Application of Common Core & Arizona State Standards to the Navajo-Hopi Astronomy Outreach Program

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Abstract: Through a time span of three weeks, I have crafted curriculum and aligned it with Arizona State Standards as well as the National Common Core Standards. The process started with reading all past evaluations and feedback summaries as well as the current activities; the most relevant feedback is found in Part 1. Next, I summarized the common core standards which is found in Part 2. Lastly, I wrote up all the lesson plans taking care to align them with the standards previously mentioned. The summary of the whole Portfolio I am giving Dr. Hunter can be found in Part 3. Due to space, formatting, and the sheer number of pages I have written I have chosen not to paste all the lesson plans in this document. To see all the lesson plans, the link to view them is here:
https://www.dropbox.com/sh/qmx2uujjfzuh9du/AAAE-XO_AIA1yqSvh-KPSUZwa?dl=0

Mentor: Dr. Hunter

PART 1: Feedback and Evaluations

From teachers:

- Hands-on activities with dramatic results keep students focused best.
- Summarize the activity. End an activity with a short (5 minute) discussion to summarize what they did and what they learned.
- Logbooks would be more useful if you tell them what information is appropriate to write down in such a logbook.
- Galactic Address activity would work better if the students first had a better understanding of the geography of Arizona.
- To reach other teachers in the school: Try to be done for an in-service afternoon and show several activities at once. Or, try to have them come observe during their lunch or prep time. Have the teacher give the others a copy of the lesson plan the day before. Consider enlisting the principal's help in arranging the get together in order to make it something the principal wants them to do.
- Meet the principal and tell them about the program to get their support.
- The workshop is a great time to prepare for the year. (So, allow time for that.)
- Students need more time to figure an activity out than you think. A single 40-minute period won't do it. It may take several days of follow-up by the teacher for it to sink in for the students. So, if you are working in short periods, keep it simple and give the teacher what they need (materials and information) to follow-up on their own.
- Organize and label everything for the students. For example, in making shield volcanoes, label cups "Baking Soda" and "Vinegar" for each group, label pens "Group n", and have a cup labeled "Group n" holding spoon, pen, and caldera for each group.
- When giving instructions for an activity, write them down on the board. Also, consider giving them instructions one step at a time, if it is something they can all keep up with together.
- Give each student a task. "You are student number 1; you do this. You are student number 2; your job is to do this." Etc.
- When working with multiple teachers, the other teachers (besides the primary one) would really like the same activities materials.
- Lesson plan with state standards are important for each activity.
- On field trip to Lowell: The students should have more participation with something to take home with them. Tour guide to explain stuff in Exhibit Hall would be nice.
- They would like Lowell Observatory to provide some lessons and a packet about planets, Mars Hill, history of Lowell and Percival.

From us:

- Just because teachers don't ask questions doesn't mean that they understand everything about the activity. In the context of a partnership, discuss the expected outcome of the activity and everything they need to know to understand it.
- Explain why you need to make more than one measurement (in, for example, the crater activity).

- Explain what a model is---for example, how is a model car different and the same as a real car?
- Use kid hooks. They are kids, so think about things that you can put in in small ways that will grab their attention. For example, in the Venus Topo Boxes: Use an alien civilization mapping Earth as an example of how you can just take pictures of planets that have clouds that move around. And, when the groups are constructing their landscapes, emphasize that they must keep them secret from the other groups so that it will be a mystery to them when they explore your landscape. Then when they have reconstructed the landscape inside, ask them what the criteria should be for landing a spacecraft.
- Leave a complete, neat package of materials (labeled plastic bin) for teachers to use in subsequent years. Include: copy of activity, any additional instructions, list of materials, tie to science standards if available, introductory images or other materials with labels, all non-volatile materials they need to carry it out with 5 groups.

Part 2: Common Core Overview

Grade 5 Overview

Operations and Algebraic Thinking

- Write and interpret numerical expressions.
- Analyze patterns and relationships.

Number and Operations in Base Ten

- Understand the place value system.
- Perform operations with multi-digit whole numbers and with decimals to hundredths.

Number and Operations—Fractions

- Use equivalent fractions as a strategy to add and subtract fractions.
- Apply and extend previous understandings of multiplication and division to multiply and divide fractions.

Measurement and Data

- Convert like measurement units within a given measurement system.
- Represent and interpret data.
- Geometric measurement: understand concepts of volume and relate volume to multiplication and to addition.

Geometry

- Graph points on the coordinate plane to solve real-world and mathematical problems.
- Classify two-dimensional figures into categories based on their properties.

Mathematical Practices

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

Grade 6 Overview

Ratios and Proportional Relationships

- Understand ratio concepts and use ratio reasoning to solve problems.

The Number System

- Apply and extend previous understandings of multiplication and division to divide fractions by fractions.
- Multiply and divide multi-digit numbers and find common factors and multiples.
- Apply and extend previous understandings of numbers to the system of rational numbers.

Expressions and Equations

- Apply and extend previous understandings of arithmetic to algebraic expressions.
- Reason about and solve one-variable equations and inequalities.
- Represent and analyze quantitative relationships between dependent and independent variables.

Geometry

- Solve real-world and mathematical problems involving area, surface area, and volume.

Statistics and Probability

- Develop understanding of statistical variability.
- Summarize and describe distributions.

Mathematical Practices

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Grade 7 Overview

Ratios and Proportional Relationships

- Analyze proportional relationships and use them to solve real-world and mathematical problems.

The Number System

- Apply and extend previous understandings of operations with fractions to add, subtract, multiply, and divide rational numbers.

Expressions and Equations

- Use properties of operations to generate equivalent expressions.
- Solve real-life and mathematical problems using numerical and algebraic expressions and equations.

Geometry

- Draw, construct and describe geometrical figures and describe the relationships between them.
- Solve real-life and mathematical problems involving angle measure, area, surface area, and volume.

Statistics and Probability

- Use random sampling to draw inferences about a population.
- Draw informal comparative inferences about two populations.
- Investigate chance processes and develop, use, and evaluate probability models.

Mathematical Practices

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Grade 8 Overview

The Number System

- Know that there are numbers that are not rational, and approximate them by rational numbers.

Expressions and Equations

- Work with radicals and integer exponents.
- Understand the connections between proportional relationships, lines, and linear equations.
- Analyze and solve linear equations and pairs of simultaneous linear equations.

Functions

- Define, evaluate, and compare functions.
- Use functions to model relationships between quantities.

Geometry

- Understand congruence and similarity using physical models, transparencies, or geometry software.
- Understand and apply the Pythagorean Theorem.
- Solve real-world and mathematical problems involving volume of cylinders, cones and spheres.

Statistics and Probability

- Investigate patterns of association in bivariate data.

Mathematical Practices

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Other Applicable Common Core Standards:

English Language Arts Standards » Science & Technical Subjects » Grade 6-8

Key Ideas and Details:

CCSS.ELA-Literacy.RST.6-8.1
Cite specific textual evidence to support analysis of science and technical texts.

CCSS.ELA-Literacy.RST.6-8.2
Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.

CCSS.ELA-Literacy.RST.6-8.3
Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

Craft and Structure:

CCSS.ELA-Literacy.RST.6-8.4
Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 6-8 texts and topics*.

CCSS.ELA-Literacy.RST.6-8.5
Analyze the structure an author uses to organize a text, including how the major sections contribute to the whole and to an understanding of the topic.

CCSS.ELA-Literacy.RST.6-8.6
Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text.

Integration of Knowledge and Ideas:

CCSS.ELA-Literacy.RST.6-8.7
Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

CCSS.ELA-Literacy.RST.6-8.8
Distinguish among facts, reasoned judgment based on research findings, and speculation in a text.

CCSS.ELA-Literacy.RST.6-8.9
Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

Range of Reading and Level of Text Complexity:

CCSS.ELA-Literacy.RST.6-8.10
By the end of grade 8, read and comprehend science/technical texts in the grades 6-8 text complexity band independently and proficiently.

Part 3: Summary of all work

Summary of Activities

The connection to Common Core and Arizona State Standards are written in the documents themselves.

1. Meteoroids and their Impact Craters
    a. It is a series of three experiments where students get to see firsthand how height, speed, and angle affect the depth, size, and shape of a crater.
2. Balloon Star Cycles
    a. Students will learn about the life cycle of stars using balloons to model the process.
    b. This activity is used to describe stellar evolution
3. Evidence for Hidden Mass
    a. This activity explores the elusive dark matter by having students work through a rotation curve then act out the distribution of velocities. (Students investigate and describe the known universe.)
4. Lotto for Life
    a. Students will use inquiry, problem solving, and reasoning to compare the likelihood of intelligent life existing elsewhere in the Universe and winning the lottery.
5. Gamma Ray Bursts
    a. Students will use inquiry, problem solving, and reasoning to learn about Gamma Ray Bursts (the most powerful thing known in the universe).
6. Modeling Phases and Movements of the Moon and Planets
    a. Students will study models of moon and planet movements to understand observations.
    b. This fits with: describing the relationship between motion of objects in the solar system and the phenomena of day, year, eclipses, phases of the Moon and seasons (Motion of objects in the solar system)
7. Far Out Planets
    a. Students will understand relative distance in the solar system in this hands-on activity.
8. Edible Rocks
    a. Students will observe and describe physical characteristics of an edible sample in preparation for describing rock or meteorite samples, work cooperatively in a team setting, and use communication skills, both oral and written.
    b. Describe the components of the solar system (the Sun, planets, moons, asteroids, comets) *(objects in the sky and universe)*
9. Star Stories to Tell
    a. Students will explore and learn about stars and constellations.
    b. Would be great fit if done after planetarium show
10. Phases of the Moon
    a. Students will observe and describe characteristics, patterns, and changes in the sky.
    b. Indicators: Observe & describe how objects move in patterns (the sun, moon, & stars)
11. Our Place in Space

    a. Students will explain the difference between a star and a planet, describe how Earth's rotation causes day and night, and name a common star pattern and the constellation in which it is found, or make up their own star pattern.
    b. This is a series of 7 activities that range from demonstrations to hands-on stuff.
    c. Recognize that the observed shape of the Moon changes from day to day during a one month period (*objects in the sky and universe*)
    d. Recognize the motion of objects in the sky (the Sun, the Moon, stars) change over time in recognizable patterns (*Motion of objects in the solar system*)
12. Pluto Files
    a. Summarizes the history of Pluto (utilizing the Pluto Files from NOVA on PBS), Lowell Observatory, and Percival Lowell. It includes a short fact sheet about Pluto.
13. All About Jupiter
    a. Students will understand that Jupiter is the largest planet in the solar system—huge enough to swallow all the other planets and still have room to spare.
14. The Great Hubble
    a. Students will understand: The Hubble Space Telescope lets us see farther into space than ever before. The Hubble gives us images that are thousands of years old because light travels at a finite speed across vast distances of space. The Hubble could be used to search the universe for other Earthlike planets, but such exploration is expensive. There are arguments for and against spending money to look for other Earthlike planets that might be thousands of light-years away.
15.

Hands-On Activities to Take Home

1. Build a Pinhole Sunspot Viewer
    a. Students will explain the importance of safety when observing the sun, gather data and calculate the diameter of the sun, & track sunspots and make observations.
    b. Describe the components of the solar system (the Sun, planets, moons, asteroids, comets) (objects in the sky and universe)
    c. There is a variation of this included where a telescope is used to look at sunspots.
2. Alka-Seltzer Rocket
    a. Students have a connection with physics, the NASA program, and a fun cheap object to take home with them when they leave the Lowell Observatory Field Trip.
3. Build your Own Spectrogram
    a. Spectroscopes need not be limited to professional scientists. Building your own spectroscope using everyday items takes just under an hour.
4. Reflective Solar Cooker
    a. This reflective solar cooker uses the Sun's energy to cook marshmallows. The target cooking area is the space where the light concentration is greatest.

Summary of Planetarium Shows

1. Winter, Spring, Summer, and Fall Shows
    a. Demonstrates different phases of the Moon as well as different seasonal constellations. This fully demonstrates patterns in the sky as well as the motion of objects that change in recognizable patters (.i.e. the earth goes around the sun so depending on the time of the year; we will have different constellations in the sky at night time).
2. Universe Planetarium Show
    a. Covers the basics of what is: a planet, star, nebula, galaxy, and universe. It is a very interesting show that won't bore.
3. Solar System Planetarium Show
    a. There is information about all 8 main planets, dwarf planets, comets, meteors, asteroids, the sun and more!

Lesson Plan Files Found Online

1. Kinesthetic Astronomy
    a. The Sky Time lesson reconnects students with the astronomical meaning of the day, year, and seasons. Like all Kinesthetic Astronomy lessons, it teaches basic astronomical concepts through choreographed bodily movements and positions that provide educational sensory experiences.

Concept 2: Earth's Processes and Systems Understand the processes acting on the Earth and their interaction with the Earth systems.
PO 1. Describe how the Moon's appearance changes during a four-week lunar cycle.
PO 2. Describe how Earth's rotation results in day and night at any particular location.
PO 3. Distinguish between revolution and rotation.
PO 4. Describe the role of gravity as an attractive force between celestial objects.

2. MESA Lesson Plans
    a. Mathematics, Engineering, Science Achievement (MESA) is a university-based outreach program operating in 8 states. In Arizona, MESA strives to provide an opportunity for ethnic minority, low income, and first generation college-bound students to explore college majors and career interests with a group of peers interested in attending college. The University of Arizona supports MESA schools in Southern Arizona and works in affiliation with Arizona State University's Fulton Schools of Engineering to support MESA in central Arizona. The southern and central regions form Arizona MESA. However, the packet I found and am including has lot of hands-on activities with lesson plans that would be very useful to teachers.
    b. Covers a lot of state standards already lined out in the packet.
3. Journey Through the Universe

    a. This could be a whole unit spanning 2 weeks of class time for a teacher. There are numerous full lesson plans covering solar system objects as well as hands-on activities. The state standards for these packets have not been matched but could be done by the teacher if they decide to use the whole packet. Overall there are 10 pdf packets.
4. Stars and Galaxies
    a. This is a fun activity I found online that applies concepts of scale to grasp the distances between stars and galaxies. Students elaborate on the question, Do galaxies collide?