Endeavor STEM Project
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5E Integrated STEM Unit Plan

Lesson Title: Engineering That

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Topic: What is mining? What negative impacts does it create? How can we restore the ecosystem post-mining? CAn you design a Rube Goldberg machine?

Targeted Grade Level: grades 6-8

The time needed for the lesson: 5-6 class periods

Subject Integration: Science, technology, engineering, arts and ELA.

Justification:

Students will be required to do some research on environmentally friendly mining. Mining can become more eco-friendly by developing and integrating practices that reduce the environmental impact of mining operations. Examples include: reducing water and energy consumption, minimizing land disturbance and waste production, preventing soil, water, and air pollution at mine sites, and conducting successful mining activities.

Students will then need to understand what a Rube Goldberg machine is. Rube Goldberg machines are devices featuring uniquely over-engineered chain reactions.

Science Standards:

MS-PS2-1. Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.

MS-PS2-2. Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

MS-PS2-3. Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.

MS-PS2-4. Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.

MS-PS2-5. Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.

NGSS Performance Expectations

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts:
Asking questions and defining problems: Define a design problem that can be solved through the development of an object, tool, process, or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. *Developing and using models: Develop and/ or use a model to generate data to test ideas about phenomena in natural or designed systems, including those representing inputs and output and*	*PS2.A: Forces and Motion For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton's third law).* *PS2.A: Forces and Motion The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The*	*Influence of engineering, technology, and science on society and the natural world: All human activity draws on natural resources and has both short- and long-term consequences, positive as well as negative, for the health of people and the natural environment.* *The uses 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 the*

those at unobservable scales. *Analyzing and interpreting data: Analyze and interpret data to determine similarities and differences in findings.* *Engaging in argument from evidence: Evaluate competing design solutions based on jointly developed and agreed-upon design criteria.*	*greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion.* *PS2.B: Types of Interactions Electric and magnetic (electromagnetic) forces can be attractive or repulsive, and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects.* *PS2.B: Types of Interactions Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass —e.g., Earth and the sun.* *PS2.B: Types of Interactions Forces that act at a distance (electric, magnetic, and gravitational) can be explained by fields that extend*	*differences in such factors as climate, natural resources, and economic conditions.*

	through space and can be mapped by their effect on a test object (a charged object, or a ball, respectively).	

Arts:

Creating Anchor Standard #1: Generate and conceptualize artistic ideas and work.

Creating Anchor Standard #2: Organize and develop artistic ideas and work.

Creating Anchor Standard #3: Refine and complete artistic work.

ELA:

CCSS.ELA-LITERACY.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.

CCSS.ELA-LITERACY.W.6.3

Write narratives to develop real or imagined experiences or events using effective technique, relevant descriptive details, and well-structured event sequences.

Technology:

Standard: CT1. Develop and employ strategies for understanding and solving problems in ways that leverage the power of technological methods to develop and test solutions.

Engineering:

MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Measurable Student Learning Objectives:

Students can conduct research based on criteria of mining and the ecosystem. (DOK 1)

Students can design and construct a Rube Goldberg machine that includes two cause and effect relationships that demonstrate Newton's first law of motion.(DOK 4)

Students can demonstrate how the electromagnet that attracts or repels to another magnet. (DOK 3)

Students can demonstrate Newton's laws of motion. (DOK 3)

Assessment : Students will complete a successful Rube Goldberg machine based off rubric provided.

Nature of STEM: Nature of Science, Nature of Engineering, and Nature of Technology

Science- Students research how mining has affected the ecosystem in Kentucky's eastern region over time.

Technology- Students find techniques that can transform negative impacts into positive outcomes.

Engineering- Design and construct a device that operates like a Rube Goldberg machine to help eliminate waste from the ecosystem.

Engaging Context/Phenomena:

Can your team build a machine for the EPA? Can you demonstrate two cause and effect relationships using Newton's first law?

Data Integration: https://archive.kftc.org/issues/health-impacts-coal-mining
https://www.pewtrusts.org/-/media/assets/2018/08/kef-coal-and-clean-energy-hia.pdf

https://www.hachettebookgroup.com/travel/planning/environmental-issues-in-kentucky/

Using the links provided, students will gather useful data from these articles to support their "why" behind designing a Rube Goldberg machine to carry out waste and mitigate those effects from it. Data will include the health risks the ecosystem faces from mining as well.

Differentiation of Instruction:

My students will work in teams. Also, if they need a reader, they can use the google extension that will read text directly to them. Modifications will be provided based on the students IEP if needed.

Real-life Connection: Here in Kentucky mining has been a part of the eastern region for many years. The Appalachian region to be more certain has dealt with mining and its effects. Students are able to gather reliable information about the situations and even talk with family who have lived or mined in the area to help gather knowledge for the project. Since, we live in Kentucky this is a problem in their own state that needs to be addressed.

Possible Misconceptions: Students often think that mining is not harmful being a natural resource. They do not realize what the waste does to the environment. Students also do not realize that there are techniques that can be put in place to help mitigate these effects.

Lesson Procedure :

5E Model	5E Objectives
Engage Students will brainstorm.	**Procedure:** Students will form teams to start proper research on the Environmental Protection Agency (EPA) and their concerns with the amount of pollution and environmental damage caused by mining. **Modifications:** Students will work in teams. They also have access to a reader if needed. **Standards Addressed:** MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
Explore Students will research and interpret data.	**Procedure:** Students will design and construct a device that operates like a Rube Goldberg machine using the information from researching the articles and working collaboratively with team members. **Modifications:** Students will be provided a reader if needed.

	Standards Addressed: Standard: CT1. Develop and employ strategies for understanding and solving problems in ways that leverage the power of technological methods to develop and test solutions. **Formative/Summative Assessments**: Students will be assessed based on rubric guidelines. **Resources**: https://docs.google.com/document/d/1VE0un22AQQimx14fi1RAOBUTgZn39gvDB1ljZdFm19g/edit
Explain Students will share and develop more understanding of the concepts.	**Procedure:** Students will be provided group blueprint design sheets to engineering teams. Have individual students sketch a prototype to present to the other members of their team. Teams will discuss the pros and cons of each sketch and then select one prototype to construct. **Modifications:** Students will work in teams. A scribe will be provided for those in need. **Standards Addressed:** MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. **Formative/Summative Assessments**: **Resources**: https://docs.google.com/document/d/1Cq7daRdiS8llmFsy9QTpDwz6I7VlRz2NsUJ5J5JskNU/

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Elaborate Students will share their understanding of the questions.	**Procedure:** Students will complete a reflections sheet based on their findings then they will share and discuss among their team. **Modifications:** Students needing a scribe will be provided one. **Standards Addressed:** MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. **Formative/Summative Assessment:** Students will be formatively assessed based on their completion of the resource provided below. **Resources:** https://docs.google.com/document/d/1PITJcudTjIT-mJUyXs-wHu8D0tpE5jmonpqw83HXk5Q/edit
Evaluate Students will share their comparisons of their Climate Tool predicted.	**Procedure:** Technology- Record your Rube Goldberg machine in action. Describe what is happening at each stage. Post the final video to our google classroom location. ELA- Write a story about the trip that a small character takes as he or she travels through your Rube Goldberg machine. Arts- Create a Rube Goldberg cartoon strip featuring your prototype. **Modifications:** Students can choose one of the evaluations to complete about their project. **Standards Addressed:**Creating Anchor Standard #3: Refine and complete artistic work. CCSS.ELA-LITERACY.W.6.3 Write narratives to develop real or imagined experiences or events using effective technique, relevant descriptive details, and well-structured event sequences.

	Formative/Summative Assessments: Summative assessment will be based on a rubric created for this lesson.

Teacher Background: Knowledge of mining in Kentucky, how Rube Goldberg machines operate, Understand Newton's Laws

References

"How Can Mining Become More Environmentally Sustainable?" Fraser Institute. Accessed July 10, 2017. http://www.miningfacts.org/Enviornment/How-can-mining-become-more-enviornmentally-sustainable/.

"Rube Goldberg History." Rube Goldberg Inc. Accessed July 10, 2017. https://www.rubegoldberg.com/contests/history/.

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