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NGSSS: Science Standards Alignment with CyGaMEs *Selene: A Lunar Construction Game* – Version 2 - July 6, 2013

<p>Big Idea 3: The Role of Theories, Laws, Hypotheses, and Models</p> <p>The terms that describe examples of scientific knowledge, for example; "theory," "law," "hypothesis," and "model" have very specific meanings and functions within science.</p>		
BENCHMARK CODE	BENCHMARK	CyGaMEs Selene
SC.4.N.3.1	<p>Explain that models can be three dimensional, two dimensional, an explanation in your mind, or a computer model.</p> <p><i>Cognitive Complexity:</i> Level 2: Basic Application of Skills & Concepts</p>	Selene uses a two-dimensional computer model.
<p>Big Idea 5: Earth in Space and Time</p> <p>Humans continue to explore Earth's place in space. Gravity and energy influence the formation of galaxies, including our own Milky Way Galaxy, stars, the Solar System, and Earth. Humankind's need to explore continues to lead to the development of knowledge and understanding of our Solar System.</p>		
BENCHMARK CODE	BENCHMARK	CyGaMEs Selene
SC.4.E.5.2	<p>Describe the changes in the observable shape of the moon over the course of about a month.</p> <p><i>Cognitive Complexity:</i> Level 2: Basic Application of Skills & Concepts</p>	MoonGazers
SC.4.E.5.4	<p>Relate that the rotation of Earth (day and night) and apparent movements of the Sun, Moon, and stars are connected.</p> <p><i>Cognitive Complexity:</i> Level 3: Strategic Thinking & Complex Reasoning</p>	MoonGazers
<p>Big Idea 8: Properties of Matter</p> <p>A. All objects and substances in the world are made of matter. Matter has two fundamental properties: matter takes up space and matter has mass.</p>		

B. Objects and substances can be classified by their physical and chemical properties. Mass is the amount of matter (or "stuff") in an object. Weight, on the other hand, is the measure of force of attraction (gravitational force) between an object and Earth.

The concepts of mass and weight are complicated and potentially confusing to elementary students. Hence, the more familiar term of "weight" is recommended for use to stand for both mass and weight in grades K-5. By grades 6-8, students are expected to understand the distinction between mass and weight, and use them appropriately.

Clarification for grades K-2: The use of the more familiar term 'weight' instead of the term "mass" is recommended for grades K-2.

Clarification for grades 3-5: In grade 3, introduce the term mass as compared to the term weight. In grade 4, investigate the concept of weight versus mass of objects. In grade 5, discuss why mass (not weight) is used to compare properties of solids, liquids and gases.

BENCHMARK CODE	BENCHMARK	CyGaMEs Selene
SC.4.P.8.3	Explore the Law of Conservation of Mass by demonstrating that the mass of a whole object is always the same as the sum of the masses of its parts. <i>Cognitive Complexity:</i> Level 2: Basic Application of Skills & Concepts	Selene involves this concept.

GRADE: 5

Big Idea 1: The Practice of Science

A: Scientific inquiry is a multifaceted activity; The processes of science include the formulation of scientifically investigable questions, construction of investigations into those questions, the collection of appropriate data, the evaluation of the meaning of those data, and the communication of this evaluation.

B: The processes of science frequently do not correspond to the traditional portrayal of "the scientific method."

C: Scientific argumentation is a necessary part of scientific inquiry and plays an important role in the generation and validation of scientific knowledge.

D: Scientific knowledge is based on observation and inference; it is important to recognize that these are very different things. Not only does science require creativity in its methods and processes, but also in its questions and explanations.

BENCHMARK CODE	BENCHMARK	CyGaMEs Selene
SC.5.N.1.1	Define a problem, use appropriate reference	DEBRIEFING: Selene gameplay guides the

	materials to support scientific understanding, plan and carry out scientific investigations of various types such as: systematic observations, experiments requiring the identification of variables, collecting and organizing data, interpreting data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions. <i>Cognitive Complexity:</i> Level 3: Strategic Thinking & Complex Reasoning	student through a process of scientific investigation through hypothesis making, testing and revision. Educators in the classroom can follow gameplay with the connection between Selene investigations – videogame inquiry and the scientific process.
SC.5.N.1.2	Explain the difference between an experiment and other types of scientific investigation. <i>Cognitive Complexity:</i> Level 2: Basic Application of Skills & Concepts	MoonGazers - Observation rather than experiment.
SC.5.N.1.3	Recognize and explain the need for repeated experimental trials. <i>Cognitive Complexity:</i> Level 2: Basic Application of Skills & Concepts	DEBRIEFING: Selene gameplay guides the student through a process of scientific investigation through hypothesis making, testing and revision. Educators in the classroom can follow gameplay with the connection between Selene investigations – videogame inquiry and the scientific process.
SC.5.N.1.4	Identify a control group and explain its importance in an experiment. <i>Cognitive Complexity:</i> Level 2: Basic Application of Skills & Concepts	
SC.5.N.1.5	Recognize and explain that authentic scientific investigation frequently does not parallel the steps of "the scientific method." <i>Cognitive Complexity:</i> Level 2: Basic Application of Skills & Concepts	DEBRIEFING: Selene gameplay guides the student through a process of scientific investigation through hypothesis making, testing and revision. Educators in the classroom can follow gameplay with the connection between Selene investigations – videogame inquiry and the scientific process.
SC.5.N.1.6	Recognize and explain the difference between personal opinion/interpretation and verified observation. <i>Cognitive Complexity:</i> Level 2: Basic Application of Skills & Concepts	DEBRIEFING: Selene gameplay guides the student through a process of scientific investigation through hypothesis making, testing and revision. Educators in the classroom can follow gameplay with the connection between Selene investigations – videogame inquiry and the scientific process.

Big Idea 13: Forces and Changes in Motion

A. It takes energy to change the motion of objects.

B. Energy change is understood in terms of forces--pushes or pulls.

C. Some forces act through physical contact, while others act at a distance.

Clarification for grades K-5: The target understanding for students in the elementary grades should focus on Big Ideas A, B, and C.

Clarification for grades 6-8: The target understanding for students in grades 6-8 should begin to transition the focus to a more specific definition of forces and changes in motion. Net forces create a change in motion. A change in momentum occurs when a net force is applied to an object over a time interval.

Grades 9-12, Standard 12: Motion - A. Motion can be measured and described qualitatively and quantitatively. Net forces create a change in motion. B. Momentum is conserved under well-defined conditions. A change in momentum occurs when a net force is applied to an object over a time interval.

BENCHMARK CODE	BENCHMARK	CyGaMEs Selene
SC.5.P.13.2	Investigate and describe that the greater the force applied to it, the greater the change in motion of a given object. <i>Cognitive Complexity:</i> Level 2: Basic Application of Skills & Concepts	Selene players act as a force that gives a particle velocity (direction and speed). The greater the distance of the slingshot, the greater the velocity.

Big Idea 2: The Characteristics of Scientific Knowledge

A: Scientific knowledge is based on empirical evidence, and is appropriate for understanding the natural world, but it provides only a limited understanding of the supernatural, aesthetic, or other ways of knowing, such as art, philosophy, or religion.

B: Scientific knowledge is durable and robust, but open to change.

C: Because science is based on empirical evidence it strives for objectivity, but as it is a human endeavor the processes, methods, and knowledge of science include subjectivity, as well as creativity and discovery.

BENCHMARK CODE	BENCHMARK	CyGaMEs Selene
SC.5.N.2.1	Recognize and explain that science is grounded in empirical observations that are testable; explanation must always be linked with evidence. <i>Cognitive Complexity:</i> Level 2: Basic Application of Skills & Concepts	Selene gameplay guides the student through a process of scientific investigation through hypothesis making, testing and revision. Educators in the classroom can follow gameplay with the connection between Selene investigations – videogame inquiry and the scientific process.
SC.5.N.2.2	Recognize and explain that when scientific investigations are carried out, the evidence produced by those investigations should be replicable by others. <i>Cognitive Complexity:</i> Level 2: Basic Application of Skills & Concepts	DEBRIEFING: Educators in the classroom should follow Selene gameplay with discussion. Students can analyze and provide their interpretations of the Selene system, warranting their claims. Conclusions from each student’s experiments with the game should be confirmed by replications of other’s gameplay results and conclusions. Discuss the connection between Selene investigations – videogame inquiry and the scientific process.

Big Idea 5: Earth in Space and Time

Humans continue to explore Earth's place in space. Gravity and energy influence the formation of galaxies, including our own Milky Way Galaxy, stars, the Solar System, and Earth. Humankind's need to explore continues to lead to the development of knowledge and understanding of our Solar System.

BENCHMARK CODE	BENCHMARK	CyGaMEs Selene
SC.5.E.5.1	Recognize that a galaxy consists of gas, dust, and	SOLAR SYSTEM ACCRETION MODULE: Selene

	many stars, including any objects orbiting the stars. Identify our home galaxy as the Milky Way. <i>Cognitive Complexity:</i> Level 1: Recall	video explains that the particles and debris are dust. Then gameplay models the accretion process.
SC.5.E.5.2	Recognize the major common characteristics of all planets and compare/contrast the properties of inner and outer planets. <i>Cognitive Complexity:</i> Level 2: Basic Application of Skills & Concepts	Players learn the characteristics of the Earth's Moon by constructing it and replicating its 4.5 billion year history.
SC.5.E.5.3	Distinguish among the following objects of the Solar System -- Sun, planets, moons, asteroids, comets -- and identify Earth's position in it. <i>Cognitive Complexity:</i> Level 3: Strategic Thinking & Complex Reasoning	Players watch the accretion of the Solar system planets and the giant impact. They construct the Moon as part of the Earth-Moon system.

Big Idea 9: Changes in Matter

A. Matter can undergo a variety of changes.

B. Matter can be changed physically or chemically.

Clarification for grades K-5: The target understanding for students in the elementary grades should focus on Big Ideas A and B.

Clarification for Grades 6-8: The target understanding for students in the middle grades should begin to transition the focus to: C. When matter changes chemically, a rearrangement of bonds between the atoms occurs. This results in new substances with new properties.

BENCHMARK CODE	BENCHMARK	CyGaMEs Selene
SC.5.P.9.1	Investigate and describe that many physical and chemical changes are affected by temperature. <i>Cognitive Complexity:</i> Level 3: Strategic Thinking & Complex Reasoning	The player causes heat, and the heat from the players' accretion gameplay melts the matter in the proto-Moon. The player gathers and accretes radioactive material. The heat generated by radioactivity melts the Moon's mantle, cause magma, and leads to lava on the Moon.

GRADE: 6

Big Idea 1: The Practice of Science

A: Scientific inquiry is a multifaceted activity; The processes of science include the formulation of scientifically investigable questions, construction of investigations into those questions, the collection of appropriate data, the evaluation of the meaning of those data, and the communication of this evaluation.

B: The processes of science frequently do not correspond to the traditional portrayal of "the scientific method."

C: Scientific argumentation is a necessary part of scientific inquiry and plays an important role in the generation and validation of scientific knowledge.

D: Scientific knowledge is based on observation and inference; it is important to recognize that these are very different things. Not only does science require creativity in its methods and processes, but also in its questions and explanations.

BENCHMARK CODE	BENCHMARK	CyGaMEs Selene
SC.6.N.1.1	<p>Define a problem from the sixth grade curriculum, use appropriate reference materials to support scientific understanding, plan and carry out scientific investigation of various types, such as systematic observations or experiments, identify variables, collect and organize data, interpret data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions.</p> <p><i>Cognitive Complexity:</i> Level 3: Strategic Thinking & Complex Reasoning</p>	<p>Selene can be used for this process. MoonGazers' can be used for this process.</p>
SC.6.N.1.2	<p>Explain why scientific investigations should be replicable.</p> <p><i>Cognitive Complexity:</i> Level 3: Strategic Thinking & Complex Reasoning</p>	<p>Selene can be used for this process. MoonGazers' can be used for this process.</p>
SC.6.N.1.3	<p>Explain the difference between an experiment and other types of scientific investigation, and explain the relative benefits and limitations of each.</p> <p><i>Cognitive Complexity:</i> Level 3: Strategic Thinking & Complex Reasoning</p>	<p>DEBRIEFING: Educators in the classroom should follow Selene gameplay with discussion. Explain that lunar geology and much Earth geology is conducted through observation. Selene allows them to conduct geological science as a series of experiments because it models the natural phenomenon through simulations.</p>
SC.6.N.1.4	<p>Discuss, compare, and negotiate methods used, results obtained, and explanations among groups of students conducting the same investigation.</p> <p><i>Cognitive Complexity:</i> Level 3: Strategic Thinking & Complex Reasoning</p>	<p>DEBRIEFING: Educators in the classroom should follow Selene gameplay with discussion. Students can analyze and provide their interpretations of the Selene system, warranting their claims. Conclusions from each student's experiments with the game should be confirmed by replications of other's gameplay results and conclusions. Discuss the connection between Selene investigations – videogame inquiry and the scientific process.</p>
SC.6.N.1.5	<p>Recognize that science involves creativity, not just in designing experiments, but also in creating explanations that fit evidence.</p> <p><i>Cognitive Complexity:</i> Level 2: Basic Application of Skills & Concepts</p>	<p>DEBRIEFING: Educators in the classroom should follow Selene gameplay with discussion. Student can analyze and provide their interpretations of the Selene system, warranting their claims. Conclusions from each student's experiments with the game should be confirmed by replications of other's gameplay results and conclusions. Discuss the connection between Selene investigations – videogame inquiry and the scientific process. Discuss the final videos, and how scientists discovered Selene science.</p>

Big Idea 12: Motion of Objects

A. Motion is a key characteristic of all matter that can be observed, described, and measured.

B. The motion of objects can be changed by forces.

BENCHMARK CODE	BENCHMARK	CyGaMEs Selene
SC.6.P.12.1	<p>Measure and graph distance versus time for an object moving at a constant speed. Interpret this relationship.</p> <p><i>Cognitive Complexity:</i> Level 3: Strategic Thinking & Complex Reasoning</p>	<p>DEBRIEFING: Educators in the classroom should follow Selene gameplay with discussion. Students can analyze and provide their interpretations of the Selene system, warranting their claims. Conclusions from each student's experiments with the game should be confirmed by replications of other's gameplay results and conclusions.</p> <p>Discuss, draw, measure the slingshot gesture and what the length and direction of the slingshot line means. Demonstrate the path of the projectile after the slingshot.</p>

Big Idea 2: The Characteristics of Scientific Knowledge

A: Scientific knowledge is based on empirical evidence, and is appropriate for understanding the natural world, but it provides only a limited understanding of the supernatural, aesthetic, or other ways of knowing, such as art, philosophy, or religion.

B: Scientific knowledge is durable and robust, but open to change.

C: Because science is based on empirical evidence it strives for objectivity, but as it is a human endeavor the processes, methods, and knowledge of science include subjectivity, as well as creativity and discovery.

Selene videos cover this.

BENCHMARK CODE	BENCHMARK	CyGaMEs Selene
SC.6.N.2.2	<p>Explain that scientific knowledge is durable because it is open to change as new evidence or interpretations are encountered.</p> <p><i>Cognitive Complexity:</i> Level 2: Basic Application of</p>	<p>Selene final videos cover this. Discuss in debriefing.</p>

	Skills & Concepts	
SC.6.N.2.3	Recognize that scientists who make contributions to scientific knowledge come from all kinds of backgrounds and possess varied talents, interests, and goals. <i>Cognitive Complexity:</i> Level 1: Recall	Profile Chuck Wood, the Selene scientist. Available at <ul style="list-style-type: none"> • http://www.lpod.org/cwm/ • http://www.wju.edu/about/adm_news_story.asp?NewsID=1534&strBack=%2Fabout%2Fadm_news_archive.asp • http://www.windows2universe.org/people/today/chuck_wood.html • http://www.skyandtelescope.com/observing/objects/moon/3308811.html • BOOKS http://www.amazon.com/books/dp/0933346999 http://www.amazon.com/dp/1441972846/ref=rdr_ext_sb_ti_hist_1

Big Idea 3: The Role of Theories, Laws, Hypotheses, and Models

The terms that describe examples of scientific knowledge, for example; "theory," "law," "hypothesis," and "model" have very specific meanings and functions within science.

BENCHMARK CODE	BENCHMARK	CyGaMEs Selene
SC.6.N.3.4	Identify the role of models in the context of the sixth grade science benchmarks. <i>Cognitive Complexity:</i> Level 2: Basic Application of Skills & Concepts	DEBRIEFING: Educators in the classroom should follow Selene gameplay with discussion. Selene allows them to conduct geological science as a series of experiments because it models the natural phenomenon through simulations.

GRADE: 7

Big Idea 1: The Practice of Science

A: Scientific inquiry is a multifaceted activity; The processes of science include the formulation of scientifically investigable questions, construction of investigations into those questions, the collection of appropriate data, the evaluation of the meaning of those data, and the communication of this evaluation.

B: The processes of science frequently do not correspond to the traditional portrayal of "the scientific method."

C: Scientific argumentation is a necessary part of scientific inquiry and plays an important role in the generation and validation of scientific knowledge.

D: Scientific knowledge is based on observation and inference; it is important to recognize that these are very different things. Not only does science require creativity in its methods and processes, but also in its questions and explanations.

BENCHMARK CODE	BENCHMARK	CyGaMEs Selene
SC.7.N.1.1	Define a problem from the seventh grade curriculum, use appropriate reference materials to support scientific understanding, plan and carry out scientific investigation of various types, such as systematic observations or experiments,	Selene can be used for this process. MoonGazers' can be used for this process.

	<p>identify variables, collect and organize data, interpret data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions.</p> <p><i>Cognitive Complexity:</i> Level 3: Strategic Thinking & Complex Reasoning</p>	
SC.7.N.1.2	<p>Differentiate replication (by others) from repetition (multiple trials).</p> <p><i>Cognitive Complexity:</i> Level 2: Basic Application of Skills & Concepts</p>	<p>Selene can be used for this process. MoonGazers' can be used for this process.</p>
SC.7.N.1.3	<p>Distinguish between an experiment (which must involve the identification and control of variables) and other forms of scientific investigation and explain that not all scientific knowledge is derived from experimentation.</p> <p><i>Cognitive Complexity:</i> Level 2: Basic Application of Skills & Concepts</p>	<p>DEBRIEFING: Educators in the classroom should follow Selene gameplay with discussion. Explain that lunar geology and much Earth geology is conducted through observation. Selene allows them to conduct geological science as a series of experiments because it models the natural phenomenon through simulations.</p>
SC.7.N.1.4	<p>Identify test variables (independent variables) and outcome variables (dependent variables) in an experiment.</p> <p><i>Cognitive Complexity:</i> Level 1: Recall</p>	<p>DEBRIEFING: Educators in the classroom should follow Selene gameplay with discussion. Identify the Selene independent and dependent variables.</p>
SC.7.N.1.5	<p>Describe the methods used in the pursuit of a scientific explanation as seen in different fields of science such as biology, geology, and physics.</p> <p><i>Cognitive Complexity:</i> Level 2: Basic Application of Skills & Concepts</p>	<p>Selene can be used for this process. MoonGazers' can be used for this process.</p>
SC.7.N.1.6	<p>Explain that empirical evidence is the cumulative body of observations of a natural phenomenon on which scientific explanations are based.</p> <p><i>Cognitive Complexity:</i> Level 2: Basic Application of Skills & Concepts</p>	<p>DEBRIEFING: Educators in the classroom should follow Selene gameplay with discussion. Students can analyze and provide their interpretations of the Selene system, warranting their claims. Conclusions from each student's experiments with the game should be confirmed by replications of other's gameplay results and conclusions. Discuss the connection between Selene investigations – videogame inquiry and the scientific process.</p>
SC.7.N.1.7	<p>Explain that scientific knowledge is the result of a great deal of debate and confirmation within the science community.</p> <p><i>Cognitive Complexity:</i> Level 2: Basic Application of Skills & Concepts</p>	<p>DEBRIEFING: Discuss the final Selene videos. Engage in debate about the science and processes of the Selene game.</p>

Big Idea 11: Energy Transfer and Transformations

A. Waves involve a transfer of energy without a transfer of matter.

B. Water and sound waves transfer energy through a material.

C. Light waves can travel through a vacuum and through matter.

D. The Law of Conservation of Energy: Energy is conserved as it transfers from one object to another and from one form to another.

BENCHMARK CODE	BENCHMARK	CyGaMEs Selene
SC.7.P.11.1	Recognize that adding heat to or removing heat from a system may result in a temperature change and possibly a change of state. <i>Cognitive Complexity:</i> Level 1: Recall	Transition from Accretion to differentiation modules and concepts.
SC.7.P.11.2	Investigate and describe the transformation of energy from one form to another. <i>Cognitive Complexity:</i> Level 2: Basic Application of Skills & Concepts	Transition from Accretion to differentiation modules and concepts. DEBRIEFING: Discuss.

Big Idea 2: The Characteristics of Scientific Knowledge

A: Scientific knowledge is based on empirical evidence, and is appropriate for understanding the natural world, but it provides only a limited understanding of the supernatural, aesthetic, or other ways of knowing, such as art, philosophy, or religion.

B: Scientific knowledge is durable and robust, but open to change.

C: Because science is based on empirical evidence it strives for objectivity, but as it is a human endeavor the processes, methods, and knowledge of science include subjectivity, as well as creativity and discovery.

BENCHMARK CODE	BENCHMARK	CyGaMEs Selene
SC.7.N.2.1	Identify an instance from the history of science in which scientific knowledge has changed when new evidence or new interpretations are encountered. <i>Cognitive Complexity:</i> Level 1: Recall	Selene final videos. DEBRIEFING: discuss.

Big Idea 6: Earth Structures

Over geologic time, internal and external sources of energy have continuously altered the features of Earth by means of both constructive and destructive forces. All life, including human civilization, is dependent on Earth's internal and external energy and material resources.

BENCHMARK CODE	BENCHMARK	CyGaMEs Selene
SC.7.E.6.1	Describe the layers of the solid Earth, including the lithosphere, the hot convecting mantle, and the dense metallic liquid and solid cores. <i>Cognitive Complexity:</i> Level 2: Basic Application of Skills & Concepts	Players accrete the proto-Moon. The composition they select and construct during gameplay determines how differentiation will form the proportions of their moon's layers.
SC.7.E.6.3	Identify current methods for measuring the age of Earth and its parts, including the law of superposition and radioactive dating. <i>Cognitive Complexity:</i> Level 2: Basic Application of Skills & Concepts	<u>This is the key concept of the Selene surface features module. Selene players actually cause the superposition of features and material on the Moon.</u>
SC.7.E.6.4	Explain and give examples of how physical evidence supports scientific theories that Earth has evolved over geologic time due to natural processes.	Selene prepares students with concrete prior knowledge that assists them to build viable mental models for Earth evolution.

Cognitive Complexity: Level 3: Strategic Thinking & Complex Reasoning

GRADE: 8

Big Idea 1: The Practice of Science

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B: The processes of science frequently do not correspond to the traditional portrayal of "the scientific method."

C: Scientific argumentation is a necessary part of scientific inquiry and plays an important role in the generation and validation of scientific knowledge.

D: Scientific knowledge is based on observation and inference; it is important to recognize that these are very different things. Not only does science require creativity in its methods and processes, but also in its questions and explanations.

BENCHMARK CODE	BENCHMARK	CyGaMEs Selene
SC.8.N.1.1	Define a problem from the eighth grade curriculum using appropriate reference materials to support scientific understanding, plan and carry out scientific investigations of various types, such as systematic observations or experiments, identify variables, collect and organize data, interpret data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions. <i>Cognitive Complexity:</i> Level 3: Strategic Thinking & Complex Reasoning	Selene can be used for this process. MoonGazers' can be used for this process.
SC.8.N.1.2	Design and conduct a study using repeated trials and replication. <i>Cognitive Complexity:</i> Level 3: Strategic Thinking & Complex Reasoning	Selene can be used for this process. MoonGazers' can be used for this process.
SC.8.N.1.3	Use phrases such as "results support" or "fail to support" in science, understanding that science does not offer conclusive 'proof' of a knowledge claim. <i>Cognitive Complexity:</i> Level 2: Basic Application of Skills & Concepts	DEBRIEFING: Educators in the classroom should follow Selene gameplay with discussion. Students use this scientific language as they make and warrant their hypotheses with gameplay evidence.
SC.8.N.1.4	Explain how hypotheses are valuable if they lead to further investigations, even if they turn out not to be supported by the data. <i>Cognitive Complexity:</i> Level 3: Strategic Thinking & Complex Reasoning	DEBRIEFING: Educators in the classroom should follow Selene gameplay with discussion. Students should reflect on how they modified their original hypotheses.
SC.8.N.1.5	Analyze the methods used to develop a scientific	DEBRIEFING: Educators in the classroom should

	explanation as seen in different fields of science. <i>Cognitive Complexity:</i> Level 3: Strategic Thinking & Complex Reasoning	follow Selene gameplay with discussion. Explain that lunar geology and much Earth geology is conducted through observation. Selene allows them to conduct geological science as a series of experiments because it models the natural phenomenon through simulations.
SC.8.N.1.6	Understand that scientific investigations involve the collection of relevant empirical evidence, the use of logical reasoning, and the application of imagination in devising hypotheses, predictions, explanations and models to make sense of the collected evidence. <i>Cognitive Complexity:</i> Level 2: Basic Application of Skills & Concepts	DEBRIEFING: Educators in the classroom should follow Selene gameplay with discussion. Explain that lunar geology and much Earth geology is conducted through observation. Selene allows them to conduct geological science as a series of experiments because it models the natural phenomenon through simulations. Guide students to make connections during discussion from Selene to this benchmark.

Big Idea 2: The Characteristics of Scientific Knowledge

A: Scientific knowledge is based on empirical evidence, and is appropriate for understanding the natural world, but it provides only a limited understanding of the supernatural, aesthetic, or other ways of knowing, such as art, philosophy, or religion.

B: Scientific knowledge is durable and robust, but open to change.

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BENCHMARK CODE	BENCHMARK	CyGaMEs Selene
SC.8.N.2.2	Discuss what characterizes science and its methods. <i>Cognitive Complexity:</i> Level 2: Basic Application of Skills & Concepts	DEBRIEFING: Educators in the classroom should follow Selene gameplay with discussion. Selene final videos support this discussion, as does the gameplay.

Big Idea 3: The Role of Theories, Laws, Hypotheses, and Models

The terms that describe examples of scientific knowledge, for example; "theory," "law," "hypothesis," and "model" have very specific meanings and functions within science.

BENCHMARK CODE	BENCHMARK	CyGaMEs Selene
SC.8.N.3.1	Select models useful in relating the results of their own investigations. <i>Cognitive Complexity:</i> Level 3: Strategic Thinking & Complex Reasoning	DEBRIEFING: Educators in the classroom should follow Selene gameplay with discussion. Students explain their hypotheses and how they used Selene to model and support or refute them. Students should draw models representing their Selene investigations and Selene science.

Big Idea 5: Earth in Space and Time

The origin and eventual fate of the Universe still remains one of the greatest questions in science. Gravity and energy influence the formation of galaxies, including our own Milky Way Galaxy, stars, the planetary systems, and Earth. Humankind's need to explore continues to lead to the development of knowledge and understanding of the nature of the Universe.

BENCHMARK CODE	BENCHMARK	CyGaMEs Selene
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SC.8.E.5.3	Distinguish the hierarchical relationships between planets and other astronomical bodies relative to solar system, galaxy, and universe, including distance, size, and composition. <i>Cognitive Complexity:</i> Level 3: Strategic Thinking & Complex Reasoning	Selene provides models of the Solar system, the Earth-Moon system, and interactive gameplay to engage with the hierarchical relationships.
SC.8.E.5.4	Explore the Law of Universal Gravitation by explaining the role that gravity plays in the formation of planets, stars, and solar systems and in determining their motions. <i>Cognitive Complexity:</i> Level 3: Strategic Thinking & Complex Reasoning	Selene models parts of this.
SC.8.E.5.7	Compare and contrast the properties of objects in the Solar System including the Sun, planets, and moons to those of Earth, such as gravitational force, distance from the Sun, speed, movement, temperature, and atmospheric conditions. <i>Cognitive Complexity:</i> Level 2: Basic Application of Skills & Concepts	Selene provides models of the Solar system, the Earth-Moon system, and interactive gameplay to engage with the hierarchical relationships.
SC.8.E.5.9	Explain the impact of objects in space on each other including: <ol style="list-style-type: none"> 1. the Sun on the Earth including seasons and gravitational attraction 2. the Moon on the Earth, including phases, tides, and eclipses, and the relative position of each body. <i>Cognitive Complexity:</i> Level 3: Strategic Thinking & Complex Reasoning	MoonGazers activities teach phases and relative positions of Earth, Moon, and Sun system.

GRADE: 9-12

Standard 12: Motion

A. Motion can be measured and described qualitatively and quantitatively. Net forces create a change in motion. When objects travel at speeds comparable to the speed of light, Einstein's special theory of relativity applies.

B. Momentum is conserved under well-defined conditions. A change in momentum occurs when a net force is applied to an object over a time interval.

C. The Law of Universal Gravitation states that gravitational forces act on all objects irrespective of their size and position.

D. Gases consist of great numbers of molecules moving in all directions. The behavior of gases can be modeled by the kinetic molecular theory.

E. Chemical reaction rates change with conditions under which they occur. Chemical equilibrium is a dynamic state in which forward and reverse processes occur at the same rates.

BENCHMARK CODE	BENCHMARK	CyGaMEs Selene
SC.912.P.12.1	Distinguish between scalar and vector quantities and assess which should be used to describe an event. <i>Cognitive Complexity:</i> Level 3: Strategic Thinking & Complex Reasoning	DEBRIEFING: Educators in the classroom should follow Selene gameplay with discussion. Students can analyze and provide their interpretations of the Selene system, warranting their claims. Conclusions from each student's experiments with the game should be confirmed by replications of other's gameplay results and conclusions. Discuss, draw, measure the slingshot gesture and what the length and direction of the slingshot line means. Demonstrate the path of the projectile after the slingshot.
SC.912.P.12.2	Analyze the motion of an object in terms of its position, velocity, and acceleration (with respect to a frame of reference) as functions of time. <i>Cognitive Complexity:</i> Level 3: Strategic Thinking & Complex Reasoning	DEBRIEFING: Educators in the classroom should follow Selene gameplay with discussion. Students can analyze and provide their interpretations of the Selene system, warranting their claims. Conclusions from each student's experiments with the game should be confirmed by replications of other's gameplay results and conclusions. Discuss, draw, measure the slingshot gesture and what the length and direction of the slingshot line means. Demonstrate the path of the projectile after the slingshot.

Body of Knowledge: EARTH AND SPACE SCIENCE

Standard 5: Earth in Space and Time

The origin and eventual fate of the Universe still remains one of the greatest questions in science. Gravity and energy influence the development and life cycles of galaxies, including our own Milky Way Galaxy, stars, the planetary systems, Earth, and residual material left from the formation of the Solar System. Humankind's need to explore continues to lead to the development of knowledge and understanding of the nature of the Universe.

BENCHMARK CODE	BENCHMARK	CyGaMEs Selene
SC.912.E.5.2	Identify patterns in the organization and distribution of matter in the universe and the forces that determine them. <i>Cognitive Complexity:</i> Level 2: Basic Application of Skills & Concepts	Selene accretion and surface features impact cratering and volcanism, underlying concepts like gravity and density enhance students' understanding of these patterns.
SC.912.E.5.5	Explain the formation of planetary systems based on our knowledge of our Solar System and apply this knowledge to newly discovered planetary systems. <i>Cognitive Complexity:</i> Level 3: Strategic Thinking & Complex Reasoning	This is the science of Selene. Selene gameplay will prepare them for this transfer task.

Standard 6: Earth Structures

The scientific theory of plate tectonics provides the framework for much of modern geology. Over geologic time, internal and external sources of energy have continuously altered the

features of Earth by means of both constructive and destructive forces. All life, including human civilization, is dependent on Earth's internal and external energy and material resources.

BENCHMARK CODE	BENCHMARK	CyGaMEs Selene
SC.912.E.6.1	Describe and differentiate the layers of Earth and the interactions among them. <i>Cognitive Complexity:</i> Level 2: Basic Application of Skills & Concepts	Selene players cause their moon to differentiate into layers. They determine the relative proportions of those layers by their Selene accretion gameplay. This experience acts as concrete prior knowledge to support knowledge construction about the layers of Earth.
SC.912.E.6.2	Connect surface features to surface processes that are responsible for their formation. <i>Cognitive Complexity:</i> Level 2: Basic Application of Skills & Concepts	Selene players construct the surface of the moon according to impacting cratering and volcanism. This experience acts as concrete prior knowledge to support knowledge construction about surface processes that are responsible for the formation of some of Earth's surface structures.

Body of Knowledge: NATURE OF SCIENCE

Standard 1: The Practice of Science

A: Scientific inquiry is a multifaceted activity; The processes of science include the formulation of scientifically investigable questions, construction of investigations into those questions, the collection of appropriate data, the evaluation of the meaning of those data, and the communication of this evaluation.

B: The processes of science frequently do not correspond to the traditional portrayal of "the scientific method."

C: Scientific argumentation is a necessary part of scientific inquiry and plays an important role in the generation and validation of scientific knowledge.

D: Scientific knowledge is based on observation and inference; it is important to recognize that these are very different things. Not only does science require creativity in its methods and processes, but also in its questions and explanations.

BENCHMARK CODE	BENCHMARK	CyGaMEs Selene
SC.912.N.1.1	Define a problem based on a specific body of knowledge, for example: biology, chemistry, physics, and earth/space science, and do the following: <ol style="list-style-type: none"> Pose questions about the natural world, (Articulate the purpose of the investigation and identify the relevant scientific concepts). Conduct systematic observations, (Write procedures that are clear and replicable. Identify observables and examine relationships between test (independent) variable and outcome (dependent) variable. Employ appropriate methods for accurate and consistent observations; 	Selene can be used for this process. MoonGazers' can be used for this process.

	<p>conduct and record measurements at appropriate levels of precision. Follow safety guidelines).</p> <ol style="list-style-type: none"> 3. Examine books and other sources of information to see what is already known, 4. Review what is known in light of empirical evidence, (Examine whether available empirical evidence can be interpreted in terms of existing knowledge and models, and if not, modify or develop new models). 5. Plan investigations, (Design and evaluate a scientific investigation). 6. Use tools to gather, analyze, and interpret data (this includes the use of measurement in metric and other systems, and also the generation and interpretation of graphical representations of data, including data tables and graphs), (Collect data or evidence in an organized way. Properly use instruments, equipment, and materials (e.g., scales, probeware, meter sticks, microscopes, computers) including set-up, calibration, technique, maintenance, and storage). 7. Pose answers, explanations, or descriptions of events, 8. Generate explanations that explicate or describe natural phenomena (inferences), 9. Use appropriate evidence and reasoning to justify these explanations to others, 10. Communicate results of scientific investigations, and 11. Evaluate the merits of the explanations produced by others. <p><i>Cognitive Complexity:</i> Level 3: Strategic Thinking & Complex Reasoning</p>	
SC.912.N.1.2	<p>Describe and explain what characterizes science and its methods.</p> <p><i>Cognitive Complexity:</i> Level 2: Basic Application of Skills & Concepts</p>	<p>Selene can be used for this process. MoonGazers' can be used for this process.</p>
SC.912.N.1.3	<p>Recognize that the strength or usefulness of a scientific claim is evaluated through scientific argumentation, which depends on critical and logical thinking, and the active consideration of alternative scientific explanations to explain the data presented.</p> <p><i>Cognitive Complexity:</i> Level 1: Recall</p>	<p>Selene can be used for this process. MoonGazers' can be used for this process.</p>
SC.912.N.1.4	<p>Identify sources of information and assess their</p>	<p>Selene can be used for this process.</p>

	reliability according to the strict standards of scientific investigation. <i>Cognitive Complexity:</i> Level 3: Strategic Thinking & Complex Reasoning	MoonGazers' can be used for this process.
SC.912.N.1.5	Describe and provide examples of how similar investigations conducted in many parts of the world result in the same outcome. <i>Cognitive Complexity:</i> Level 2: Basic Application of Skills & Concepts	Selene can be used for this process. MoonGazers' can be used for this process.
SC.912.N.1.6	Describe how scientific inferences are drawn from scientific observations and provide examples from the content being studied. <i>Cognitive Complexity:</i> Level 2: Basic Application of Skills & Concepts	Selene can be used for this process. MoonGazers' can be used for this process.
SC.912.N.1.7	Recognize the role of creativity in constructing scientific questions, methods and explanations. <i>Cognitive Complexity:</i> Level 1: Recall	Selene can be used for this process. MoonGazers' can be used for this process.

Standard 2: The Characteristics of Scientific Knowledge

A: Scientific knowledge is based on empirical evidence, and is appropriate for understanding the natural world, but it provides only a limited understanding of the supernatural, aesthetic, or other ways of knowing, such as art, philosophy, or religion.

B: Scientific knowledge is durable and robust, but open to change.

C: Because science is based on empirical evidence it strives for objectivity, but as it is a human endeavor the processes, methods, and knowledge of science include subjectivity, as well as creativity and discovery.

BENCHMARK CODE	BENCHMARK	CyGAMES Selene
SC.912.N.2.4	Explain that scientific knowledge is both durable and robust and open to change. Scientific knowledge can change because it is often examined and re-examined by new investigations and scientific argumentation. Because of these frequent examinations, scientific knowledge becomes stronger, leading to its durability. <i>Cognitive Complexity:</i> Level 3: Strategic Thinking & Complex Reasoning	DEBRIEFING: Educators in the classroom should follow Selene gameplay with discussion. Selene videos provide example of how this occurred within lunar science.
SC.912.N.2.5	Describe instances in which scientists' varied backgrounds, talents, interests, and goals influence the inferences and thus the explanations that they make about observations of natural phenomena and describe that competing interpretations (explanations) of scientists are a strength of science as they are a source of new, testable ideas that have the potential to add new evidence to support one or another of the explanations. <i>Cognitive Complexity:</i> Level 3: Strategic Thinking & Complex Reasoning	Follow Selene with use of Charles A. Wood's The Modern Moon: A Personal View. Many chapters contain accessible stories of how these factors influenced lunar science hypotheses and theories and how they changed over time. Dr. Wood's new edition of the book will add a new chapter updating the book with discoveries and interpretations resultant over the decade since Sky and Telescope published the book.



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