



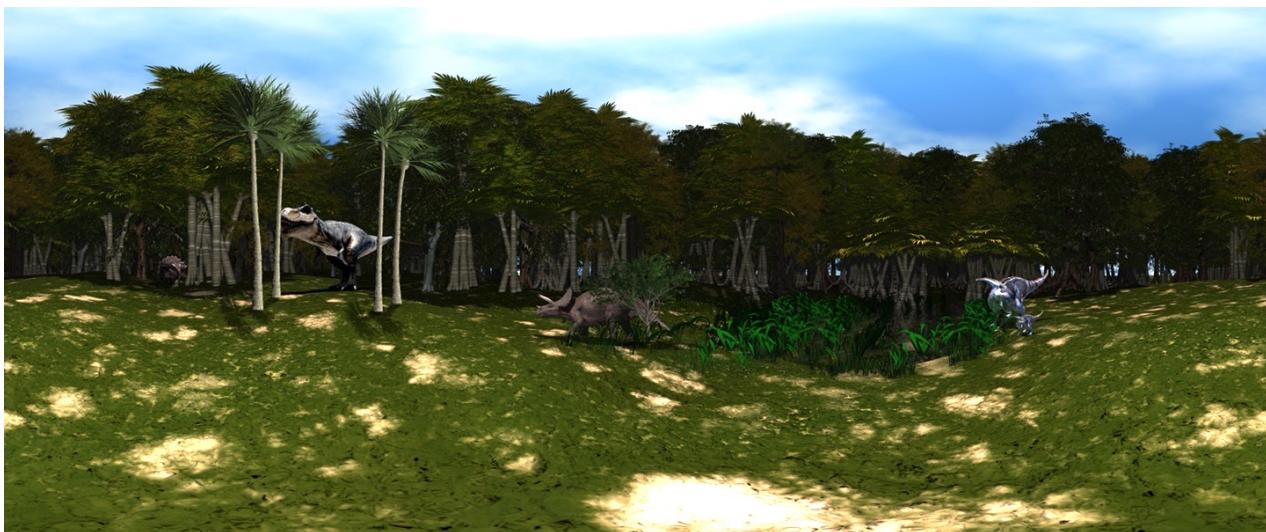
dinodoom





# Dino Doom

## High School Next Generation Science Standards Alignment Document



### WHAT STUDENTS DO: Explore the extinction event at the KPg boundary.

Students will explore sites around the world searching for clues to the mass extinction event that occurred 66 mya. They will collect evidence from each site to tell a piece of the KPg story. Finally, students will combine all of the evidence to explain how natural events impact life on Earth.

#### NRC FRAMEWORK/NGSS CORE & COMPONENT QUESTIONS

### HOW AND WHY DO ORGANISMS INTERACT WITH THEIR ENVIRONMENT AND WHAT ARE THE EFFECTS OF THESE INTERACTIONS?

NGSS Core Question: LS2: *Ecosystems: Interactions, Energy, and Dynamics*

### How do organisms interact with the living and nonliving environments to obtain matter and energy?

NGSS LS2.A: *Interdependent Relationships in Ecosystems*

### What happens to ecosystems when the environment changes?

NGSS LS2.C: *Ecosystem Dynamics, Functioning, and Resilience*

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#### INSTRUCTIONAL OBJECTIVES (IO)

*Students will be able to*

IO1: **Construct an explanation, using empirical and observational data from the rock record, for the impact of a natural event on the carrying capacities of an ecosystem and the natural selection that results from limited resources.**



## HOW CAN THERE BE SO MANY SIMILARITIES AMONG ORGANISMS YET SO MANY DIFFERENT KINDS OF PLANTS, ANIMALS, AND MICROORGANISMS?

*NGSS Core Question: LS4: Biological Evolution: Unity and Diversity*

### How does the environment influence populations of organisms over multiple generations?

*NGSS LS4.C: Adaptation*

## HOW AND WHY IS EARTH CONSTANTLY CHANGING?

*NGSS Core Question: ESS2: Earth Systems*

### How do Earth's major systems interact?

*NGSS ESS2.A: Earth Materials and Systems*

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## 1.0 About This Activity

*How Students Learn: Science in the Classroom* (Donovan & Bransford, 2005) advocates the use of a research-based instructional model for improving students' grasp of central science concepts. Based on conceptual-change theory in science education, the 5E Instructional Model (BSCS, 2006) includes five steps for teaching and learning: Engage, Explore, Explain, Elaborate, and Evaluate. The Engage stage is used like a traditional warm-up to pique student curiosity, interest, and other motivation-related behaviors and to assess students' prior knowledge. The Explore step allows students to deepen their understanding and challenges existing preconceptions and misconceptions, offering alternative explanations that help them form new schemata. In Explain, students communicate what they have learned, illustrating initial conceptual change. The Elaborate phase gives students the opportunity to apply their newfound knowledge to novel situations and supports the reinforcement of new schemata or its transfer. Finally, the Evaluate stage serves as a time for students' own formative assessment, as well as for educators' diagnosis of areas of confusion and differentiation of further instruction. The 5E stages can be cyclical and iterative.

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## 2.0 Instructional Objectives, Learning Outcomes, Standards, & Rubrics

Instructional objectives and learning outcomes are aligned with

- Achieve Inc.'s, *Next Generation Science Standards (NGSS)*
- National Research Council's, *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*
- National Governors Association Center for Best Practices (NGA Center) and Council of Chief State School Officers (CCSSO)'s, *Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects*

The following chart provides details on alignment among the core and component NGSS questions, instructional objectives, learning outcomes, and educational standards.

- Your **instructional objectives (IO)** for this lesson align with the NRC Framework and NGSS.
- You will know that you have achieved these instructional objectives if students demonstrate the related **learning outcomes (LO)**, also aligned with the NRC Framework and NGSS.
- You will know the level to which your students have achieved the learning outcomes by using the suggested **rubrics**.

**Important Note:** This lesson is color-coded to help teachers identify each of the three dimensions of NGSS. The following identifying colors are used: **Practices are blue**, **Cross-Cutting Concepts are green**, and **Disciplinary Core Ideas are orange**.

**This color-coding is consistent with the NGSS Performance Expectations and Foundation Boxes.**

### Quick View of Standards Alignment:

This alignment document provides full details of the way in which instructional objectives, learning outcomes, 5E activity procedures, and rubric assessments were derived through, and align with the Next Generation Science Standards (NGSS). For convenience, a quick view follows:

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## HOW AND WHY DO ORGANISMS INTERACT WITH THEIR ENVIRONMENT AND WHAT ARE THE EFFECTS OF THESE INTERACTIONS?

*NGSS Core Question: LS2: Ecosystems: Interactions, Energy, and Dynamics*

**How do organisms interact with the living and nonliving environments to obtain matter and energy?**

*NGSS LS2.A: Interdependent Relationships in Ecosystems*

**What happens to ecosystems when the environment changes?**

*NGSS LS2.C: Ecosystem Dynamics, Functioning, and Resilience*

**HOW CAN THERE BE SO MANY SIMILARITIES AMONG ORGANISMS YET SO MANY DIFFERENT KINDS OF PLANTS, ANIMALS, AND MICROORGANISMS?**

*NGSS Core Question: LS4: Biological Evolution: Unity and Diversity*

**How does the environment influence populations of organisms over multiple generations?**

*NGSS LS4.C: Adaptation*

**HOW AND WHY IS EARTH CONSTANTLY CHANGING?**

*NGSS Core Question: ESS2: Earth Systems*

**How do Earth's major systems interact?**

*NGSS ESS2.A: Earth Materials and Systems*

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Instructional Objective <i>Students will be able to</i>	Learning Outcomes <i>Students will demonstrate the measurable abilities</i>	Standards <i>Students will address</i>
<b>IO1: Construct an explanation, using empirical and observational data from the rock record, for the impact of a natural event on the carrying capacities of an ecosystem and the natural selection that results from limited resources.</b>	<b>LO1a:</b> Investigate the patterns in fossil data over time that aid in the discovery of significant events in Earth's history.  <b>LO1b:</b> Investigate the global patterns in chemical composition data over time that aid in the discovery of significant events in Earth's history.  <b>LO1c:</b> Determine the size of the impact crater, using the global patterns of iridium in the rock record, to search for the location of the impact potentially responsible for changes to the environment.  <b>LO1d:</b> Investigate the global patterns of living organisms, before and after the KPg boundary, to identify the significant changes to life on Earth.	<p><b>PRACTICES:</b></p> <ol style="list-style-type: none"> <li>1. Planning and Carrying Out Investigations</li> <li>2. Analyzing and Interpreting Data</li> <li>3. Using Mathematics and Computational Thinking</li> <li>4. Constructing Explanations and Designing Solutions</li> <li>5. Obtaining, Evaluating, and Communicating information</li> </ol> <p><b>Scientific Knowledge is Based on Empirical Evidence</b></p> <p><b>DISCIPLINARY CORE IDEAS:</b></p> <p>LS2.A: Interdependent Relationships in Ecosystems    LS2.C: Ecosystem Dynamics, Functioning, and Resilience    LS4.C: Adaptation    ESS2.A: Earth Materials and Systems</p> <p><b>CROSSCUTTING CONCEPTS:</b></p> <ol style="list-style-type: none"> <li>1. Patterns</li> <li>2. Cause and Effect: Mechanism and Prediction</li> </ol> <p><b>Scientific Knowledge Assumes an Order and Consistency in Natural Systems</b></p>

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## 4.0 Evaluation/Assessment

Use the (*N*) *Dino Doom Alignment Rubric* as a formative and summative assessment, allowing students to improve their work and learn from mistakes during class. The rubric evaluates the activities using the Next Generation Science Standards (NGSS).

## 5.0 References

Achieve, Inc. (2013). *Next generation science standards*. Achieve, Inc. on behalf of the twenty-six states and partners that collaborated on the NGSS.

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**(M) Teacher Resource. Dino Doom NGSS Alignment (1 of 3)**

You will know the level to which your students have achieved the **Learning Outcomes**, and thus the **Instructional Objective(s)**, by using the suggested **Rubrics** below.

**Related Standard(s)**

This lesson supports the preparation of students toward achieving Performance Expectations using the **Practices**, **Cross-Cutting Concepts** and **Disciplinary Core Ideas** defined below: (HS-LS2-2), (HS-LS2-1), (HS-LS4-2), (HS-LS4-3), (HS-LS4-4), (HS-LS4-5), (HS-ESS2-4).

Next Generation Science Standards			
Instructional Objective	Science and Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts
IO1: <b>Construct an explanation, using empirical and observational data from the rock record, for the impact of a natural event on the carrying capacities of an ecosystem and the natural selection that results from limited resources.</b>	<p><b>Constructing Explanation and Designing Solutions</b> Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulation, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.</p> <p><b>Scientific Knowledge is Based on Empirical Evidence</b> Science arguments are strengthened by multiple lines of evidence supporting a single explanation</p>	<p><b>LS2.A: Interdependent Relationships in Ecosystems</b> 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. (HS-LS2-2, HS-LS2-1)</p> <p><b>LS2.C: Ecosystem Dynamics, Functioning, and Resilience</b> A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods</p>	<p><b>Patterns</b> Empirical evidence is needed to identify patterns</p> <p><b>Cause and Effect: Mechanism and Prediction:</b> Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.</p> <p>Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.</p> <p><b>Scientific Knowledge Assumes an Order and Consistency in Natural Systems</b></p>

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		<p>of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-2)</p> <p><b>LS4.C: Adaptation</b></p> <p>Evolution is a consequence of the interaction of four factors: (1) the potential for a species to increase in number, (2) the genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for an environment's limited supply of the resources that individuals need in order to survive and reproduce, and (4) the ensuing proliferation of those organisms that are better able to survive and reproduce in that environment. (HS-LS4-2)</p> <p>Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not. (HS-LS4-3, HS-LS4-4)</p> <p>Adaptation also means that the distribution of traits in a population can change when conditions change. (HS-LS4-3)</p>	Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future.
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		<p>Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline—and sometimes the extinction—of some species. (HS-LS4-5)</p> <p>Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost. (HS-LS4-5)</p> <p><b>ESS2.A: Earth Materials and Systems</b></p> <p>The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. (HS-ESS2-4)</p>	
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## (M) Teacher Resource. Dino Doom NGSS Alignment (2 of 3)

Next Generation Science Standards			
Learning Outcomes	Science and Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts
<b>LO1a:</b> <b>Investigate the patterns in fossil data over time that aid in the discovery of significant events in Earth's history.</b>	<b>Planning and Carrying Out Investigations</b> Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meet the goals of the investigation. ( <i>Reconnect to 6-8 Practices</i> )  <b>Analyzing and Interpreting Data</b> Analyze data using tools, technologies, and/or models in order to make valid and reliable scientific claims.	<b>LS2.C: Ecosystem Dynamics, Functioning, and Resilience</b> A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-2, HS-LS2-1)  <b>LS4.C: Adaptation</b> A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources	<b>Patterns</b> Empirical evidence is needed to identify patterns  <b>Cause and Effect: Mechanism and Prediction:</b> Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.  <b>Scientific Knowledge Assumes an Order and Consistency in Natural Systems</b> Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future.

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	<p>and habitat availability. (HS-LS2-2, HS-LS2-1)</p> <p>Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not. (HS-LS4-3, HS-LS4-4)</p> <p>Adaptation also means that the distribution of traits in a population can change when conditions change. (HS-LS4-3)</p> <p>Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline—and sometimes the extinction—of some species. (HS-LS4-5)</p> <p>Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost. (HS-LS4-5)</p> <p><b>ESS2.A: Earth Materials and Systems</b></p> <p>Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-2)</p> <p>The geological record shows that changes to global and regional climate can be caused by</p>	
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		<p>interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. (HS-ESS2-4)</p>	
<p><b>LO1b:</b>  <b>Investigate the global patterns in chemical composition data over time that aid in the discovery of significant events in Earth's history.</b></p>	<p><b>Planning and Carrying Out Investigations</b>  Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meet the goals of the investigation. (<i>Reconnect to 6-8 Practices</i>)</p> <p><b>Analyzing and Interpreting Data</b>  Analyze data using tools, technologies, and/or models in order to make valid and reliable scientific claims.</p>	<p><b>LS2.C: Ecosystem Dynamics, Functioning, and Resilience</b>  A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-2, HS-LS2-1)</p> <p><b>LS4.C: Adaptation</b>  Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline—and sometimes the extinction—of some species. (HS-LS4-5)</p> <p>Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost. (HS-LS4-5)</p>	<p><b>Patterns</b>  Empirical evidence is needed to identify patterns</p> <p><b>Cause and Effect: Mechanism and Prediction:</b>  Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.</p> <p><b>Scientific Knowledge Assumes an Order and Consistency in Natural Systems</b>  Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future.</p>

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		<p><b>ESS2.A: Earth Materials and Systems</b>  The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. (HS-ESS2-4)</p>	
<p><b>LO1c:</b>  <b>Determine the size of the impact crater, using the global patterns of iridium in the rock record, to search for the location of the impact potentially responsible for changes to the environment.</b></p>	<p><b>Using Mathematics and Computational Thinking</b>  Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.    Apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m<sup>3</sup>, acre-feet, etc.).</p> <p><b>Analyzing and Interpreting Data</b>  Analyze data using tools, technologies, and/or models in order to make valid and reliable scientific claims.</p>	<p><b>ESS2.A: Earth Materials and Systems</b>  The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. (HS-ESS2-4)</p>	<p><b>Patterns</b>  Empirical evidence is needed to identify patterns</p> <p><b>Cause and Effect: Mechanism and Prediction:</b>  Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.</p> <p><b>Scientific Knowledge Assumes an Order and Consistency in Natural Systems</b>  Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future.</p>

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<p><b>LO1d:</b>  <b>Investigate the global patterns of living organisms, before and after the KPg boundary, to identify the significant changes to life on Earth.</b></p>	<p><b>Planning and Carrying Out Investigations</b>  Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meet the goals of the investigation. (<i>Reconnect to 6-8 Practices</i>)</p> <p><b>Analyzing and Interpreting Data</b>  Analyze data using tools, technologies, and/or models in order to make valid and reliable scientific claims.</p>	<p><b>LS2.C: Ecosystem Dynamics, Functioning, and Resilience</b>  A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-2, HS-LS2-1)</p> <p><b>LS4.C: Adaptation</b>  Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not. (HS-LS4-3, HS-LS4-4)</p> <p>Adaptation also means that the distribution of traits in a population can change when conditions change. (HS-LS4-3)</p> <p>Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the</p>	<p><b>Patterns</b>  Empirical evidence is needed to identify patterns</p> <p><b>Cause and Effect: Mechanism and Prediction:</b>  Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.</p> <p><b>Scientific Knowledge Assumes an Order and Consistency in Natural Systems</b>  Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future.</p>
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		<p>decline—and sometimes the extinction—of some species. (HS-LS4-5)</p> <p>Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost. (HS-LS4-5)</p> <p><b>ESS2.A: Earth Materials and Systems</b></p> <p>Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-2)</p> <p>The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. (HS-ESS2-4)</p>	
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## (M) Teacher Resource. Dino Doom NGSS Individual Activity Alignment (3 of 3)

Next Generation Science Standards Activity Alignments (NGSS)				
Activity	Phases of 5E Instructional Model	Science and Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts
Dino Doom Virtual Field Trip Video Intro	Engage			
Dino Doom Virtual Field Trip	Explore	<p><b>Planning and Carrying Out Investigations</b> Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meet the goals of the investigation. (<i>Reconnect to 6-8 Practices</i>)</p> <p><b>Using Mathematics and Computational Thinking</b> Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.</p>	<p><b>LS2.C: Ecosystem Dynamics, Functioning, and Resilience</b> A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-2, HS-LS2-1)</p> <p><b>LS4.C: Adaptation</b> Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and</p>	<p><b>Patterns</b> Empirical evidence is needed to identify patterns</p> <p><b>Cause and Effect: Mechanism and Prediction:</b> Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.</p> <p><b>Scientific Knowledge Assumes an Order and Consistency in Natural Systems</b> Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future.</p>

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		<p>Apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m<sup>3</sup>, acre-feet, etc.).</p> <p><b>Analyzing and Interpreting Data</b></p> <p>Analyze data using tools, technologies, and/or models in order to make valid and reliable scientific claims.</p>	<p>physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not. (HS-LS4-3, HS-LS4-4)</p> <p>Adaptation also means that the distribution of traits in a population can change when conditions change. (HS-LS4-3)</p> <p>Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline—and sometimes the extinction—of some species. (HS-LS4-5)</p> <p>Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost. (HS-LS4-5)</p> <p><b>ESS2.A: Earth Materials and Systems</b></p> <p>Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-2)</p> <p>The geological record shows that changes to global and regional climate can be caused by</p>	
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			interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. (HS-ESS2-4)	
<b>(A) Story of Fossils (Section 1) Recording Sheet</b>	<b>Explore Explain</b>	<p><b>Planning and Carrying Out Investigations</b> Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meet the goals of the investigation. (<i>Reconnect to 6-8 Practices</i>)</p> <p><b>Analyzing and Interpreting Data</b> Analyze data using tools, technologies, and/or models in order to make valid and reliable scientific claims.</p>	<p><b>LS2.C: Ecosystem Dynamics, Functioning, and Resilience</b> A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-2, HS-LS2-1)</p> <p><b>LS4.C: Adaptation</b> Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a</p>	<p><b>Patterns</b> Empirical evidence is needed to identify patterns</p> <p><b>Cause and Effect: Mechanism and Prediction:</b> Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.</p> <p><b>Scientific Knowledge Assumes an Order and Consistency in Natural Systems</b> Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future.</p>

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		<p>decrease in the proportion of individuals that do not. (HS-LS4-3, HS-LS4-4)</p> <p>Adaptation also means that the distribution of traits in a population can change when conditions change. (HS-LS4-3)</p> <p>Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline—and sometimes the extinction—of some species. (HS-LS4-5)</p> <p>Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost. (HS-LS4-5)</p> <p><b>ESS2.A: Earth Materials and Systems</b> Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-2)</p> <p>The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. (HS-ESS2-4)</p>	
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<p><b>(B) Origin of Iridium (Section 2) Recording Sheet</b></p>	<p><b>Explore Explain</b></p>	<p><b>Planning and Carrying Out Investigations</b> Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meet the goals of the investigation. (<i>Reconnect to 6-8 Practices</i>)</p> <p><b>Analyzing and Interpreting Data</b> Analyze data using tools, technologies, and/or models in order to make valid and reliable scientific claims.</p> <p><b>LS2.C: Ecosystem Dynamics, Functioning, and Resilience</b> A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-2, HS-LS2-1)</p> <p><b>LS4.C: Adaptation</b> Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline—and sometimes the extinction—of some species. (HS-LS4-5)</p> <p>Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost. (HS-LS4-5)</p> <p><b>ESS2.A: Earth Materials and Systems</b> The geological record shows that changes to global and regional climate can be caused by</p>	<p><b>Patterns</b> Empirical evidence is needed to identify patterns</p> <p><b>Cause and Effect: Mechanism and Prediction:</b> Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.</p> <p><b>Scientific Knowledge Assumes an Order and Consistency in Natural Systems</b> Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future.</p>
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			interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. (HS-ESS2-4)	
<b>(C) Determine the Diameter of the Asteroid (Section 3) Recording Sheet</b>  <b>(D) Locating the Crater (Section 4) Recording Sheet</b>	<b>Explore Explain</b>	<p><b>Using Mathematics and Computational Thinking</b> Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.</p> <p>Apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m<sup>3</sup>, acre-feet, etc.).</p> <p><b>Analyzing and Interpreting Data</b> Analyze data using tools, technologies, and/or models in order to make valid and reliable scientific claims.</p>	<p><b>ESS2.A: Earth Materials and Systems</b> The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. (HS-ESS2-4)</p>	<p><b>Patterns</b> Empirical evidence is needed to identify patterns</p> <p><b>Cause and Effect: Mechanism and Prediction:</b> Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.</p> <p><b>Scientific Knowledge Assumes an Order and Consistency in Natural Systems</b> Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future.</p>

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<p><b>(E) Mass Extinction (Section 5) Recording Sheet</b></p> <p><b>(F) Adaptation and Recovery (Section 6) Recording Sheet</b></p>	<p><b>Explore Explain</b></p>	<p><b>Planning and Carrying Out Investigations</b> Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meet the goals of the investigation. (<i>Reconnect to 6-8 Practices</i>)</p> <p><b>Analyzing and Interpreting Data</b> Analyze data using tools, technologies, and/or models in order to make valid and reliable scientific claims.</p>	<p><b>LS2.C: Ecosystem Dynamics, Functioning, and Resilience</b> A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-2, HS-LS2-1)</p> <p><b>LS4.C: Adaptation</b> Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not. (HS-LS4-3, HS-LS4-4)</p> <p>Adaptation also means that the distribution of traits in a population can change when conditions change. (HS-LS4-3)</p> <p>Changes in the physical environment, whether naturally occurring or human</p>	<p><b>Patterns</b> Empirical evidence is needed to identify patterns</p> <p><b>Cause and Effect: Mechanism and Prediction:</b> Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.</p> <p><b>Scientific Knowledge Assumes an Order and Consistency in Natural Systems</b> Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future.</p>
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		<p>induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline—and sometimes the extinction—of some species. (HS-LS4-5)</p> <p>Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost. (HS-LS4-5)</p> <p><b>ESS2.A: Earth Materials and Systems</b> Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-2)</p> <p>The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. (HS-ESS2-4)</p>	
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KPg Food Web	Elaborate	<p><b>Analyzing and Interpreting Data</b> Analyze data using tools, technologies, and/or models in order to make valid and reliable scientific claims.</p> <p><b>Obtaining, Evaluating, and Communicating information</b> Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).</p>	<p><b>LS2.C: Ecosystem Dynamics, Functioning, and Resilience</b> A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-2, HS-LS2-1)</p>	<p><b>Cause and Effect: Mechanism and Prediction:</b> Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.</p>
(G) Dino Doom Evaluation	Evaluate	<p><b>Constructing Explanation and Designing Solutions</b> Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulation, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to</p>	<p><b>LS2.A: Interdependent Relationships in Ecosystems</b> 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</p>	<p><b>Patterns</b> Empirical evidence is needed to identify patterns</p> <p><b>Cause and Effect: Mechanism and Prediction:</b> Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.</p> <p>Cause and effect relationships can be suggested and</p>

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	<p>do so in the future.</p> <p><b>Scientific Knowledge is Based on Empirical Evidence</b> Science arguments are strengthened by multiple lines of evidence supporting a single explanation</p>	<p>ecosystem. (HS-LS2-2, HS-LS2-1)</p> <p><b>LS2.C: Ecosystem Dynamics, Functioning, and Resilience</b> A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-2)</p> <p><b>LS4.C: Adaptation</b> Evolution is a consequence of the interaction of four factors: (1) the potential for a species to increase in number, (2) the genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for an environment's limited supply of the resources that individuals need in order to survive and reproduce, and (4) the ensuing proliferation of those organisms that are better able to survive and reproduce in that environment. (HS-LS4-2)</p> <p>Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of</p>	<p>predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.</p> <p><b>Scientific Knowledge Assumes an Order and Consistency in Natural Systems</b> Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future.</p>
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		<p>organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not. (HS-LS4-3, HS-LS4-4)</p> <p>Adaptation also means that the distribution of traits in a population can change when conditions change. (HS-LS4-3)</p> <p>Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline—and sometimes the extinction—of some species. (HS-LS4-5)</p> <p>Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost. (HS-LS4-5)</p> <p><b>ESS2.A: Earth Materials and Systems</b> The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. (HS-ESS2-4)</p>	
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## (N) Teacher Resource. Dino Doom NGSS Alignment Rubric

## Related Rubrics for the Assessment of Learning Outcomes Associated with the Above Standard(s):

 Next Generation Science Standards Alignment (NGSS)

Learning Outcome	Expert	Proficient	Intermediate	Beginner
<b>LO1a:</b> Investigate the patterns in fossil data over time that aid in the discovery of significant events in Earth's history	Accurately describes the diversity and size of forams, including adaptations of some and the extinction of others at the 66 mya mark.	Describes the diversity <i>or</i> size of forams, including adaptations of some and the extinction of others at the 66 mya mark.	Describes the diversity <i>or</i> size of forams, including the adaptations of some <i>or</i> the extinction of others at the 66 mya mark.	Discusses adaptation and/or extinction.
<b>LO1b:</b> Investigate the global patterns in chemical composition data over time that aid in the discovery of significant events in Earth's history.	Accurately describes the iridium <b>ratio</b> found at and around the 66 mya mark, including the type of rock, at a variety of global locations.	Describes the iridium <b>spike</b> found at and around the 66 mya mark, including the type of rock, at a variety of global locations.	Describes the iridium ratio <i>or</i> spike found at and around the 66 mya mark, including the type of rock.	Claims there is an iridium spike at 66 mya.
<b>LO1c:</b> Determine the size of the impact crater, using the global patterns of iridium in the rock record, to search for the location of the impact potentially responsible for changes to the environment.	Identifies the process used to find the diameter of the asteroid and crater, then correctly narrows the possible locations to three based on diameter, and to the most probable site of impact based on age.	Identifies the process used to find the diameter of the asteroid and crater, then narrows to the possible locations, and to the most probable site of impact based on age.	Identifies the process used to find the diameter of the asteroid and crater, then narrows to the possible locations based on diameter.	Identifies the process used to find the diameter of the asteroid and crater.
<b>LO1d:</b> Investigate the global patterns of living organisms, before and after the KPg boundary, to identify the significant changes to life on Earth.	Accurately describes the difference between the characteristics of organisms that survived the extinction and those that did not, and explains the significance of this extinction event.	Describes the characteristics of organisms that survived the extinction and includes a description of the significance of this extinction event.	Describes the characteristics of organisms that survived the extinction and those that did not.	Describes the characteristics of organisms that survived the extinction.

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