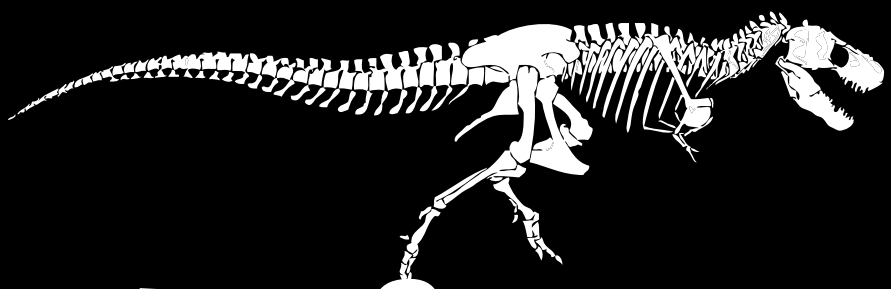

DINOSAURS IN MOTION

WHERE ART & SCIENCE MEET

PRODUCED BY:
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EDUCATOR GUIDE | GRADES 3-5

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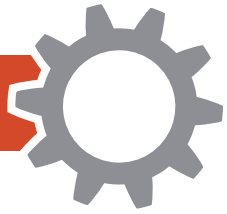


DINOSAURS IN MOTION
WHERE ART & SCIENCE MEET

EDUCATOR GUIDE

DINOSAURS IN MOTION
WHERE ART & SCIENCE MEET

Forget everything you think you know about dinosaur exhibitions and start your imagination now! **DINOSAURS IN MOTION** is unlike anything you've seen before. It's the dream work of Asheville, NC artist John Payne who wanted not just to create scientifically accurate sculptures of dinosaurs, but also to infuse them with kinetics and creativity. **DINOSAURS IN MOTION** is more than an exhibition about dinosaurs. It is a showcase of the power of integrating Art, Science, and Innovation. The exhibition takes you on a journey through four studios, Beginner, Intermediate, Advanced, and Master, to showcase how technological, artistic, and scientific advances all contributed to the creation of these amazing sculptures. Visit **www.imagineexhibitions.com/tabid/554/Default.aspx** for an overview of the exhibition.

Included in This Guide

This guide provides teachers and students with multiple ways to engage with the exhibition. You can choose what will best fit your students' needs and interests. Here's what the guide contains:

- A brief overview of each studio with a list of grade specific standards and activities you can do while visiting the exhibition.
- A 3-lesson unit to bridge your classroom and field trip experience.
- A Scavenger Hunt that challenges students to explore the exhibition using the Cross Cutting Concepts outlined in the Next Generation Science Standards.
- Additional ideas for activities to do before, during, and after your field trip!

NEXT GENERATION SCIENCE STANDARDS

DINOSAURS IN MOTION
WHERE ART & SCIENCE MEET

We used the 3rd – 5th grade Next Generation Science Standards (NGSS) to structure this guide because **DINOSAURS IN MOTION** and NGSS both embrace the concepts of innovation and integration. All of the activities in this guide are based off of NGSS standards. The NGSS outlines 7 Cross Cutting Concepts that are present at all levels of science. Five of these concepts are clearly reflected in this exhibition. Below are the relevant cross cutting themes and questions to ponder as you walk through the exhibition. These are also the concepts used to structure the **DINOSAURS IN MOTION** Scavenger Hunt.

NGSS Cross Cutting Concepts

Cause and Effect

What happens when you push, pull, or press on the sculptures?

Scale, Proportion and Quantity

How were fossils used to ensure that these model dinosaurs were built accurately and to scale?

Structure and Function

How are the parts of the dinosaurs, including their teeth, legs, jaws, and shapes different, and what are the functions of those parts?

Systems and System Models

What can you learn about real dinosaurs from these models? How does making models help us learn about what they represent?

Energy and Matter; Flows, Cycles, and Conservation

What different forms of energy are used to move these models? How is energy converted when you move the dinosaurs?

THE EXHIBITION

DINOSAURS IN MOTION
WHERE ART & SCIENCE MEET

DINOSAURS IN MOTION is composed of four studios, each highlighting different aspects of Art, Science, and Innovation.

Beginner Studio: Meet the Dinosaurs

In this studio, you will be exposed to the basic skills used to produce these amazing metal creations. Using dinosaurs as the medium, fascinating concepts are explored such as sketching as a way to study a subject and treasure hunting in places like junkyards to find materials to build a masterpiece. Biomechanics and balance points are also explored to further animate the science behind creating these massive creatures. Emphasis in this studio is on sketching, found art, kinetic sculptures, anatomical movement, fossils, the biomechanics of jaws, balance, springs, and how paleontology accounts for missing information.

BEGINNER STUDIO	
Third Grade Standard	**3-PS2-2.** Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion
Activity	Observe 5 people pushing the *Ankylosaurus'* mouth and count how many times it opens and closes before coming to rest. Make a prediction of how many times it will open and close when you push it. Test your prediction.
Fourth Grade Standard	**4-PS3-1.** Use evidence to construct an explanation relating the speed of an object to the energy of that object.
Activity	Pull and RELEASE the tail of the *Ankylosaurus* and observe what happens. Then, pull and PUSH the tail of the *Ankylosaurus* and observe what happens. Explain how the two attempts were different using the terms "speed "and "energy."
Fifth Grade Standard	**5-PS1-3.** Make observations and measurements to identify materials based on their properties.
Activity	Observe the ribs of the Triceratops and the Ankylosaurus. Describe how the material is similar and different. Which dinosaur uses more material for its ribs? Share your answer with a partner.

DINOSAURS IN MOTION
WHERE ART & SCIENCE MEET

Intermediate Studio: Mechanics Lab

This studio allows you to explore the next phase of John Payne's work: dinosaurs with full-body movement. While the Beginner Studio also allowed manipulation and movement of the creatures, the Intermediate Studio intensifies these kinetic principles by adding additional axes of movement. It also explores concepts such as metalworking, puppetry, simple machines (pulleys), and color through patinas. Emphasis in this studio is on metal, metalworking, cables (wire ropes), connections, welding, patinas, puppetry, pulleys, and the biomechanics of speed.

INTERMEDIATE STUDIO	
Third Grade Standard	**3-PS2-1.** Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.
Activity	Find the balance point on the *T-Rex*. Now sketch the *Ouranosaurus* and indicate where you think its balance point is. Explain why you put the balance point where you did.
Fourth Grade Standard	**4-PS3-1.** Use evidence to construct an explanation relating the speed of an object to the energy of that object.
Activity	Pull the two pulleys on the panel in front of the *Gastornis* at the same time and at the same speed. Observe the two models rising. With a partner, explain why they do not rise at the same rate.
Fifth Grade Standard	**5-PS1-3.** Support an argument that the gravitational force exerted by Earth on an object is directed down.
Activity	Test every dinosaur in the Intermediate Studio and observe how they move. With a partner, explain how gravity affects all of their movements.

Advanced Studio: Robotics 101

In this studio, you are presented with an additional interactive level: robotics. Hands-on interactions guide you through the multiple ways in which motors can maneuver these giant metal creatures in life-like, natural shifts using such concepts as electric power, motors, and controllers. Emphasis in this studio is on robotics, animatronics, sound, discovering colors in fossils, the biomechanics of blood-flow in long-necked dinosaurs, electric power, electric motors, and controllers.

ADVANCED STUDIO	
Third Grade Standard	**3-PS2-3.** Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.
Activity	Choose any one dinosaur in the Advanced Studio to observe. Write down 10 questions about how the dinosaur moves.
Fourth Grade Standard	Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.
Activity	Sketch a diagram and label how energy is transferred throughout 2 different dinosaurs in the Advanced Studio. Be sure to use the terms stored energy, electrical energy, and mechanical energy.
Fifth Grade Standard	**3-5-ETS1-3.** Plan and carry out tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
Activity	Plan and carry out a test to determine if the two *Ornithomimus* move in the same way. Explain how you conducted your test and explain what, if any, modifications could be made to improve the models.

Master Studio: Art + Science = Innovation

Some paleontologists think that modern birds are living dinosaurs because of key similarities in their skeletons. Our mentor and master craftsman John Payne followed this evolutionary progression with his art, starting with dinosaurs and continuing to his last and most intricate creations of modern birds.

Great craftsmanship and skills are necessary to create metal birds with movement. Apprentices in the Master Studio will experience the grace and beauty of these sculptures and learn about John Payne's most exquisite pieces. Emphasis in this studio is on complex and advanced metalworking techniques, the exploration of different materials, and the evolution of non-avian dinosaurs into birds.

MASTER STUDIO	
Third Grade Standard	**3-PS2-4.** Define a simple design problem that can be solved by applying scientific ideas about magnets.
Activity	Build a three story house using the magnets in this studio. Explain how the magnets helped keep the house together.
Fourth Grade Standard	**4-PS3-4.** Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.
Activity	Using the materials in the Master Studio, make a device that converts motion to sound. Explain your device to a partner. Challenge: Create a device that turns sound into motion.
Fifth Grade Standard	**5-PS1-3.** Make observations and measurements to identify materials based on their properties.
Activity	Identify at least 3 types of materials used on the Whooping Crane. Observe how the crane moves and describe the properties of the materials used to create the movement.

SCAVENGER HUNT

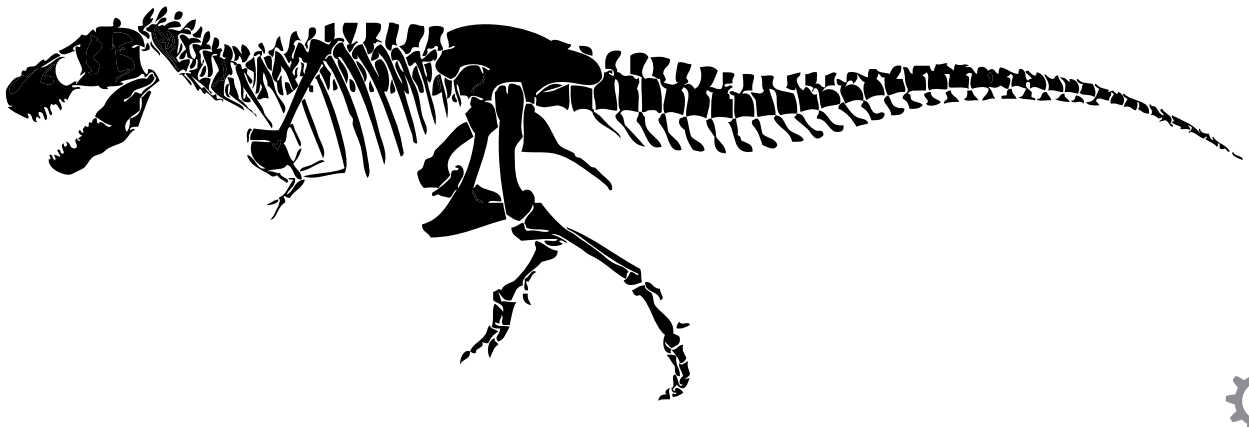
DINOSAURS IN MOTION
WHERE ART & SCIENCE MEET

This Scavenger Hunt challenges you to explore DINOSAURS IN MOTION by engaging with several of the Next Generation Science Standards Cross Cutting Concepts.

Cause and Effect

You can do many things in this exhibition that will cause the dinosaurs to move. Find the dinosaurs on which you can perform the following actions and describe the effect.

ACTION (CAUSE)	DINOSAUR	DESCRIBE HOW THE DINOSAUR MOVES (EFFECT)
Push		
Pull a lever		
Press a button		
Move a joystick		
Other? Your choice! Your action (cause): _____		



SCAVENGER HUNT

DINOSAURS IN MOTION
WHERE ART & SCIENCE MEET

Scale, Proportion, and Quantity

Find the dinosaur that is the largest and the dinosaur that is the smallest. Make a sketch of those two dinosaurs and of yourself. Make sure that you draw yourself and the dinosaurs with the correct proportions. Your drawing should show how big you are compared to the dinosaurs.

Structure and Function

Find two dinosaurs that have differently shaped teeth. List which dinosaurs you choose, sketch their teeth and explain why you think their teeth are shaped differently using the information in the panels.

1 _____ DINOSAUR NAME	2 _____ DINOSAUR NAME
Sketch of teeth	Sketch of teeth

SCAVENGER HUNT

DINOSAURS IN MOTION
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Systems and System Models

Explore all of the dinosaur models in the exhibition and observe how they move. Choose any one dinosaur and list what behavior the model is mimicking. For example, is the dinosaur searching for food or is it trying to attract a mate? Describe the behavior and explain why you think the dinosaur is modeling that specific behavior.

Name of Dinosaur:	**Explain why you think the dinosaur is modeling that behavior:**
What behavior is it modeling?	

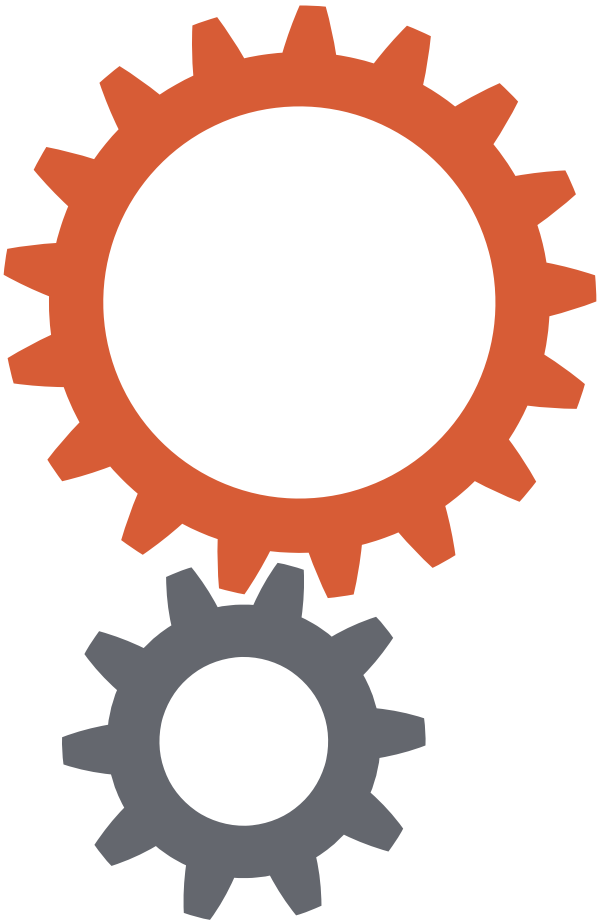
Energy and Matter; Flows, Cycles, and Conservation

Find a dinosaur model that converts electrical energy into motion and draw that model labeling all the different forms of energy that are used. Be sure to think about how the energy is stored, how sound is generated, and where mechanical energy (the motor) is used. Your diagram should include arrows and list a minimum of 3 different types of energy.

DINOSAURS IN MOTION
WHERE ART & SCIENCE MEET

Design Challenge: Unit Overview

This 3 part unit gives students the opportunity to design and construct their own models of dinosaurs. Students will experience a design process similar to **DINOSAURS IN MOTION** sculptor, John Payne's, by designing and constructing a simple, and later, a more complex model. The opening activity prompts students to discuss what a model is, gives them an overview of the exhibition, and challenges them to create a movable 2-D model. The second lesson takes place at the museum and asks students to identify what is causing the sculptures in the exhibition to move. The final lesson challenges students create an improved, movable, 3-D model based on their collective learning from their experience at **DINOSAURS IN MOTION**.



Essential Question:

- What makes a good model?

Objective:

- Students will be able to identify cause and effect relationships and will create and understand the purpose and characteristics of models.

NGSS Cross Cutting Concepts addressed:

- **Cause and Effect:**
  Students will identify cause and effect relationships in the sculptures within the exhibition and in their own models.

- **Scale, Proportion, and Quantity:**
  Students will use images and the sculptures from the exhibition to create scale models of dinosaurs.

- **Systems and System Models:**
  Students will create a model of a sculpture from **DINOSAURS IN MOTION** that mimics the sculpture's movements.

DINOSAURS IN MOTION
WHERE ART & SCIENCE MEET

Design Challenge: Pre Field Trip Lesson

Materials:

- Video Screen and Projector
- Rulers
- Printout of *Triceratops*
- Poster or Giant Sticky
- Craft Materials (glue, brackets, paper clips, markers, etc.)

Procedure:

1. Introduce the project by asking students the following questions and recording their responses on a poster or slide.
   - What is a model?
   - Why do we make models?
   - What are some examples of models?
   - What are the characteristics of a good model?
2. Explain to the class that Dinosaurs in Motion is an exhibition that showcases John Payne's models of dinosaurs. Show students the following introduction video **www.dropbox.com/sh/rnphf49fo1zh1bk/i8eEQw1gmO**. As you watch the video, ask students to identify what John Payne considered to be the most important aspects of models.
3. Ask students if, based on the video, they want to add anything to their list of ideas on the poster.
   - The list should include; correct proportions, accuracy, aesthetically pleasing, etc.
4. Tell students that they are going to create a two dimensional model of a *Triceratops*. Show them the handout of *Triceratops* and tell them the requirement for their model is that it needs to be twice the size of the drawing, it must be able to move its legs, and it needs to be attractive.
5. Pass out the handout of the *Triceratops*, blank paper, scissors, rulers, and craft materials. Give the students 20 minutes to create their models.
   - Teachers may want to explain how to double the the size of *Triceratops* to the entire class, or, if you are short on time, you can simply have students make a moveable model from the cut out of the *Triceratops*.

Debrief:

1. Have students share their models and discuss the questions below. Help students use the term "cause and effect" when describing the motion of their models. For example, "the cause of my model moving was me using my finger to pull on it. The effect was that its jaw opened."
   - How did you make the model the right size?
   - How did you make the model move?
2. Tell students that during the field trip they will look for cause and effect relationships that make the dinosaur models move.

TRICERATOPS HANDOUT

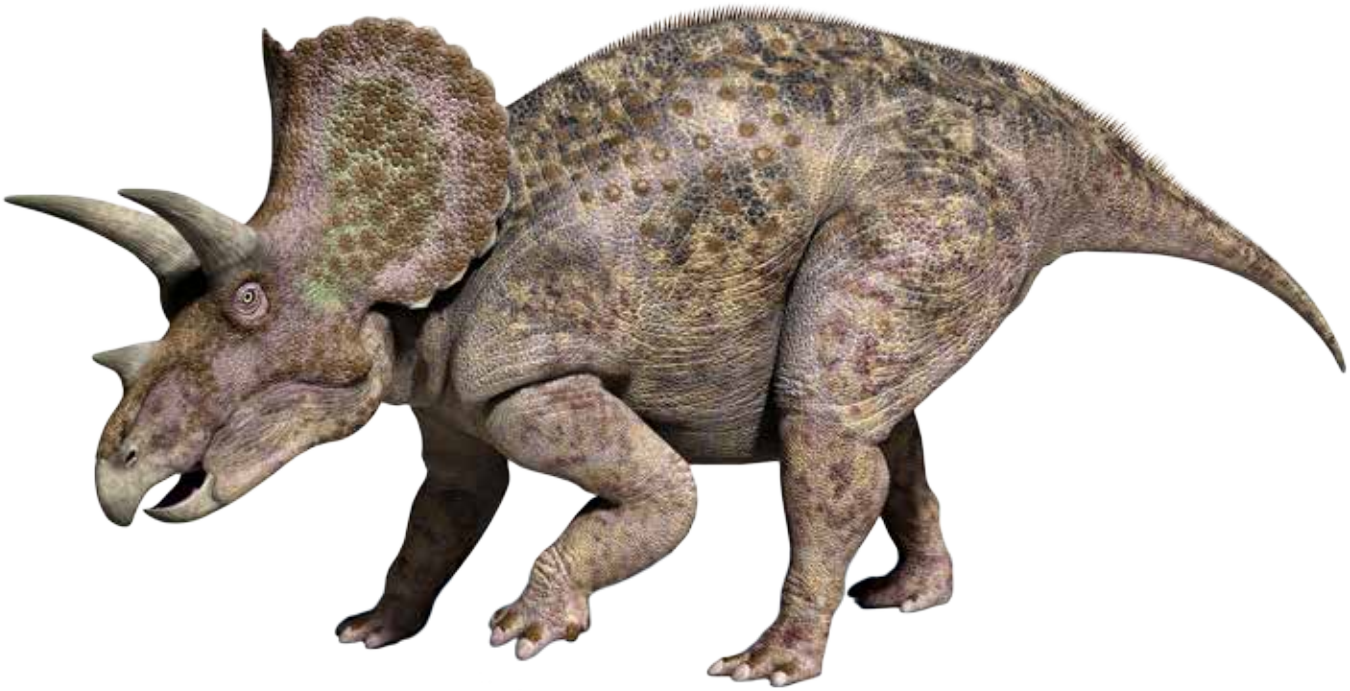
DINOSAURS IN MOTION
WHERE ART & SCIENCE MEET

Triceratops, Meaning Three-Horned Face

Description: *Triceratops* was one of the first dinosaur fossils found in the North American west.

Known for its large skull with neck frill and three horns, a *Triceratops's* head could grow to be over 7 feet long and made up almost a third of its body length. The original discoverers thought that the horns might belong to a giant extinct bison.

Although the horns look fearsome, evidence indicates that they were used for display, like the antlers and horns of modern plant eaters such as deer and antelope. This animal walked on four legs and was preyed upon by *Tyrannosaurus Rex*.



DINOSAURS IN MOTION
WHERE ART & SCIENCE MEET

Design Challenge: Field Trip Lesson

Materials:

- Cause and Effect handout
- Clipboard or something on which to write

Procedure:

1. Before entering the exhibition, distribute the Cause and Effect handout and tell students that they need to sketch one model in each of the four studios and label at least one cause and effect relationship for each.
   - For example, the cause is pulling on the cable and the effect is lifting the dinosaur's arm.
2. As a class, have students sketch and label the cause and effect relationships for the *Triceratops*. Discuss the relationships they identified.
3. Give students 45 minutes to explore the rest of the exhibit and to complete their worksheets.

Debrief:

1. Have students share their handouts and explain the cause and effect relationships they found. Be sure to have students ask each other questions and comment on each other's responses.

CAUSE AND EFFECT HANDOUT

DINOSAURS IN MOTION
WHERE ART & SCIENCE MEET

BEGINNER STUDIO	INTERMEDIATE STUDIO
Sketch of *Triceratops*:	Sketch of _____ :
Cause:	Cause:
Effect:	Effect:
ADVANCED STUDIO	**MASTER STUDIO**
Sketch of _____ :	Sketch of _____ :
Cause:	Cause:
Effect:	Effect:

DINOSAURS IN MOTION
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Design Challenge: Post Field Trip Lesson

Materials:

- Rubric
- Craft materials (cardboard, glue, string, markers, etc.)
- Poster and models created in the first lesson
- 3-D model rubric

Procedure:

1. Ask students to reflect on the exhibition and share the cause and effect relationships they identified.

2. Tell students that, in groups, they now have the opportunity to design their own 3-D model of a Triceratops that can move its legs and jaw. Use the field trip handout and the models the students created in the first lesson to help them with their new models. Tell students that they are not required to use the same techniques they used before or that they saw in the exhibit.

3. Pass out rubric and go over expectations.
   Criteria for 3-D model:
   - **Science:** Correct proportions
   - **Art:** Aesthetically pleasing
   - **Innovation:** Multiple techniques used to create movement

4. Give students 30-45 minutes to design and construct their models

5. Have students score their own model on the rubric.

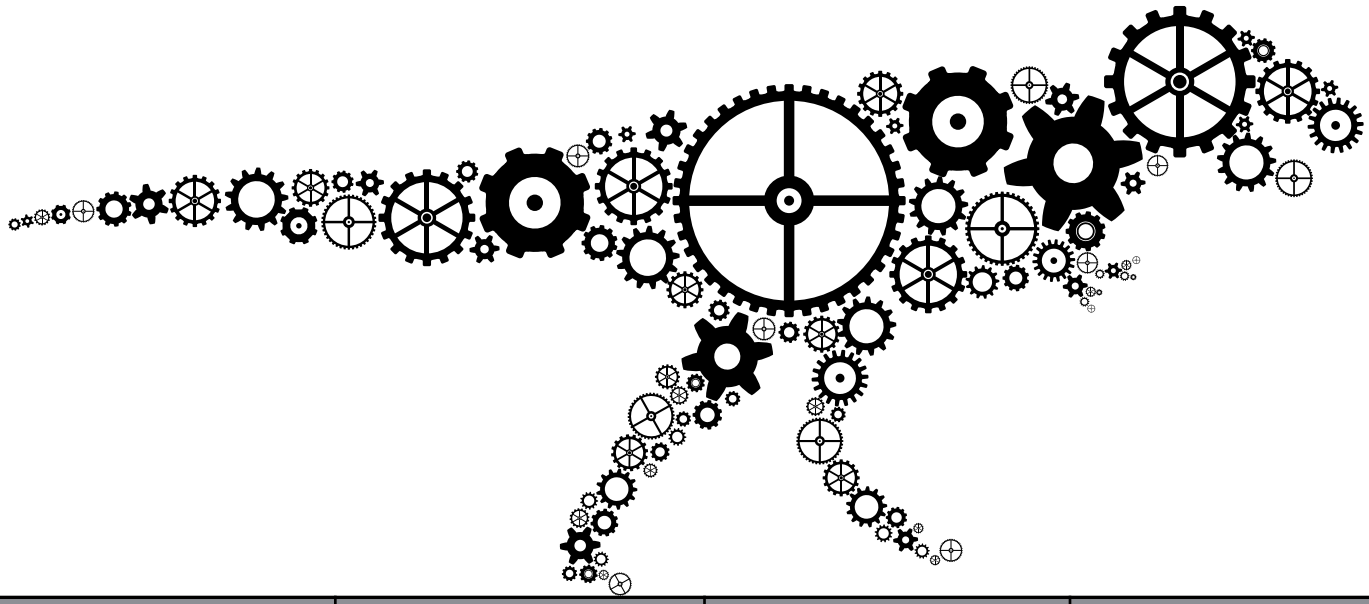
6. Have students present their models by identifying the cause and effect relationships and by sharing why they scored themselves how they did on the rubric.

Debrief:

1. Readdress the essential question "what is a good model?" and revisit the poster or slide created during the first lesson outlining key characteristics of models.
   - Ask students if there is anything they need to add or remove from the list.
   - Develop a class definition for the purpose of models and a definition for what makes a good model. Post definitions in room to reference and revise whenever models are used during the rest of the school year.

3-D MODEL RUBRIC

DINOSAURS IN MOTION
WHERE ART & SCIENCE MEET



	0	1	2
SCIENCE	My model is not to scale	Some of my model is to scale, but not all of it	Everything on my model is to scale
ART	Everything on my model is to scale	My model is either colored or looks realistic, but not both	My model is both colored and looks realistic
INNOVATION	My model is not colored or realistic	Only the jaw or the legs of my model move, but not both	Both the jaw and the legs on my model move

ADDITIONAL ACTIVITIES

DINOSAURS IN MOTION
WHERE ART & SCIENCE MEET

Pre Field Trip Activities:

- Make puppet dinosaurs out of brown paper bags.
- Show pictures of various dinosaurs and have students draw a picture of a dinosaur with the student standing next to the dinosaur to estimate their relative size.

Activities during Field Trip:

- Adaptation Scavenger Hunt

  Have students identify adaptations on the dinosaurs and ask them to describe how the adaptations helped the dinosaur survive.

- Cause and Effect

  In each studio, have students identify the initiating force and the effect it had on the dinosaur's motion.

- Find Shapes

  Find as many triangles as you can. Explain what part of the dinosaur the triangles are on and what you think their functions are. Try again with a new shape!

- Mimic your favorite dinosaur and ask your partner if he/she can tell which dinosaur you are.

- Sketch a dinosaur model and label how energy is converted as it moves through the model.

Post Field Trip Activities:

- Categorize Objects

  Have students compare and contrast different dinosaurs, add the information to a chart, and categorize the dinosaurs based on their data.

- Create your own story related to the exhibition using creative writing skills. Explore connections to literature or even develop your own exhibition on the topic!

- Defend or refute the idea that these models are like real dinosaurs.

QUESTIONS?

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