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Lesson Title: *Building a Better BUG*

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Topic: *Life Sciences*

Targeted Grade Level: *Grades 3-5*

Time Needed: *Two 45 minute class periods*

Subject Integration: *Science, Technology, Engineering* and Art

Justification:

Science- Science is incorporated in much of the lesson- using the JPL lesson, Design a Robotic Insect, students will understand the characteristics of insects. In addition, they will learn about the Martian surface. Practices will be developed as students differentiate between an insect and a spider. Furthermore, students will observe photos of the Martian terrain and make the correlation between what type of rover or insect would best suit the terrain.

Technology- Students will observe the robots inspired by nature. Using Hexbugs, students will make direct comparisons to cockroaches and note similarities and differences. Students will design a BrushBot "insect" to take on the challenge of the Martian Terrain (baby pool).

Engineering- Students will compare Hexbugs to cockroaches and note how they traverse various terrains. They will engineer a BrushBot to look like an insect. They will need to connect the battery to the motor to complete the circuit. The integration is logical as, the JPL lesson encourages students to draw a robotic insect, but this lesson will outline how to create a working model of a motorized insect.

Art- The engineering design and art component overlap. Students will design a battery operated micro bug that should be capable of traversing the Martian surface (plastic baby pool). Using craft items like feathers, googly eyes, stickers, chenille stems, students will create a unique motorized insect.

Standards:

NGSS Performance Expectations

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts:
If applicable *3-5 ETS1- Engineering Design*	*If applicable* *3-LS4-4 Biological Evolution:Unity & Diversity* *4-LS1-1 From Molecules to Organisms: Structures and Processes* K-ESS3-1 Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live. 3-LS4-3 Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all. ** 3-LS4-4 Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.	*If applicable*

	3-5-ETS1-3 Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.	
Common Core State Standards: Math: *Not applicable* ELA: *Not applicable*		
ITEEA Standards *(Not applicable)*		
Other Standards *(Not applicable)*		

Measurable Student Learning Objectives:

Students will be able to compare and contrast Hexbugs and cockroaches as they navigate different terrains.

Students will be able design and construct a "robotic" micro insect (BrushBot)that will be able to traverse a child's sized swimming pool.

Nature of STEM:

The lesson embraces the Nature of STEM as it incorporates many elements:

Science- Students discover how cockroaches legs are equipped with spike like protrusions that enable it to walk on various terrains. Plus, they will delve into the anatomy of insects.

Students will learn about the Martian surface and what might be needed to travel across the terrain.

Technology- Hexbugs, BrushBots and iPads will be utilized within the lesson.

Engineering- Students will design and create a small robotic insect (BrushBot) using a coin cell battery, a cell phone motor and small electrical diodes.

Math- Students will collect data in graph form to determine if there is a correlation to having spikes and the ability to move across various terrains. Students will summarize whether or not manmade counterparts, Hexbugs are able to navigate different terrains.

Engaging Context/Phenomena:

Using the Nasa lesson, Design a Robotic Bug, students will observe photos and videos of various robots (LEMUR, Puffer, Sparrow and others) created for different jobs to help engineers and scientists. These robots were inspired by the natural world and comparisons may be drawn between natural occurring elements and those that are man-made. Students' curiosity will be peaked and Hexbugs and Madagascar hissing cockroaches will be introduced. Furthermore, students will build their own version of an insect that is capable of traversing the "Martian landscape".

Data Integration:

I have looked into finding research from NASA to use with this lesson. I found this great resource that includes a multitude of links. I was thinking of using data to establish a relationship between Earth's deserts and that of the Martian landscape. What specific needs must be considered when designing a robot that works in extreme conditions. I would like students to predict how desert conditions are similar to those found on Mars and extrapolate as to what adaptations might be best when designing their insects.

https://mynasadata.larc.nasa.gov/basic-page/locating-data-imagery-student-investigations

I'm not sure how to integrate NASA data in a meaningful way with this lesson…

The data the students will collect will be to note if adding paper clip spikes to Hexbug legs makes a difference in the terrains they are able to navigate.

Differentiation of Instruction:

This lesson might be adjusted to meet the needs of all students by providing written, audio and perhaps video clip instructions in addition to multi-media examples. Using multi modalities allows many students to benefit from the lesson; encouraging participation and understanding.

Real-life Connection:

What better way to have student buy-in then to discuss insects and robots? Add Nasa's robots inspired by nature and it's sure to be a crowd pleaser. We interact with insects every day, but rarely take time to understand the anatomy and functionality of insects in today's world.

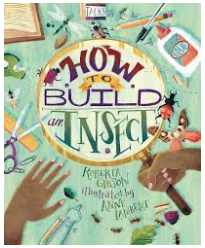
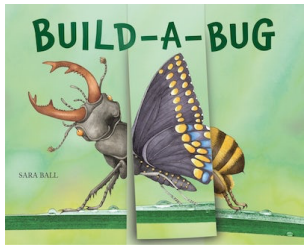
Culturally responsive practices would be to consider that not all schools can afford Hexbugs, Brushbots, iPads or Madagascar hissing cockroaches in the classroom.

Possible Misconceptions:

Students view insects as gross or useless instilling fear and misconceptions. Furthermore, students may have limited knowledge about what the Martian landscape is like… perhaps they envision aliens or Martians or other images depicted in media.

Lesson Procedure:

5E Model	5E Objectives
Engage What do we know about insects that could help when designing a robot to explore Mars?	**Procedure:** Teacher shows pictures of insects and of NASA's photos of robots that reflect the natural world in their designs. Begin to introduce Martian atmosphere and landscape. **Modifications** Allow students to handle books, pictures and insect specimens. For nonreaders, play the video of the book How to Build an Insect- https://youtu.be/QCjFBu_O9Ac?si=AQl5SM_HuLpoMEbE **Standards Addressed** *3-LS4-4 Biological Evolution:Unity & Diversity* **Formative/Summative Assessments** This is an informal stage of the lesson. Teachers are gathering information about what students know. A KWL chart would be a good way to organize information and address any misunderstandings. **Resources** NASA's design a robotic insect lesson https://www.jpl.nasa.gov/edu/learn/project/design-a-robotic-insect/

	Book-How to Build an Insect by Roberta Gibson Book- Build a Bug by Sara Ball Sci Show kids- Build an Insect- https://youtu.be/2O7RV-4zYRs?si=ePONaFGKqoBmiqSr Insect specimens- https://www.amazon.com/Real-Insect-Resin-Specimens-Collection/dp/B0BZPCYNVR?source=ps-sl-shoppingads-lpcontext&ref_=fplfs&psc=1&smid=A2I528W1GM6ARF  
Explore Students will begin to design a robotic bug.	**Procedure:** 1. First part of lesson- Given Spider Hexbugs, hissing cockroaches and Spider Hexbugs that have been modified with small pieces of paper clips attached to the base of the legs (mimicking spikes on cockroaches) Students will test how they cross different terrains. Teacher models how to place Hexbugs on various screens, showing students how to pick the Hexbug up should it get stuck. Teacher also demonstrates care and keeping of cockroach- we don't scream, we gently pick up or use a large plastic cup to scoop the cockroach up. Students record on the graph if the Hexbugs and cockroaches are able to navigate different terrains (various screens, meshes, baby pool and table top.) 2. Second part of lesson- Students will use NASA's Design a Robotic Insect and draw insects with certain specifications that can navigate in a Martian environment.

Then given BristleBot kits and craft supplies, students will design, and create a working robotic bug. Students will test BristleBots on the different terrains- particularly the “Martian terrain” (baby pool which can be decorated to look like the Martian surface).

Modifications

Building BristleBots can be challenging as they require small motor skills, so it might be nice to have parent assistance or older students come in and help with assembling. Seek donations from local businesses to offset costs.

Standards Addressed

K-ESS3-1 Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live.

3-5-ETS1-3 Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Formative/Summative Assessments

Students can use Seesaw or other app to organize information. Teacher walks around and ensures that students are using data table appropriately. Teacher collects data table (either on paper or digitally)

Students will continue to work on BristleBots fixing them as needed. They will assess as they work on them.

	Round screen	Wide screen	Small screen	Table top	Martian landscape
					
No leg spikes 					
Paper clip leg spikes 					
 BristleBot Insect					

Google slide link to data table- click here

	BristleBot kits click here Spider Hexbug- https://www.hexbug.com/hexbug-spider.html
Explain Students will work in table groups to determine if Hexbugs, cockroaches or enhanced Hexbugs traverse the terrains better than the others.	**Procedure:** *Students collaborate using Hexbugs, paper clip enhanced Hexbugs and cockroaches to see if one did particularly better than the other when traversing various screens. Students will make individual BrushBot insects but are encouraged to help one another. Teacher is acting as a facilitator and walks around run helping as needed. Students will record observations using the Seesaw application and document observations; this information can be shared with classmates and/or parents.* Teacher gathers students together and asks what was discovered. Students should share that cockroaches are able to traverse over all terrains. Did the modified Hexbugs perform better compared to their non-spiked counterparts? How did the BristleBot fare? Could it go across the Martian terrain (baby pool)? **Modifications** *(What student needs must be addressed? How can you make each experience accessible for ALL learners?)* **Standards Addressed** 3-LS4-3 Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all. **Formative/Summative Assessments** This is a time to discuss successes and failures. What would they do differently next time? What could be modified? Why are the spikes important to cockroaches? How might scientists and researchers use insects as models to create beneficial robots to explore Mars and other planetary bodies? **Resources** *(List all resources and materials used in this part of the lesson.)* Seesaw learning Platform, iPads

Elaborate Students will use Hexbug Nanos, create mazes and compare them to their own BristleBots and make comparisons as to how they both behave.	**Procedure:** Students build mazes or roads using blocks and other classroom items for their BristleBot insects. Then they use Hexbug Nanos and their BristleBots and note similarities and differences. Following the AIMs lesson plans, teacher asks questions and guide students as they test their mazes. (the Nanos are very similar, but more streamlines than the BristleBot). Hexbug makes Nano mazes as well (Hexbug Nano Zone). **Modifications** *(What student needs must be addressed? How can you make each experience accessible for ALL learners?)* Again, there are additional costs for supplies, so seek donations. Plan on using Hexbugs from year to year. Zoom with a pet expert that could speak about cockroaches and how they adapt to extreme environments and how their legs are suited to climb and cling to many surfaces. **Standards Addressed** 3-5-ETS1-3 Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved. **Formative/Summative Assessments** *(How will you assess in each phase?)* Students design and redesign learning from failures and challenges. **Resources**  **Hexbug nano- https://www.hexbug.com/hexbug-flash-nano-single-assorted.html**

aims CENTER

MAKE WAY FOR HEXBUGS

MATERIALS

- Hexbugs
- Containment area: shoe box, tray, large sheet of cardboard or LEGO baseplate
- Materials to interact with the Hexbugs (blocks, paper towel rolls, books, etc.)

OBSERVE

Allow children to see how Hexbugs move on a table, tray, their hand, etc.

CREATE

Using various objects allow children to investigate how the material can influence the Hexbug's movement.

PLAY

After viewing an example of a maze/obstacle course, encourage the children to create their own adventure for the Hexbugs.

KEY CONCEPTS

Science: Cause & Effect

Children observe how the various objects influence the bug's movements.

Technology: Robotics

Children create mazes to "program" the bugs to move in a desired direction.

QUESTIONS TO ASK

- What does it feel like when you hold or touch the Hexbug?
- How is the Hexbug moving if it doesn't have wheels? Do the legs move?
- What happens when the Hexbug hits a wall or an object?
- How can you get the Hexbug to go from a starting point to a finish point?

THINGS TO NOTICE

- Children's laughter and excitement. This is what learning should be like.
- Children's curiosities and the goals they make for themselves.
- How long a child is engaged with this activity.
- How the child is adapting and learning how to influence the Hexbug's movements.

Evaluate **Revisit the KWL chart. Discuss what students learned about insects and the Martian environment.**	**Procedure:** Teacher revisits the KWL chart, what has been learned from this lesson(s) What would students do differently in the future. **Modifications** *(What student needs must be addressed? How can you make each experience accessible for ALL learners?)* **Standards Addressed** *3-5 ETS1- Engineering Design* **Formative/Summative Assessments** *(How will you assess in each phase?)* From the NASA Design and Insect lesson: • Students should be able to describe how a feature included in their design is expected to function. • Students should be able to explain how they changed their design as new information was presented to them. **Resources** *(List all resources and materials used in this part of the lesson.)*

Teacher Background: *What background information does the teacher need to effectively teach this lesson? If you can provide links to resources, please do so.*