Science & Literacy Activity

ACTIVITY OVERVIEW

This activity, which is aligned to the Common Core State Standards (CCSS) for English Language Arts, introduces students to scientific knowledge and language related to what paleontologists learn from fossils.

This activity has three components:

1. **BEFORE YOUR VISIT**, students will read a content-rich article about what fossils teach us about dinosaurs. This article will provide context for the visit, and also help them complete the post-visit writing task.
2. **AT THE MUSEUM**, students will read and engage with additional texts (including printed text, digital and physical/hands-on interactives, video, diagrams, models). This information will help them complete the post-visit writing task.
3. **BACK IN THE CLASSROOM**, students will draw on the first two components of the activity to complete a CCSS-aligned explanatory writing task about what they have learned from the fossils they have seen and read about.

Materials in this packet include:

For Teachers

- Activity Overview (p. 1-2)
- Article (teacher version): "Piecing Together the Story of Dinosaurs from Fossils" (p. 3-5)
- Answers to student worksheet (p. 6-7)
- Assessment rubric for student writing task (p. 8)

For Students

- Article (student version): "Piecing Together the Story of Dinosaurs from Fossils" (p. 9-11)
- Student worksheet for the *Dinosaurs Among Us* exhibition visit (p. 12-13)
- Student writing task and rubric (p. 14-15)

Common Core State Standards

RI.5.1 Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text.

RI.5.2 Determine two or more main ideas of a text and explain how they are supported by key details; summarize the text.

W.5.2 Write informative/explanatory texts to examine a topic and convey ideas and information clearly.

New York State Science Core Curriculum

LE3.2c

Next Generation Science Standards

DCI LS4.A: Evidence of Common Ancestry and Diversity
Some kinds of plants and animals that once lived on Earth are no longer found anywhere. Fossils provide evidence about the types of organisms that lived long ago and also about the nature of their environments.

SEP 8: Obtaining, Evaluating and Communicating Information
- Obtain and combine information from books and/or other reliable media to explain phenomena.
- Communicate information in written formats.

1. BEFORE YOUR VISIT

Students will read a content-rich article about what fossils teach us about dinosaurs. This article will provide context for the visit, and help them complete the post-visit writing task.

Preparation

- Familiarize yourself with the student writing task and rubric (p. 14-15).
- Familiarize yourself with the teacher version of the article (p. 3-5), and plan how to facilitate the students' reading of the article.

Instructions

- Explain the goal: to complete a writing task explaining what fossils teach us about how birds are similar to extinct dinosaurs. You may want to read through the writing task with students at this point.
- Tell students that they will need to read an article before visiting the Museum, and read additional texts during the visit.
- Distribute, read, and discuss the article, using the teacher notes to facilitate.
- At this point, students may use the text and photo of *Citipati* from the reading to begin work on the first page of the student worksheet (p. 12). This fossil is also featured in the *Dinosaurs Among Us* exhibition, so this page may be completed either in the classroom, in the exhibition, or a combination.

2. DURING YOUR VISIT

At the Museum, students will read and engage with additional texts (including printed text, digital and physical/hands-on interactives, video, diagrams, models). The information they'll gather from these multiple sources will help them complete the post-visit writing task.

Preparation

- Review the Educator's Guide to see how themes in the exhibition connect to your curriculum and to get an advance look at what your students will encounter. (Guide is downloadable at **amnh.org/dinosaurs-among-us/educators**)
- Familiarize yourself with the student worksheet (p.12-13) and the map of the exhibition in the Educator's Guide.

Instructions

- Explain the goal of the Museum visit: to read and engage with texts (including printed text, digital and physical/hands-on interactives, video, diagrams, models), and to gather information to help them complete the post-visit writing task.
- Distribute and review the worksheet and map. Clarify what information students should collect, and where.

Supports for Diverse Learners

This resource has been designed to engage all learners with the principles of Universal Design for Learning in mind. It represents information in multiple ways and offers multiple ways for your students to engage with content as they read about, discuss, view, and write about scientific concepts. Different parts of the experience (e.g. reading texts, or locating information in the Museum) may challenge individual students. However, the arc of learning is designed to offer varied opportunities to learn. We suggest that all learners experience each activity, even if challenging. If any students have an Individualized Education Program (IEP), consult it for additional accommodations or modifications.

Alternate Version of Article

Another version of the same article with a lower lexile level is available for download at amnh.org/dinosaurs-among-us/educators. You can use this same activity with that article.

Additional Suggestions for Facilitating the Museum Visit

- Have students explore the exhibition in pairs, with each student completing his or her own student worksheet.
- The answers to student worksheet pages includes a list of the fossils in the exhibition to choose from, along with their locations on the exhibition map. Use this information to help them find suitable fossils to choose.
- Encourage student pairs to ask you or their peers for help locating information. Tell students they may not share answers with other pairs, but may point each other to places where answers can be found.
- There is a second, identical, *Citipati* nest fossil replica in the permanent dinosaur hall; see the answer key to the student worksheet (p. 6) for information on where it can be found.
- To make the visit more challenging, students may be given an additional copy of the second page of the student worksheet (p. 13) to allow them to investigate additional fossils.

3. BACK IN THE CLASSROOM

Students will use what they have learned from the pre-visit article and at the Museum to complete a CCSS-aligned explanatory writing task about what fossils teach us about dinosaurs.

Preparation

- Plan how you will explain the student writing task and rubric (p. 14-15) to students.

Instructions

- Distribute the student writing task and rubric. Explain that they will use it while composing, and also to evaluate and revise what they have written.

Suggestions for Facilitating Writing Task

- Before they begin to write, have students use the writing task to frame a discussion around the information that they gathered at the Museum. They can work in pairs, small groups, or as a class, and can compare their findings.
- Referring to the writing task, have students underline or highlight all relevant passages and information from the article and from the notes taken at the Museum.
- Students should write their essays individually.

ARTICLE: TEACHER VERSION

About this Article

Lexile: 930

Wordcount: 634

Text Complexity: The Lexile level for this text falls towards the high end of the grades 4-5 CCSS text complexity band. This text is suitable as an interactive read-aloud. Teachers should use their professional judgment and knowledge of students' independent reading levels regarding assigning this text for independent reading.

Note: Students should be sitting with elbow partners for this interactive read-aloud. Whenever the teacher notes suggest Think/Pair/Share, it is generally followed by instructions to "listen in" to student conversations. This enables the teacher to select students to share out thinking that would benefit the whole group to hear. Additionally, it allows the teacher to informally assess student thinking about the text. The teacher can follow up with a think aloud to help clarify parts of the text as needed. At times, the teacher may want to facilitate whole class discussion after Think/Pair/Share.

Key for Teacher Notes

- Green text
  specific strategies
- Regular text
  instructions for teachers
- *Italicized text*
  teacher's instructions to students
- Underlined text
  important domain-specific words

STUDENT READING

Piecing Together the Story of Dinosaurs from Fossils

You've probably seen pictures, models, or movies about dinosaurs that lived millions of years ago. But how do we know so much about these animals? How do we know what they looked like and how they lived? Since the early 1800s, scientists have been piecing together this mystery with fossils.

Fossils are the remains of ancient life. In order to become a fossil, the remains of a living thing must be buried quickly, usually in mud, sand, or volcanic ash. Over time, as the remains are buried deeper and deeper, the material around them hardens into rock. Minerals eventually replace the remains, turning them to rock too. Most fossils form from the hard parts of organisms such as teeth, shells, and bones. They also form from things a plant or animal leaves behind, like a footprint, a leaf print, and even eggs.

Think Aloud: *Aha! Since dinosaurs lived millions of years ago, scientists rely on fossils to learn about how they lived and what they looked like.*

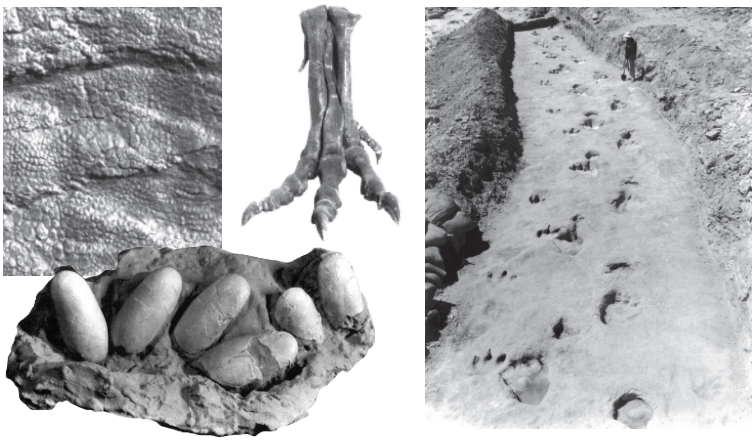
After reading this paragraph once, reread it aloud, stopping as follows:

Stop after the **first sentence** and underline the words "remains" and "ancient." Coach students to determine the meanings of these words, providing assistance as needed. Scribe definitions of these two words on chart paper. The definitions should ideally be constructed by students with your assistance. (E.g., remains = parts of a dead organism, ancient = from a very long time ago.) Paraphrase this first sentence for students using the new definitions. (Optional: scribe your paraphrase of the sentence on chart paper).

Tell students that the s**econd, third and fourth sentences** talk about how fossils are formed. *Let's read this very closely and then explain it to our partners in our own words*. Prompt students to think-pair-share after each sentence (partners can take turns paraphrasing). Listen in to students' conversations and invite selected students to share their paraphrase with the class. Allow for whole class discussion around the question, "How are fossils formed?" before finishing the rest of the paragraph.

After reading the **fifth and sixth sentences**, think-pair-share: What more have we learned about fossils from these last two sentences? Listen in to students' conversations and invite selected students to share out with the class.

Fossils show us what Earth was like long ago. They give us a picture of ancient environments. Scientists compare fossils from different time periods to investigate how life on Earth has changed over time.



From left to right: fossil skin impressions, fossil eggs, fossil theropod foot, fossil dinosaur trackway

Think of fossils like puzzle pieces. The more pieces you have, the easier it is to put them together and tell what the whole picture looks like. And sometimes when you find and add new pieces, the picture looks very different from how you thought it would be.

Think-Pair-Share: *How do fossils help scientists? OR How do scientists use fossils? OR Why do scientists study fossils?* Listen in to students' conversations and invite selected students to share out with the class. Optional: Chart some of the key points of this section to start a record of the class's thinking about this text.

Think-Pair-Share: *What do you notice about these pictures?* Listen in and select one or two pairs to share out.

Think-Pair-Share: *Based on this paragraph, what do you predict you will learn about next in the text? You can also look at the subtitle of the next section, "Egg Thief or Egg Protetor?." to help you make a prediction*

Egg Thief or Egg Protector?

In 1923, a team of paleontologists from the American Museum of Natural History made a surprising discovery in Mongolia's Gobi Desert. They found three large rocks that turned out to be fossilized dinosaur eggs. Then they discovered another fossil nearby: a toothless dinosaur. The leader of the expedition, Roy Chapman Andrews, guessed that the dinosaur had been stealing the eggs from the nest. He named it *Oviraptor* (OH-vee-rap-tor) or "egg thief."

Seventy years later, in 1993, another team from the Museum found very similar fossil eggs in the same desert. One of the eggs held a fossil embryo, or developing baby dinosaur. It turned out to be a baby *Citipati* (sit-uh-PAH-tee), a kind of dinosaur very similar to *Oviraptor*. Later, the team discovered a fossil of an adult *Citipati* over a nest. It was brooding, or sitting on the nest, the same way birds do: with its arms spread to protect the eggs. And if its arms were covered with feathers, as scientists suspected, these wings would have shielded the eggs from heat and cold. Paleontologists realized that these dinosaurs nested like birds living today.

Think Aloud: *Wow! We just learned of an important discovery of dinosaur fossils in 1993.* Think-Pair-Share: *Describe the discovery that Museum scientists made in the Gobi desert in 1993. Explain how the fossils they found led them to a very different conclusion than the team of scientists that had gone to the same place seventy years earlier.* If students are struggling readers, you may want to pause after each paragraph in this section to summarize the information before reading on, rather than merely giving these instructions at the end of the section.

This is one of the *Citipati* fossils. The feathered wings are spread over the nest to protect the eggs, the same way birds do today.

Think-Pair-Share: *What does this fossil show?*

These dinosaurs didn't steal eggs. They were caring parents!

When the discovery was made, the group of dinosaurs that includes *Citipati* and *Oviraptor* had already been named "oviraptorids." Even though scientists no longer think these dinosaurs were "egg thieves," the name stuck.

The Link Between Ancient Dinosaurs and Birds

Over 100 years ago, scientists started to notice similarities between birds and a group of dinosaurs called theropods (THERE-uh-pods). This group included *Tyrannosaurus rex*, *Velociraptor*, and *Citipati*. As new theropod fossils were discovered, the link with birds became even clearer. Scientists discovered that like birds, theropods laid eggs. And they walked on two feet with their legs directly underneath them. They also had three-toed feet with claws, an s-shaped neck, and hollow bones. Some even had sharp, bird-like beaks. And many theropods had feathers!

Think-Pair-Share: *Partner A: In your own words, paraphrase scientists' change in thinking. Partner B: Look back in the text and identify the evidence supported this new idea. Explain it to your partner.* Listen in and select one or two pairs to share out a response to each question. Chart responses: scribe the new idea about dinosaurs, and list bullet points of evidence below it, inviting students to contribute (shared writing). Sample notes: Theropod dinosaurs were actually birds (new idea): they laid eggs; they walked upright on two feet; they had three-toed feet with claws; they had an "S" shaped neck; they had hollow bones; some had beaks; many had feathers (evidence).

***Citipati* lived about 80 million years ago. These bird-like theropods grew to about nine feet long, with a toothless beak and feathered tail and front limbs.**

Think-Pair-Share: *What do you notice about the physical features of this dinosaur? What similarities does it have with the birds we see living today?* Listen in and select one or two pairs to share out a response to each question.

Because birds are so similar to these animals, scientists have placed them in the same group. Birds are theropods. This means birds are a kind of dinosaur! By piecing together fossils of extinct dinosaurs, we've learned that dinosaurs aren't extinct after all.

Think-Pair-Share: *Turn and talk to your partner about what you learned in this article.* Listen in and select one or two pairs to share out.

STUDENT WORKSHEET

Name ANSWER KEY

Welcome to the *Dinosaurs Among Us* exhibition! Today, you will investigate fossils to explore what they tell us about the animals that left them behind.

Directions: Choose two fossils in the exhibition to investigate (the first one is chosen for you; it is one of the fossils discussed in the article you read in the classroom). Draw, label, and describe them below. Remember to choose fossils, NOT models of what the dinosaurs may have looked like when they were alive.

1. Fossil of: *Citipati osmolskae*

Describe what this fossil shows about the connection between birds and dinosaurs.

You can find this fossil by going to stop 2a in the Educator's Guide, in the "Nests, Eggs & Babies" section of the Exhibition. Another replica of this same fossil can be found outside of the Dinosaurs Among Us exhibition, in the hallway behind the Hall of Saurischian Dinosaurs. To find it, take the right-hand hallway upon exiting the Dinosaurs Among Us exhibition, it is in a case on the right-hand side.

Draw and label the fossil.

Caption:

STUDENT WORKSHEET

Name **ANSWER KEY**

2. Fossil of: _____

Describe what this fossil shows about the connection between birds and dinosaurs.

There are many possible fossils in the exhibition that students may use (remind them to use fossils and fossil casts, NOT models of what the animals may have looked like in life). Refer to the map sections in the Educator's Guide to help you locate these possibilities: oviraptorid eggs and embryo (2b), Khaan mckennai (4a), Yutyrannus huali (5a), Archaeopteryx siemensii (5a), Sinornithosaurus millenii, Caudipteryx zoui, Tianyulong confuciusi, Juravenator starki, Anchiornis huxleyi, Messelornis cristata, Effigia okeeffeae (5c), Microraptor gui, Confuciousornis sanctus, Xiaotingia zhengi, (6a) Jeholornis (6b), Paracoracias occidentalis, Gastornis gigantea, Lithnornis (6c), Unnamed troodontid (near the exit door)]

Draw and label the fossil.

Caption:

ESSAY SCORING RUBRIC: TEACHER VERSION

	Exceeds	Meets	Approaches	Needs Additonal Support
	4	3	2	1
Research: "Piecing Together the Story of Birds and Dinosuars" Article	Accurately presents information relevant to all parts of the prompt with effective paraphrased details from the article	Presents paraphrased information from the article relevant to the prompt with sufficient accuracy and detail	Presents information from the article mostly relevant to the purpose of the prompt with some lapses in accuracy or completeness AND/OR information is copied from the text	Attempts to present information in response to the prompt, but lacks connections to the article or relevance to the purpose of the prompt
Research: *Dinosaurs Among Us* Museum Exhibition	Accurately presents information relevant to all parts of the prompt with effective paraphrased details from the exhibition	Presents paraphrased information from the exhibition relevant to the prompt with sufficient accuracy and detail	Presents information from the exhibition mostly relevant to the purpose of the prompt with some lapses in accuracy or completeness AND/OR information is copied from the text	Attempts to present information in response to the prompt, but lacks connections to the exhibition content or relevance to the purpose of the prompt
Science Explanations	Integrates relevant and accurate science content with thorough explanations that demonstrate in-depth understanding of the connections between birds and other dinosaurs	Presents science content relevant to the prompt with sufficient accuracy and explanations that demonstrate understanding of the connections between birds and other dinosaurs	Presents science content mostly relevant to the prompt; shows basic or uneven understanding of the connections between birds and other dinosaurs; some errors in explanation	Attempts to include science content in explanations, but understanding of the connections between birds and dinosaurs is weak; content is irrelevant, inappropriate, or inaccurate
	Uses labeled illustrations of *Citipati* and one other dinosaur fossil to effectively communicate relevant information	Uses labeled illustrations of *Citipati* and one other dinosaur fossil to sufficiently communicate relevant information	Illustrations are unlabeled/uncaptioned OR only one fossil is illustrated	No illustrations
	Consistent use of precise and domain-specific language where appropriate	Some use of precise and domain-specific language	Little use of precise and domain-specific language	No use of precise and domain-specific language
Development	Includes an opening section that clearly introduces the topic of dinosaur fossils and what they show	Includes an opening section about dinosaur fossils	Includes an opening section that is insufficient or irrelevant	Does not include an introduction
	Essay includes more examples than *Citipati* and one other dinosaur to clearly explain in detail how birds and other dinosaurs are connected	Essay includes both *Citipati* and one other dinosaur example to sufficiently explain how birds and other dinosaurs are connected	Essay only includes one example to explain how birds and other dinosaurs are connected	Essay does not include examples to explain how birds and dinosaurs are connected
	Provides a relevant concluding paragraph	Provides a relevant concluding section	Provides a concluding statement	Provides no sense of closure
Conventions	Demonstrates and maintains a well-developed command of standard English conventions and cohesion, with few errors; response includes language and tone consistently appropriate to the purpose and specific requirements of the prompt	Demonstrates a command of standard English conventions and cohesion, with few errors; response includes language and tone appropriate to the purpose and specific requirements of the prompt	Demonstrates an uneven command of standard English conventions and cohesion; uses language and tone with some inaccurate, inappropriate, or uneven features	Attempts to demonstrate standard English conventions, but lacks cohesion and control of grammar, usage, and mechanics

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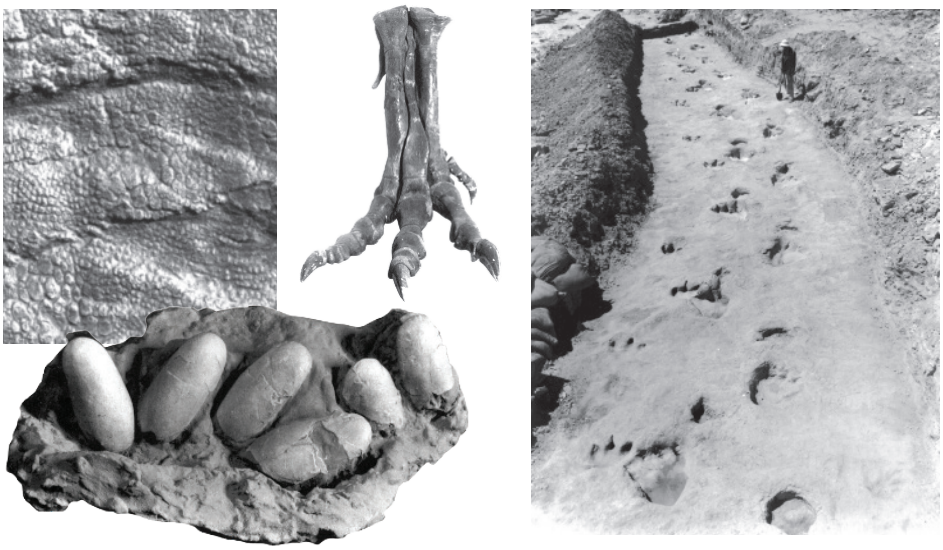
Fossils are the remains of ancient life. In order to become a fossil, the remains of a living thing must be buried quickly, usually in mud, sand, or volcanic ash. Over time, as the remains are buried deeper and deeper, the material around them hardens into rock. Minerals eventually replace the remains, turning them to rock too. Most fossils form from the hard parts of organisms such as teeth, shells, and bones. They also form from things a plant or animal leaves behind, like a footprint, a leaf print, and even eggs.

Fossils show us what Earth was like long ago. They give us a picture of ancient environments. Scientists compare fossils from different time periods to investigate how life on Earth has changed over time.



From left to right: fossil skin impressions, fossil eggs, fossil theropod foot, fossil dinosaur trackway

Think of fossils like puzzle pieces. The more pieces you have, the easier it is to put them together and tell what the whole picture looks like. And sometimes when you find and add new pieces, the picture looks very different from how you thought it would be.

Egg Thief or Egg Protector?

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This is one of the *Citipati* fossils. The feathered wings are spread over the nest to protect the eggs, the same way birds do today.

These dinosaurs didn't steal eggs. They were caring parents!

When the discovery was made, the group of dinosaurs that includes *Citipati* and *Oviraptor* had already been named "oviraptorids." Even though scientists no longer think these dinosaurs were "egg thieves," the name stuck.

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***Citipati* lived about 80 million years ago. These bird-like theropods grew to about nine feet long, with a toothless beak and feathered tail and front limbs.**

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Image Credits

Fossil skin impression, theropod foot, dinosaur eggs, and trackway, © AMNH; *Citipati* fossil, © AMNH/ M. Ellison; *Citipati* illustration, Zhao Chuang, Courtesy of Peking Natural Science Organization.

STUDENT WORKSHEET

Name _____

Welcome to the *Dinosaurs Among Us* exhibition! Today, you will investigate fossils to explore what they tell us about the animals that left them behind.

Directions: Choose two fossils in the exhibition to investigate (the first one is chosen for you; it is one of the fossils discussed in the article you read in the classroom). Draw, label, and describe them below. Remember to choose fossils, NOT models of what the dinosaurs may have looked like when they were alive.

1. Fossil of: *Citipati osmolskae*

Describe what this fossil shows about the connection between birds and dinosaurs.

Draw and label the fossil.

Caption:

STUDENT WORKSHEET

Name _____

2. Fossil of: _____

Describe what this fossil shows about the connection between birds and dinosaurs.

Draw and label the fossil.

Caption:

STUDENT WRITING TASK

By reading "Piecing Together the Story of Dinosaurs from Fossils" and visiting the *Dinosaurs Among Us* exhibition, you have learned about what fossils reveal to us about the animals that left them behind. Now you will write an essay that gives examples of what fossils reveal about ancient animals.

Your essay will include two examples: *Citipati* from "Piecing Together the Story of Dinosaurs from Fossils", and a dinosaur fossil of your choice from the *Dinosaurs Among Us* exhibition.

For each one, you will explain what this fossil shows about the connection between birds and other dinosaurs. Then you will draw the fossil, label its most important features, and include a caption.

ESSAY SCORING RUBRIC: STUDENT VERSION

	Exceeds	Meets	Approaches	Needs Additonal Support
	4	3	2	1
Research: "Piecing Together the Story of Birds and Dinosaurs" Article	I have used information correctly from the article to write my essay; I have given a lot of detail to explain the information in my own words.	I have used information correctly from the article to write my essay in my own words.	I have used information from the article to write my essay, but not all of my information is correct AND/ OR I didn't use my own words.	I did not use information from the article to write my essay.
Research: *Dinosaurs Among Us* Museum Exhibition	I have used information correctly from the exhibition to write my essay; I have given a lot of detail to explain the information in my own words.	I have used information correctly from the exhibition to write my essay in my own words.	I have used information from the exhibition to write my essay, but not all of my information is correct AND/ OR I didn't use my own words.	I did not use information from the exhibition to write my essay.
Science Explanations	All of the information I included about what the fossils show about the connections between birds and other dinosaurs is correct.	Most of the information I included about the connections between birds and other dinosaurs is correct.	Some of the information I included about the connections between birds and other dinosaurs is correct.	None of the information I included about the connections between birds and other dinosaurs is correct.
	I included labeled illustrations with captions of both fossils that help the reader understand how birds are similar to other dinosaurs.	I included labeled illustrations with captions of both dinosaur fossils.	I included labeled illustrations of only one dinosaur fossil.	I did not include any illustrations.
	I used all appropriate science vocabulary words correctly.	I used most science vocabulary words correctly.	I used some science vocabulary words correctly.	I did not use any science vocabulary words.
Development	I included a clear introductory paragraph on dinosaur fossils and what they show.	I included a relevant introduction in the essay.	I included an irrelevant introduction to the essay.	I did not include an introduction.
	I included more examples than *Citipati* and one other dinosaur to clearly explain how birds and other dinosaurs are connected.	I included *Citipati* and one other dinosaur example to explain how birds and other dinosaurs are connected.	I only included one example to explain how birds and other dinosaurs are connected.	I didn't include any examples to show to explain how birds and other dinosaurs are connected.
	I wrote a concluding paragraph that relates to the information in my essay.	I wrote a concluding sentence that relates to the information in my essay.	I wrote a concluding sentence at the end of the essay.	I did not write a concluding sentence at the end of the essay.
Conventions	I edited my essay for spelling, punctuation, and grammar; there are no errors.	I edited my essay for spelling, punctuation, and grammar; there are some minor errors but the reader can still understand my writing.	I did not carefully edit my essay for spelling, punctuation, and grammar; there are errors that may make the essay hard for readers to understand.	I did not edit my essay for spelling, punctuation, and grammar; there are many errors that make the essay hard for readers to understand.