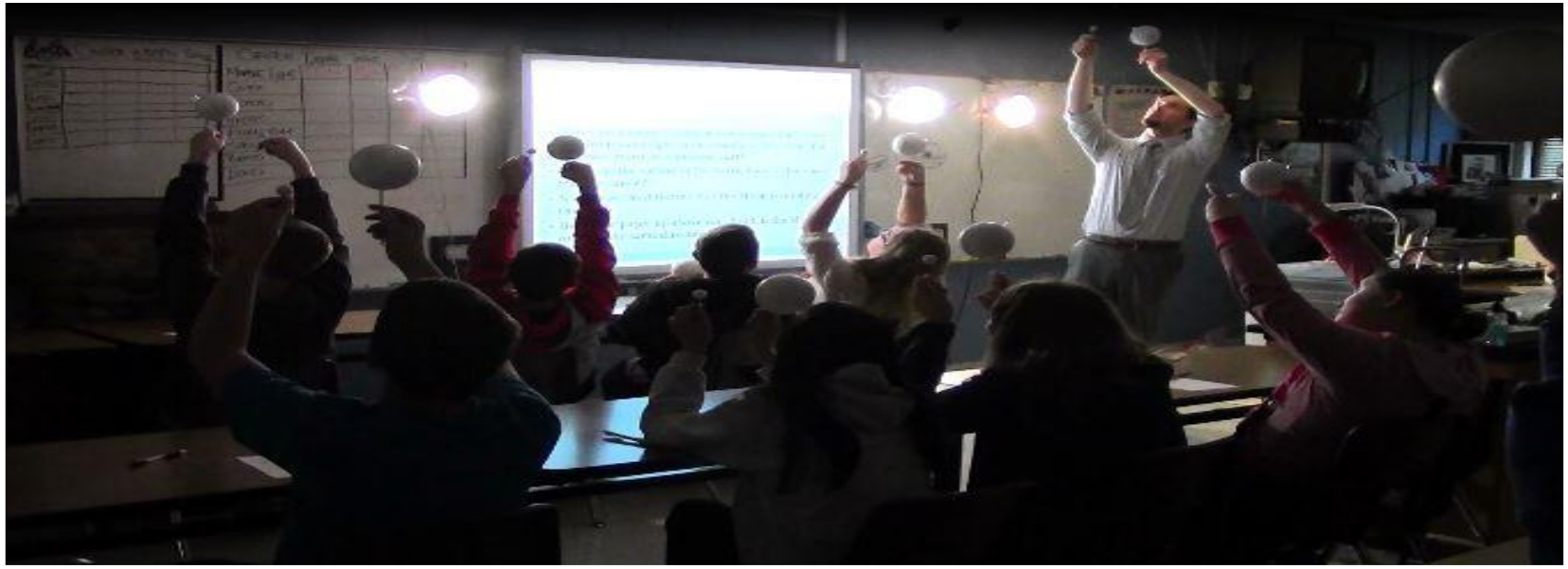


Implementation of a Project-Based Earth/Space Unit

Spanning Astronomical and Atomic Spaces

Project SAAS

Contents

- Introduction
- What is Project-based Instruction?
- REAL Curriculum
- *Many Moons*
- Moon Journaling
- Stellarium

Project-based Instruction Framework

Features of a PBI Classroom

- Driving Research Question (*Krajcik, J. and Blumenfeld, P.,* 2006)
- Sub-driving Research Questions
- Benchmark Lessons to scaffold understanding (*Singer, J., Marx, R., and Krajcik, J.,* 2000)
- Milestones (*Polman,* 2000)

What is a Driving Question?

Characteristics of driving questions

- **Feasible**: Students can design and perform investigations to answer the questions.
- **Worthwhile**: They contain rich science and/or mathematics content, relate to what scientists or mathematicians really do, and can be broken down into smaller questions.
- **Contextualized**: They are pertinent to the world, nontrivial, and important.
- **Meaningful**: They are interesting and exciting to learners.
- **Sustainable**: They lead to the pursuit of detailed answers over time.

PBI with the REAL Unit
(Realistic Explorations in Astronomical Learning)

- ***Our Unit Driving Question***

Why does the Moon's appearance always seem to change?

- **The unit and driving question should be guided by standards and practices.**

  Students who demonstrate understanding can (Disciplinary Core Ideas from NGSS):

  - MS-ESS1-1.Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases.
  - MS-ESS1-3.Analyze and interpret data to determine scale properties of objects in the solar system.

Common Core State Standards-Mathematics and Next Generation Science & Engineering Practices

Mathematical Practices	Scientific & Engineering Practices
1. Make sense of problems and persevere in solving them	1. Asking questions and defining problems.
2. Reason abstractly and quantitatively	2. Developing and using models
3. Construct viable arguments and critique the reasoning of others	3. Planning and carrying out investigations
4. Model with mathematics	4. Analyzing and interpreting data
5. Use appropriate tools strategically	5. Using mathematics and computational thinking
6. Attend to precision	6. Constructing explanations and designing solutions
7. Look for and make use of structure	7. Engaging in argument from evidence
8. Look for and express regularity and repeated reasoning	8. Obtaining, evaluating, and communicating information.

REAL Benchmark Lessons

Lesson One: Can I see the Moon every day and night, and why does it appear to change its shape?

Lesson Two: How do I measure the distance between objects in the sky?

Lesson Three: How can I say where I am on the Earth?

Lesson Four: How can I locate things in the sky?

Lesson Five: What are the Global Features of the Moon?

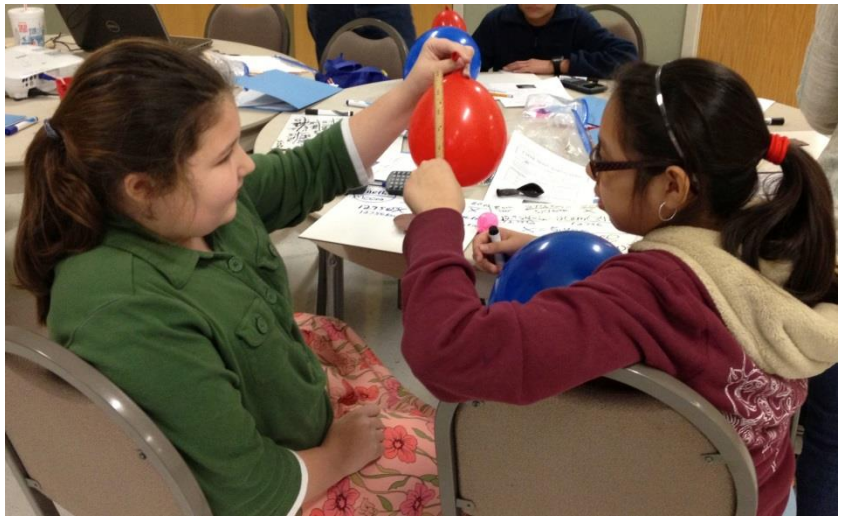
Lesson Six: What can we learn by examining the Moon's surface?

Lesson Seven: What affects a crater’s size?

Lesson Eight: The Scaling Earth/Moon/Mars NASA Activity

Lesson Eight A: The Moon Finale

- Lesson nine: What Makes a Planet Geologically Active?
- Lesson ten: Surface Activity on Planets and Moons
- Lesson eleven: Crater Number Density
- Lesson twelve: Experts' Lesson
- Lesson thirteen: Martian Surface Age Exploration



http://www.uky.edu/~jwi229/real/real_main.html

Spatial Reasoning Ability and Understanding Scientific Phenomena

Reynolds (1990); Wellner (1995); Bishop (1996)	Students more likely to report a correct cause of lunar phases when they have strong projective spatial skills.
Pribyl & Bodner (1987);Hake (2002); Sorby (2006); Wilhelm et al. (2013)	**Students' scores** and success on science assessments are **correlated to their spatial ability**.
Black (2005); Wilhelm (2009); Plummer (2009); Plummer et al. (2011); Wilhelm et al. (2013)	**Well-developed spatial thinking is necessary for understanding astronomical concepts** such as celestial motions and lunar phases. Spatial thinking includes: **Mental rotations**, Perspective, Geometric Spatial Visualization, Spatial Projection, Periodic Patterns, and Cardinal Directions.

Prior Research

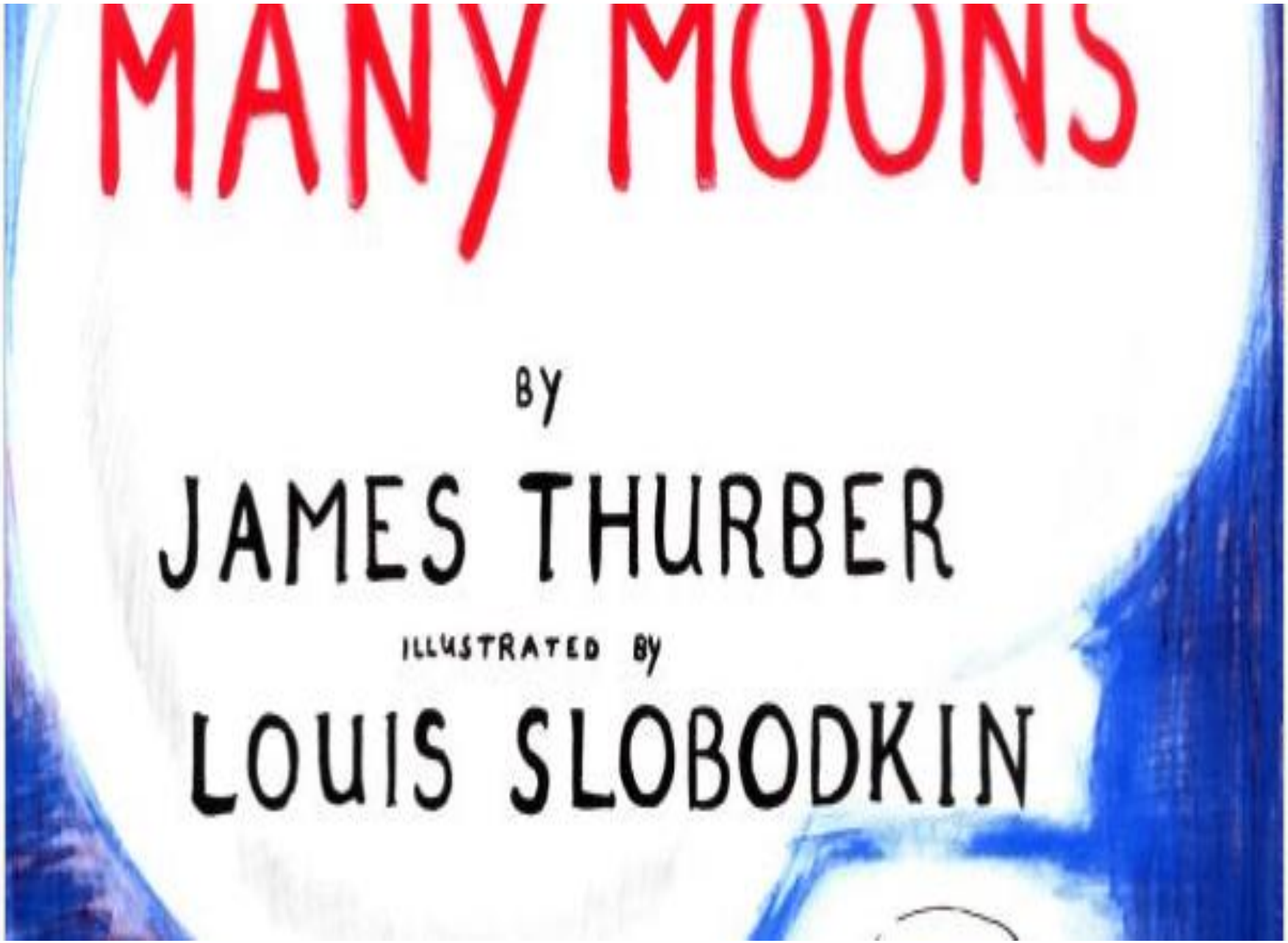
There is a link between well-developed spatial skill and lunar phase understanding (Wilhelm 2009; Wilhelm et al. 2013; Wilhelm et al. 2014)

- **Geometric Spatial Visualization**
- **Spatial Projection**
- **Cardinal Directions**
- **Periodic Patterns**

Lesson 1:

Can I see the Moon every day and night, and why does it appear to change its shape?

- **Engage:** Begin lesson by discussing stories that students know about the Moon. Introduce the story "Many Moons" by James Thurber and either read the whole book or book excerpts from the story.


MANY MOONS
BY
JAMES THURBER
ILLUSTRATED BY
LOUIS SLOBODKIN

From the Lord High Chamberlain...

Too Far: 35,000 miles away

Too Big: It's bigger than the room where the Princess lies. Besides, it's made of molten copper.

From the Royal Wizard...

Too Far: 150,000 miles away

Too Big: It's twice as big as this palace. Besides, it's made of green cheese.

From the Royal Mathematician...

Too Far: 300,000 miles away

Too Big: It's half the size of this kingdom.

Besides, it's round and flat like a coin, it's made of asbestos, and it's pasted on the sky.

Princess Lenore said...

Not that far: Sometimes it gets caught in the top branches of the big tree outside my window.

Not that big: It's just a little smaller than my thumbnail. And, it's made of gold!

What do you think the size, distance, and composition of the Moon is?

Moon Journaling

Cole, M., Wilhelm, J., & Yang, H. (2015). Student Moon Observations and Spatial-Scientific Reasoning. *International Journal of Science Education*, (ahead-of-print), 1-19.

- Date, time, location
- A drawing of the Moon and sky
- Altitude and Azimuth of the Moon
- 4+ sentences about your observation
- Predictions of observations

Moon Journal Blogging

On YOUR day, create a new blog entry with the same information as in your paper journal. Feel free to write extra!

- Date, time, location
- A drawing of the Moon and sky
- Altitude and Azimuth of the Moon
- 4+ sentences about your observation
- Predictions of observations

The rest of the month…

- You should comment on at least two entries per week.
- Compare/contrast your observation to the posted observation.
- Comment on patterns you see emerging.
- Ask questions
- Other comments that are relevant to the observation.

https://projectsaas.wordpress.com/

Stellarium

Stellarium is free planetarium software that allows you to observe the night sky virtually.

http://stellarium.org/

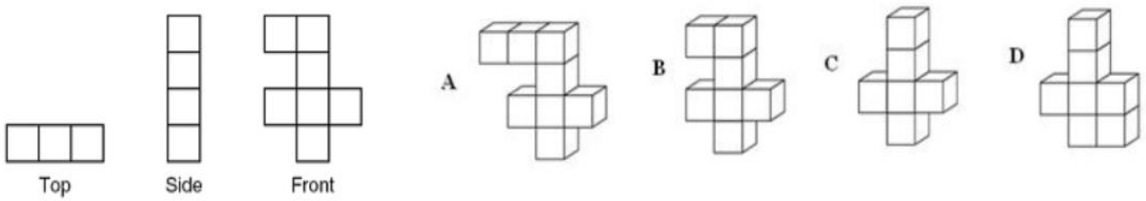
Instructions for download and operation are in your binder.

Geometric Spatial Visualization

- Visualizing the geometric spatial features of a given system as it appears in space above/below/within the system's plane.

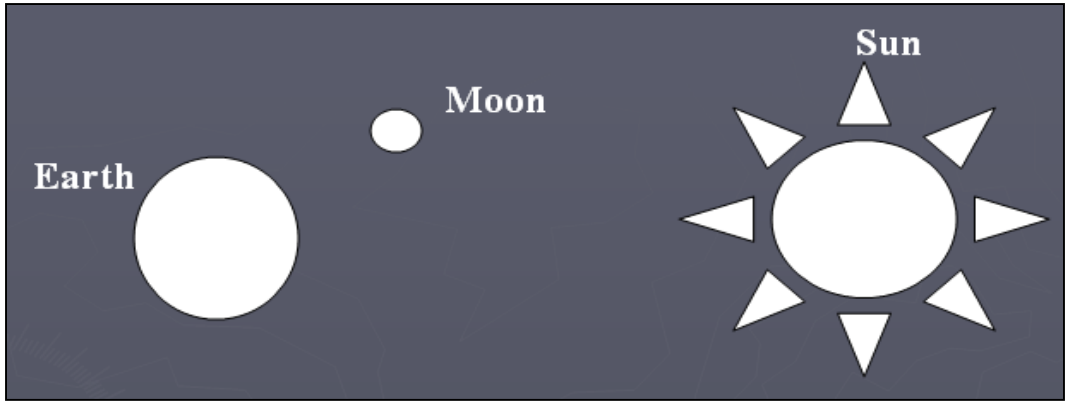
***14. The top, side, and front views of a solid figure made of cubes are shown below. Which solid figure is best represented by these views?**

- A
- B
- C
- D



Geometric Spatial Visualization

- Visualizing the geometric spatial features of the Sun/Earth/Moon system as it appears in space from above/below/within the Sun/Earth/Moon plane.



Warning: Not to scale.

Spatial Projection

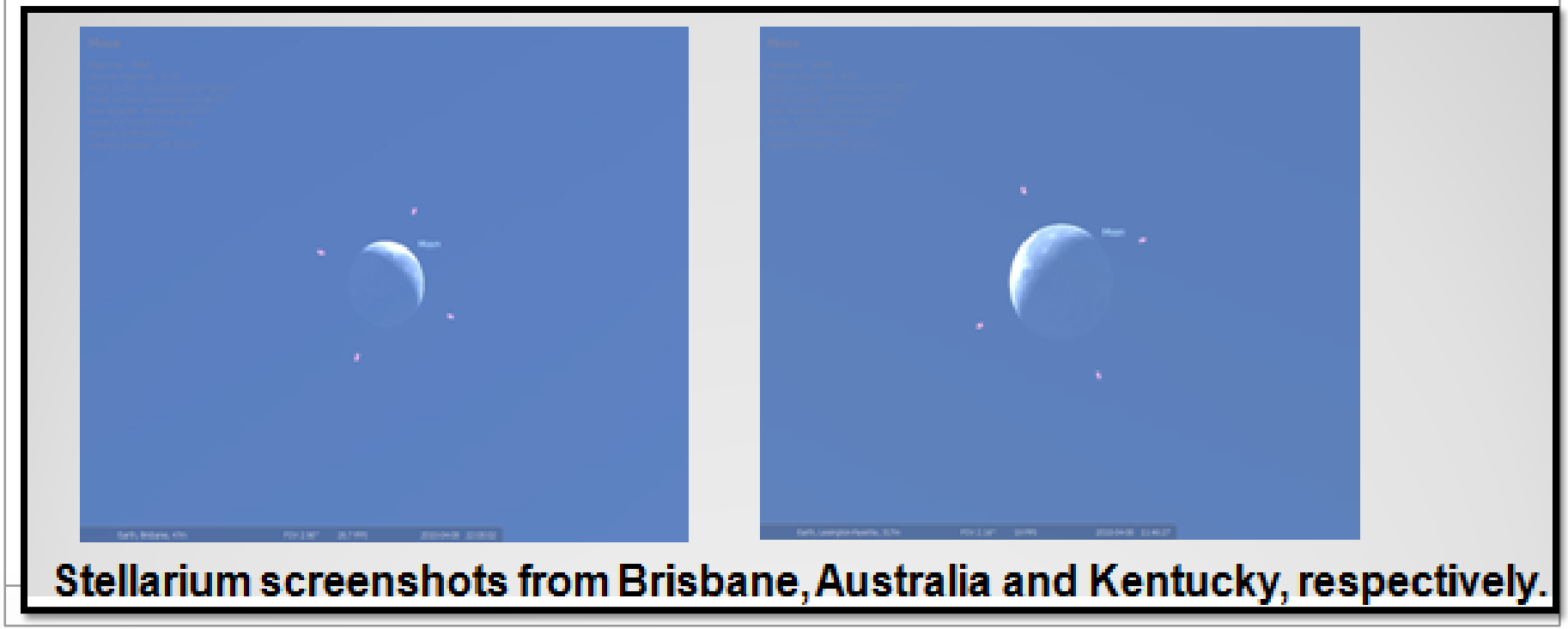
- Spatially projecting one's self to a different location and visualizing from that global perspective.

*20. You live in Florida and it is evening. Your shadow is as shown in the picture. Your cousin, who lives in Texas, is looking at his shadow at the same time. His shadow is _____.

- (A) the same
- (B) longer
- (C) shorter
- (D) on the other side

Spatial Projection

- Spatially projecting one's self into a different Earthly location and visualizing the sky from that global perspective.



Stellarium screenshots from Brisbane, Australia and Kentucky, respectively.

Cardinal Directions

- Documenting an object's vector direction from a given position (N, S, E, W).

7. In the map below, Wyoming is west of which of the following states?

(A) South Dakota (B) Montana (C) Colorado (D) Idaho

Cardinal Directions

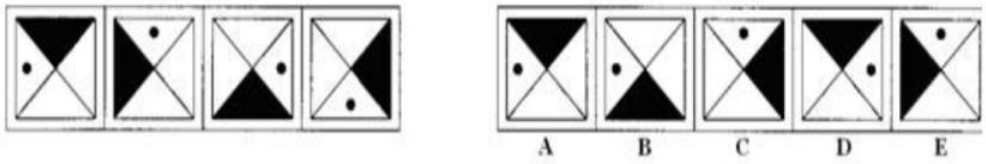
- Documenting the moon's vector direction from a given position on Earth (N, S, E, W).

Periodic Patterns

- Something occurring at regular intervals of time and/or space.

∗7. Below you will find 4 figures or designs in a series. Please look for a pattern and find the best choice for the fifth figure from the list of choices on the right. Choose the letter of what you believe to be the 5th figure or design in the series.

- A
- B
- C
- D
- E



Periodic Patterns

- Something occurring at regular intervals of time and/or space.