Umbrella Sky as a Model for Celestial Motion

Purpose/Overview: This activity allows you to apply the concepts modeled by the **Umbrella Sky - RA and Dec** to the construction of a student version of the umbrella. The lesson explained below is one possible approach. The directions in this lesson use a northern hemisphere perspective.

Hand out the Student Sheet for this lesson - it is **2a) Umbrella Sky Student Sheet**

Standards Addressed:

Cross Cutting Concept: Systems and System Models
Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. **(HS-PS4-3)**

ESS1.A: The Universe and Its Stars
Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models. **(MS-ESS1-1)**

ESS1.B: Earth and the Solar System
This model of the solar system can explain eclipses of the sun and the moon. Earth's spin axis is fixed in direction over the short-term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year. **(MS-ESS1-1)**

Focus Questions:

1. Can you use an umbrella to model the motion of the sun in the sky on the first day of spring (vernal equinox), the first day of summer (summer solstice) and the first day of fall (autumnal equinox)?
2. Can you recreate a constellation on your umbrella sky using the celestial coordinates for the given stars?
3. How can you use the model to determine differences in the motion of objects in the sky at your location, at the north pole, and at the equator?

Materials:

1. One full-dome umbrella for each group of 3 - 4 students
2. Tape measures
3. Markers
4. Scissors
5. Glue
6. An assortment of wax stix
7. An assortment of beads, brads, and textured stickers
8. A large number of chenille sticks (pipe cleaners)
9. Copies of the constellation coordinates at **2b) Constellation Coordinates for Teachers/Leaders.**

Time: Two 40 - 50 min. class periods, including time for students to present their work

In advance: This activity assumes that you have introduced the vocabulary associated with the celestial sphere and have explored how astronomers describe the location of objects on the dome of the sky (celestial sphere). Once you have gathered the necessary craft materials and the umbrella, you are ready to begin. A complete description of the vocabulary and concepts that can be demonstrated using this model are found in IDATA Tool - Umbrella Sky, RA and Dec.

Procedures:

1. Divide students into groups of 3 - 4.
2. Provide each group with an umbrella. We suggest leaving all other craft supplies in a central location.
3. Hand out the instruction sheet and review. Let students know if you want all umbrellas to be tactile or not. All groups will need to problem solve how to create the lines of declination at the correct spacing. See Construction of RA and Dec Umbrella for reference if needed.
4. Allow sufficient time for students to plan their model and complete construction. We strongly recommend that you check students' understanding of the model by having them demonstrate the path of the sun on the first day of spring, summer and fall before you give them the coordinates for the stars.
5. As students model the motion of the sun, observe to be sure they are using the model correctly and can correctly identify the cardinal directions. This will be helpful when describing what they observe. Many students have difficulty identifying that the sun appears to rise directly in the east and set directly in the west on the first day of spring and fall.

6. If you distribute the star coordinate sheets in order of greatest number to plot to least, you can accommodate for some variation in creative intensity of the groups. Most of the constellations are circumpolar. Students should be able to describe the motion of their constellation. You may choose to provide the sheet with the constellations listed for students to reference when they are done or challenge them to discover which constellation they were given using online or classroom resources. Choosing descriptors for their searches is instructive.
7. When you are finished, you may want each group to share their umbrella and constellation so that they can compare motions and reinforce the vocabulary from this lesson.

Accessibility Considerations:

1. If you have BVI students in your class, we suggest that all groups create tactile versions of their umbrella.
2. BVI students will benefit from keeping contact with the movable sun as groups model the motion of the sun at different times of the year. BVI students should be encouraged to participate, both by holding the model umbrella when rotating the sky and by touching the sun.
3. Although the concept of a horizon will not be unfamiliar, BVI students may have little prior experience with the fact that the sunrise and sunset points move northward between the first day of spring and the first day of summer and then back again. Care may be needed to draw students' attention to this aspect of the lesson because there is no obvious horizon line.

Extensions/Modifications:

1. This activity assumes prior instruction about celestial motion. With additional time and resources, you could make this activity more open-ended by providing students with the motions the model is expected to demonstrate and the vocabulary you expect them to use when describing that motion.
2. Combining this activity with actual measurements of the angle of the sun throughout the day and at different times of the year can support making connections between the model and observations.

Credits: **Innovators Developing Accessible Tools for Astronomy (IDATA)**, officially known as *Research Supporting Multisensory Engagement by Blind, Visually Impaired,* and *Sighted Students to Advance Integrated Learning of Astronomy and Computer Science,* and the resulting curricular resources, Afterglow Access software, and project research were made possible with support from the U.S. National Science Foundation's STEM+C program (Award 1640131). IDATA institutional collaborators include AUI, GLAS Education, Linder Research & Development Inc., Logos Consulting Group, TERC, University of Nevada – Las Vegas, University of North Carolina at Chapel Hill, and Universidad Diego Portales. Individual consultants on the project include Kathy Gustavson and Alexandra Dean Grossi. IDATA Teacher collaborators in the U.S. include Amanda Allen, Jacqueline Barge, Holly

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