Endeavor STEM Teaching Certificate Project
Rachel Kiper
4/4/2022

5E Arts Integrated STEM Lesson Plan – Template

This template serves as a guide for developing a lesson that integrates across subject areas and includes the components of a quality STEM lesson. Please use it to support your work and engage in discussions with your instructors and peers when you have questions.

Lesson Title: *Explosive Populations!*
Author: *Rachel Kiper*
Topic: *Ecosystems: Interactions, Energy, and Dynamics*
Targeted Grade Level: *9-12*
Time Needed: *1 hour- 2 hours*
Subject Integration: *Science, Art and Engineering*
Justification: *Science- This lesson focuses on factors that affect carrying capacity of ecosystems at different scales. This lesson will focus on Ecosystem interdependence between predators and prey. It will then focus on the environmental factors that affect a local National Park. Students will focus on the effects of the contaminated runoff water at Mammoth Cave National Park.*
Engineering- Students will create a mini wastewater treatment project to help the runoff water in Mammoth Cave.
Standards:
HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems. (Grades 9 - 12
HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. (Grades 9 - 12)
HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. (Grades 9 - 12)
*HS-LS2-1.*Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
Art- 5. Develop and refine artistic techniques and work for presentation.

6. Convey meaning through the presentation of artistic work.

HS-ESS3-4. *Evaluate or refine a technological solution that reduces impacts of human activities on natural systems. (Grades 9 - 12)*

Do you agree with this alignment?

Click to view other curriculum aligned to this Performance Expectation

This activity focuses on the following Three Dimensional Learning aspects of NGSS:

Design or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. ***Alignment agreement:***	*Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.* ***Alignment agreement:*** *When evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts.* ***Alignment agreement:***	*Feedback (negative or positive) can stabilize or destabilize a system.* ***Alignment agreement:*** *Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks.* ***Alignment agreement:***

HS-ETS1-3. *Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. (Grades 9 - 12)*

Do you agree with this alignment?

Click to view other curriculum aligned to this Performance Expectation

This activity focuses on the following Three Dimensional Learning aspects of NGSS:

Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. ***Alignment agreement:***	*When evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts.* ***Alignment agreement:***	*New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.* ***Alignment agreement:***

HS-LS2-7. *Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. (Grades 9 - 12)*

Do you agree with this alignment?

Click to view other curriculum aligned to this Performance Expectation

This activity focuses on the following Three Dimensional Learning aspects of NGSS:

Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. ***Alignment agreement:***	*Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species.* ***Alignment agreement:*** *Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction).* ***Alignment agreement:*** *Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of*	*Much of science deals with constructing explanations of how things change and how they remain stable.* ***Alignment agreement:***

	recreational or inspirational value. ***Alignment agreement:*** *When evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts.* ***Alignment agreement:***	

NGSS Performance Expectations *HS-LS2-1.***Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.** [Clarification Statement: Emphasis is on quantitative analysis and comparison of the relationships among interdependent factors including boundaries, resources, climate, and competition. Examples of mathematical comparisons could include graphs, charts, histograms, and population changes gathered from simulations or historical data sets.] [*Assessment Boundary: Assessment does not include deriving mathematical equations to make comparisons.*]

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts:

Using Mathematics and Computational Thinking *Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.* *Use mathematical and/or computational representations of phenomena or design solutions to support explanations.*	***LS2.A: Interdependent Relationships in Ecosystems*** • *Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem.*	***Scale, Proportion, and Quantity*** *The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.*

Measurable Student Learning Objectives:

Students will be able to observe population explosions.

Students will be able to collaborate with others.

Students will be able to make inferences from graphs and predict outcomes.

Students will be able to research environmental impacts on Mammoth Cave.

Students will design and create mini wastewater treatment plants.

Nature of STEM:

Engaging Context/Phenomena:

https://thewonderofscience.com/videos/2017/12/10/ls2c-ecosystem-dynamics-functioning-and-resilience

After students watch the video, they will collaborate using a jamboard to discuss takeaways. Guiding question- How are the organisms dependent on each other?

Data Integration: Students will compare predator/prey relationships on graphs to determine ecosystem interdependence. They will also explore Mammoth Cave's National Park data to determine environmental effects.

Differentiation of Instruction: *Students in Special Education will work collaboratively with their group to make a collaboration board about Ecosystem Interdependence.*

They will receive a modified evaluation and more guidance when looking at the graphs and making inferences. Students can use the reader extension to listen to the material read to them.

Real-life Connection: *Students who live in this area need to be aware of the environmental impacts on Mammoth Cave and how this is their ecosystem and they depend on it.*

Possible Misconceptions: *Students will be surprised with how much predators and prey numbers influence each other.*

Lesson Procedure:

5E Model	5E Objectives
Engage *Introduce the lesson with an anchoring phenomenon. Facilitate student questions, discussion, etc. as appropriate. Learn about what students already know and want to know.*	**Procedure:** The teacher will begin the lesson by asking students: What is a predator/prey relationship? (Give examples) If deer are on an island without a predator- will that have a positive or negative effect on the deer? https://thewonderofscience.com/videos/2017/12/10/ls2c-ecosystem-dynamics-functioning-and-resilience After students watch the video, they will collaborate using a jamboard to discuss takeaways. Guiding question- How are the organisms dependent on each other? **Modifications-** *Students that struggle to spell can use the images to insert an image on the jamboard but will also have a word bank given to them to help them write their responses. The word bank has pictures and will be placed on their desk.* **Standards Addressed** *HS-LS2-1.*Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales. **Formative/Summative Assessments** *The jamboard will be used to assess this phase.* **Resources** https://thewonderofscience.com/videos/2017/12/10/ls2c-ecosystem-dynamics-functioning-and-resilience

	Jamboard *word bank*
Explore *Plan for students to engage in hands-on activities that are designed to facilitate conceptual change.*	**Procedure:** *Students will launch this interactive to explore what happens when the population of one species explodes. They will work with direct and indirect connections. They will answer the questions as they work through the trophic cascades on the Google Doc.* **Modifications** *Students in Special Education will have a different Google Doc to work in that has a word bank and multiple choices for the answers.* **Standards Addressed** *HS-LS2-1.* **Formative/Summative Assessments** *The Google Doc that walks the students through the trophic cascades.* **Resources** interactive Google Doc Modified Google Doc
Explain *Facilitate opportunities for students to explain their understanding of concepts and processes and make sense of new*	**Procedure:** *Students work together on this part of the lesson. They will work in groups and create anchor charts that map out what they think of when they think of Ecosystem interdependence. They will use this rubric to guide their charts.* **Modifications** *The teacher should be selective when making groups. It works best if students in special education are either in a group together with a modified rubric or if they are the only one in the group in special education. If they are the only one in the group they would make a great "reporter" (the one who writes down the information). Another "job" that would work well is to allow that student to be the illustrator. If there was an area of the cascades that interested that student more, that may be a good area to allow them to work on.* **Standards Addressed** *Art- 5. Develop and refine artistic techniques and work for presentation.* *6. Convey meaning through the presentation of artistic work.* *HS-LS2-1*

	Formative/Summative Assessments *The teacher needs to walk around the room and monitor participation so that one student is not completing the whole assignment. Students will use this Group Role Chart to know their job for this task and the infographic. The teacher will write their names down on their role and use this as an observation checklist for both activities. This rubric and the modified rubric can also be used to assess the charts.*

concepts.	**Resources** *chart paper, markers, coloring pencils,rubric, modified rubric, Group role chart*
Elaborate *Provide applications of concepts and opportunities to challenge and deep ideas; build on or extend understanding and skills.*	**Procedure:** *Students will look on this* website to see how the poor quality of runoff water has affected Mammoth Cave's ecosystem. Students will use the Engineering Design Process to create mini wastewater treatment plants that would help the runoff water going into Mammoth Cave. Students will work in groups and use this Engineering Design Process sheet. This is the rubric that will be used. **Modifications** *Once again, this is a group activity. Students in Special Education can work within their group as the person who copies the information found on the website.* **Standards Addressed** **HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. (Grades 9 - 12)** **Formative/Summative Assessments** Assessment **Resources** *wastewater mini treatment plants guide*, Engineering Design Process sheet., rubric

Evaluate *Assess students knowledge, skills and abilities.*	**Procedure:** *Making Sense Assessment* **Modifications** *Students in Special Education will get a reader for this assessment.* **Standards Addressed** **HS-ETS1-3** **Formative/Summative Assessments** *Making Sense Assessment* **Resources***Making Sense Assessment*

Teacher Background: *Students have previously learned about carrying capacity and balancing ecosystems. The teacher should also be aware which students need modified assignments and/or instructions. This is a high school lesson and students have typically been exposed to ecosystems at this point in their education and they have a pretty clear understanding of balancing ecosystems and carrying capacity.*