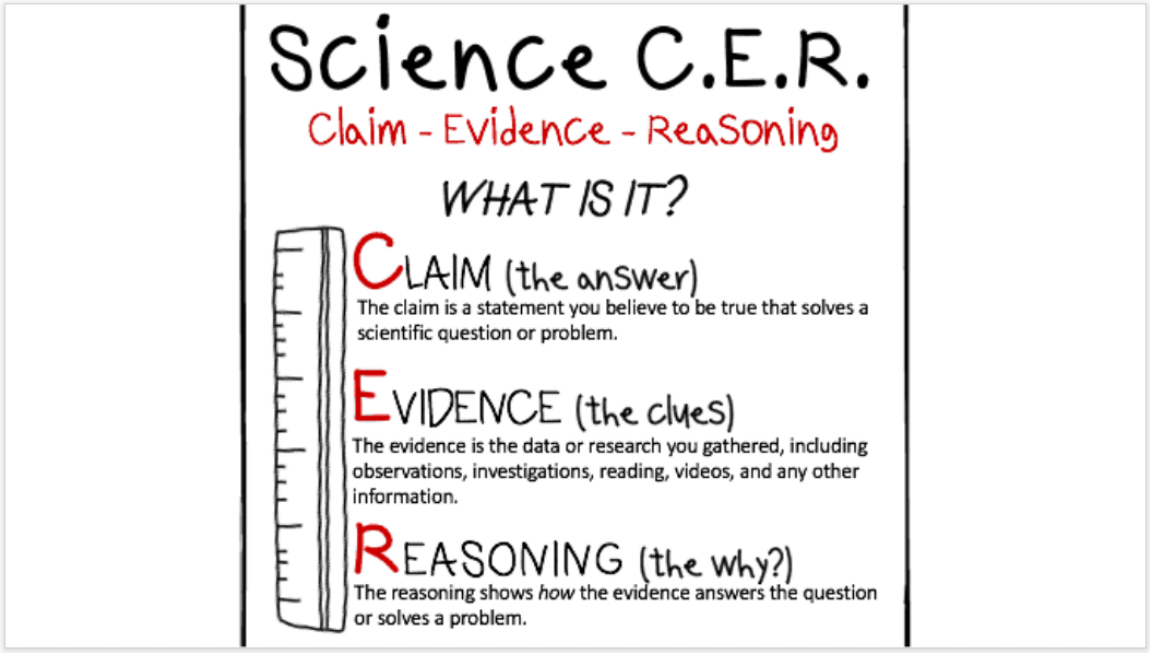
g. How many trials will you conduct? Will you use the same cricket? Different crickets?

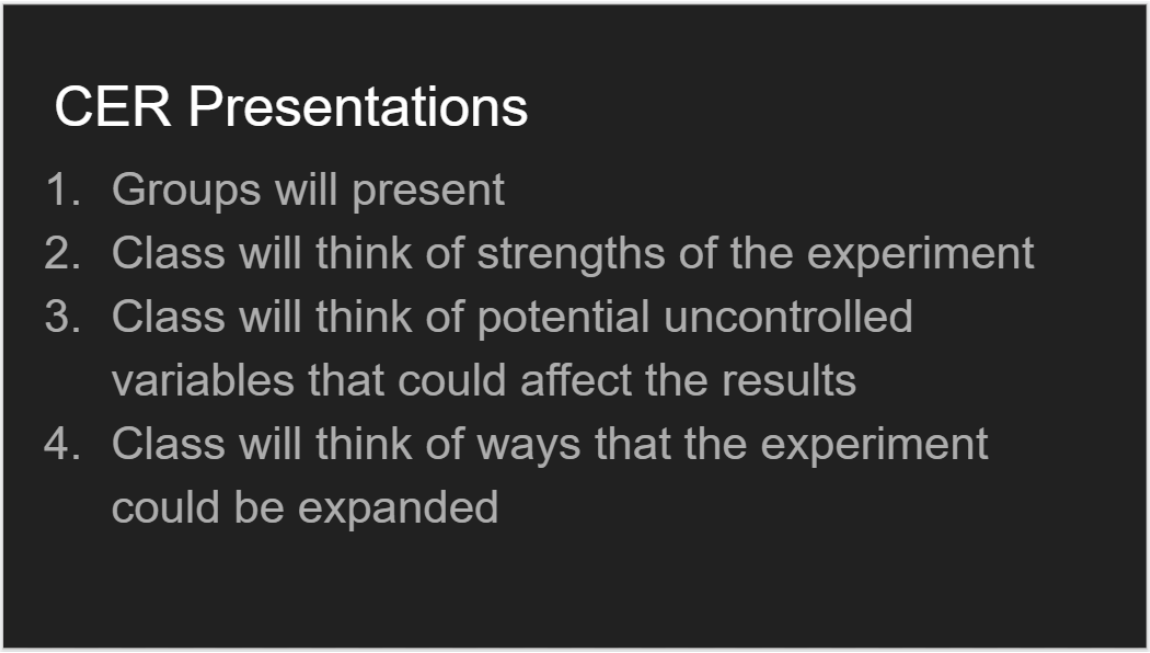
5. How will you collect your data? (date table, measuring time, tallying instances, etc.)

6. Set up your experiment. Draw your setup below.
    a. Be careful when moving crickets!

7. Conduct your experiment and collect data.

CER Presentation Instructions and Template Example





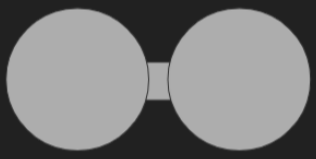
[Research Question Goes Here]

- Claim:
- Evidence:

  [Include Data Here]

- Reasoning:

Include a model of your experiment setup.



Example

Cricket Lab CER Rubric

	4	3	2	1
Claim – a conclusion that answers the original question	· Scientifically accurate · Completely answers the question · Common inaccurate claim(s) are clearly addressed.	· Scientifically accurate · Nearly completely answers the question · Inaccurate claim(s) are only generally addressed, no specifics	· Partially scientifically accurate · Partially answers the question · Inaccurate claim(s) are not addressed	· Is not scientifically accurate overall · Does not adequately answer the question
Evidence – scientific data that supports the claim	· The data are scientifically appropriate to support the claim. · The data are thorough and convincing – enough details and evidence provided. · Proper units are used in data · Shows with evidence why alternate claims do not work	· The data are scientifically appropriate to support the claim · The data are basically sufficient and convincing, but tend to be more general and not as specific and in depth · Does not address why alternate claims do not work · Evidence may be repetitive	· The data relate to the claim, but are not entirely scientifically appropriate · The data are not sufficient, though generally support the claim	· There is some evidence provided, but it is not logically linked to the claim or scientifically appropriate

Reasoning – a justification that links the claim and evidence	· Reasoning clearly links evidence to claim · Shows why the data count as evidence by using appropriate scientific principles · There are sufficient scientific principles to make links clear between claim and evidence	· Reasoning adequately links claim to evidence · Includes related scientific principles, but only passably clarifies why this data count as evidence · Reasoning tends to be more general and shows only partial depth of content understanding	· Reasoning does not adequately link claim to evidence, or clarify why data count as evidence · Includes related and non-related scientific principles, and shows little depth of content understanding	· Reasoning is clearly insufficient and relates only tangentially to question and claim at hand · Scientific understanding is very limited
Language and Vocabulary	· Response clearly and effectively expresses ideas using precise, scientifically appropriate descriptions and vocabulary	· Response adequately expresses ideas and scientifically appropriate descriptions and vocabulary, but they are more general than specific	· Response inconsistently and sometimes inappropriately expresses ideas or scientific descriptions and vocabulary	· Scientific language and vocabulary are not precise or appropriate
Focus and Organization	· Focus only on question at hand · Logical progression of ideas · Clearly stated and focused claim that is	· Focus mainly on question at hand, some loosely connected material present · Logical progression of ideas	· Focus not consistent on question at hand · Progression of ideas not entirely logical · Have a claim, but it's not	· Focus not at all consistent · Progression of ideas not logical · Have an unclear claim that is not maintained

	strongly maintained	· Clearly stated and focused claim that is adequately maintained	entirely clear or maintained	

Rubric adapted by Kevin J. B. Anderson from K. McNeill and J. Krajcik, NSTA, and SBAC Argumentative Writing Rubric for grades 6-11

Appendix E

Title: Animal Behavior: Lesson 4 (4 Days)
Topic: Mate Selection Lab
Subject/Course: Biology Kingdoms **Grade: 10**

Stage 1 - Desired Results

State Aligned Standards:
9L.4.1.1.1 Evaluate evidence for the role of group behavior on an individual's and species' chances to survive and reproduce. (P: 7, CC: 2, CI: LS2) Emphasis of the practice is on identifying evidence supporting the outcomes of group behavior, and developing logical and reasonable arguments based on evidence. Emphasis of the core idea is on distinguishing between group and individual behavior. Examples of group behavior may include herding, migratory behaviors, or various symbioses.

9L.3.2.1.5 Construct an explanation based on evidence for how natural selection leads to the adaptation of populations. (P: 6, CC: 2, CI: LS4) Emphasis is on using data to provide evidence for how specific biotic and abiotic differences in ecosystems contribute to a change in gene frequency over time, leading to adaptation of populations. Examples of selective forces may include long-term climate change, or variations in seasonal temperatures, pH, light cycles, geographic barriers, or in response to the evolution of other organisms.

9L.2.2.1.1 Use a computational model to support or revise an evidence-based explanation for factors that have ecological and economic impacts on different sized ecosystems, including factors caused by the practices of various human groups.** (P: 5, CC: 3, CI: LS2) Examples of ecological impacts might include changes in the carrying capacity, species numbers and/or types of organisms present in an environment. Examples of human practices that can have positive or negative impacts, such as stream restoration versus deforestation as an ecological example. Examples of computational models may include online simulations of population dynamics, population ecology, or population growth.

Understandings: ● Students will understand how environmental factors can affect natural selection and sexual selection. ● Students will understand how to design and test a hypothesis.	Essential Questions: ● How can mate preference in different environmental conditions be tested? ● How do environmental factors influence natural and sexual selection? ● How does mate selection influence evolution?
Students will know… ● The definitions of the words: natural selection, fitness, sexual selection, courtship display ● How environmental factors, both naturally occurring and human induced, can influence natural selection.	Students will be able to… ● Design and carry out an experiment ● Create and test a hypothesis ● Collect evidence and draw a conclusion ● Support a claim using data-based evidence ● Identify how mate selection influences evolution ● Model how different environmental factors affect natural selection

Stage 2 - Assessment Evidence

Performance Tasks: ● Students will write a conclusion statement answering their research question.	Other Evidence: ● Students will draw a conclusion based on evidence

	● Students will record and organize data in their lab packet.

Stage 3 - Learning Plan

Learning Activities

Day 8

- Mate preference discussion
  - Watch videos of courtship rituals - https://youtu.be/nNrieMwfpWQ
  - Why would females be the "choosy" sex
- Mate preference lab setup
  - Research question design
  - Write hypothesis
  - Determine what defines mate preference in guppies

Day 9

- Complete mate preference lab
  - Write concluding statement using data collected
- Mate preference discussion
  - What did you conclude? What evidence supports your claim? How could this affect evolution?

Day 10

- See Appendix B

Guppy Mate Selection Lab Preparation

1. Observe a male fish for 5 minutes. Describe the physical appearance of the fish and make a list of the behaviors that you see below. Repeat with a female fish.

Male	Female

2. Define each behavior above.
3. Come up with an abbreviation for each.
    a. Ex. Eating (E), Resting (R)
4. Fill out your Ethogram with the behaviors that you identified.
5. Watch the male fish and fill out the ethogram for the fish. Repeat with a female.

Name of Observer: Study Species: Study Animal: Details of environment:						
	Types of Behaviors Male			**Types of Behaviors Female**		
Time						
0:00						
0:15						
0:30						
0:45						
1:00						
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4:45						
5:00						
Total						

Project Objective: *Do environmental factors affect mate selection?* Guppies (*Poecilia reticulata*) have been used extensively to gain an understanding of sexual selection and the evolution of mating systems. Several competing and complementary theories can be used to explain the evolution of female choice.

The purpose of your experiment is to determine the effect of the environment on mate choice by female guppies.

Is the orange coloration an honest signal of healthy genes in male guppies?

An alternate theory suggests that the male's orange coloration may be a “sensory trap”. According to this theory the males orange color exploits the female's preference for orange that initially evolved for detecting the nutrient rich cabrehash fruits. Signals that contrast the environment are more readily detected. Therefore, once established, preference for a color may evolve further due to contrast with the environment.

By determining whether a female's preference varies with the degree of contrast between signal and environment, we can test these hypotheses. We will measure a female's preference for showy over drab males on orange (low contrast) and blue (high contrast) backgrounds. We will also measure the coloration of the males in the experiment to determine which body color, blue or orange, affects preference in different environments. Before you begin lab, consider what experimental results will support the "Good genes" theory over the "Sensory Trap enhanced by Contrast" theory.

6. What do you need to research before designing an experiment to test mate preference under different environmental conditions?

Get in your Groups

7. Write your research question. (Hint - this will include your prediction of which male guppies a female guppy will choose in different environments.)

<u>METHODS</u>

Materials for each photostation (3/lab):
1 camera
1 tripod
paper towels
ruler
pencils

Materials for each pair of students:
Animals: 4 female guppies (housed 4 weeks in all female tanks)
8 male guppies (housed 4 weeks in all male tanks) (4 showy and 4 drab)
(ideally all animals would be inexperienced virgin animals)

Setup:
2 five gallon aquaria
4 clear plexiglass dividers
4 black plastic dividers
4 finger bowls (for holding males)
1 orange, 1 blue, 1 white and 1 black tank shroud (10 inches X tank circumference)
1 small dip net
ruler
Sharpie
timer

Experimental Trial: Each lab group will test 2 females in 4 background color conditions (orange, blue, white, black). The female will be placed in the center compartment while 1 showy male will be placed on one end compartment and one dull male will be placed in the other end compartment. The fish should be allowed to acclimate to the testing apparatus for 10 minutes. Begin the trial by lifting the two removable black dividers. A timer should be set to beep every 10 seconds for 5 minutes. A score will be recorded on each beep.

Setup: Divide a 5 gallon aquarium into 3 sections. Each end section, 6 cm, will be used for one male while the center section will contain the female. The center section is divided into three equal sections. The water depth will be only 6 centimeters and the background color shroud will extend 4 centimeters above the water. Use tape on the table under the tank to identify the center sections because the experiment will be viewed from above.

8. Write a hypothesis. (What do you think the answer to your question will be?)

9. Design your lab setup.

b. What backgrounds will you use? Why did you choose those backgrounds?

c. What are your controlled variables? (The variables that will not change)

d. What are your uncontrollable variables? (The variables that could affect your experiment, but you cannot control)

10. How will you determine which male the female preferred? You may need to research how to determine which mate has been chosen (ex. How long the female spends with the male, orientation, etc.)

11. How will you organize your data? Make your data table below.

12. Draw and label your setup below. (Feel free to draw on a piece of paper. Include a photo of your drawing here, or submit a picture to the Google Classroom assignment).

13. If you were to do this experiment again, what is something you would do differently? Why would you make this change?

14. CONCLUSIONS: Write a simple concluding statement that evaluates your results in light of the alternate hypotheses that were proposed to explain the evolution of female preference for orange color in male guppies.

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Appendix F

Animal Behavior Unit Reflection

1. How has our animal behavior unit been similar or different to other units in biology class?

2. On a scale of 1-5 (1 being very little, 3 being neutral, 5 being very much), how did you enjoy the lessons? Why?

3. On a scale of 1-5 (1 being very difficult, 3 being appropriate difficulty, 5 being very easy), how would you rate the difficulty of the lessons? Why?

4. If you did any of the labs again, what would you do differently?

5. What were the 3 main things you learned in our animal behavior unit?