IDATA Tool

Umbrella Sky - Constellation Umbrella Activity

Purpose/Overview: The purpose of this tool is to provide a resource in the form of a model of the common northern hemisphere constellations and their motion. The sense of touch is the dominant modality. This model is useful for demonstrating the following concepts: constellations, motion of Northern Hemisphere stars, circumpolar constellations, and why the sky is visualized as a dome. Some possibilities for instruction are suggested by the guiding questions below while later instructions primarily focus on the mechanics of the tool itself.

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)

Focus Questions:

1. What can you learn from the umbrella model about the motion of stars in the night sky?
2. What are some ways that you can describe the location of stars in the sky?

Materials: Well in advance of this lesson, you will need to acquire and embellish a constellation umbrella (Amazon has these for $19.99) so that it is tactile. Then follow the instructions contained in **0) Construction - RA and Dec Umbrella**.

The Tool: Be sure you are oriented to the umbrella as a model of the night sky. The constellations of the Northern Hemisphere are printed on the inside surface of the umbrella. The point of the umbrella represents the celestial

north pole. You can imagine the shaft of the umbrella as the axis of Earth reaching out to the night sky.

The bottom edge of the umbrella represents an approximate declination of 30 degrees. Declination is the term astronomers give to imaginary lines on the night sky similar to the lines of latitude on Earth. A declination of 30 degrees is thirty degrees above the imaginary zero line in the sky (the celestial equator). This model does not demonstrate the celestial equator. Moving from one line of declination in the sky to the next is how astronomers measure north/south positions on the sky Other than the edge of the umbrella (thirty degrees declination) and the point (ninety degrees declination), no other lines of declination are marked on the umbrella.

Right ascension hours are indicated by writing and braille on hang tags along the bottom of the umbrella. Lines of right ascension allow astronomers to define east/west locations in the night sky. The ribs of the umbrella are spaced at three-hour intervals. The full circle of the umbrella correctly models the twenty-four hours it takes for a star or constellation to complete a full circle and return to its starting position in the sky.

The motion of the sky is modeled by turning the axis of the umbrella counterclockwise as seen if you are facing the north pole. If you, however, are standing with the umbrella over your shoulder, then you turn the handle of the umbrella clockwise to simulate the correct motion. In this position, you are facing imaginary south with the axis of the system at an angle similar to what would be observed in the northern United States. You also observe the stars rising in the east and arcing toward the west before setting, although this particular umbrella is neither large enough nor domed enough to demonstrate this well.

The umbrella contains eighteen constellations or asterisms, in full or in part. Six of these have been embellished with tactile elements to indicate the stars and the imaginary lines which connect them. For your reference, each is described below.

- **Draco the Dragon**
  - Main Stars: 14
  - Shape: Four stars forming a square for the head with ten remaining stars in a curving, snake-like line.
  - How to find on umbrella: Follow the 18-hour rib up towards the north pole. A little over halfway up, you will find four stars that form a square on either side of the rib. This is Draco's head. There is a line that continues up from his head, then swoops down to the right and then up again. Along the way, you will find the ten remaining stars in the constellation.

- Other constellations nearby: Draco's tail coils around the Little Dipper and the north pole.

- **Cepheus**
  - Main Stars: 7
  - Shape: A square with a triangle on top
  - How to find on the umbrella: Follow the 0-hour rib along its right side up towards the north pole. Just before you reach the north pole, you will find a star that is the top of the triangle. From this point, follow the two lines that form the sides of the triangle and then the square that forms the base of the triangle.
  - Other constellations nearby: Cassiopeia on the left and Draco on the right.

- **Cassiopeia**
  - Main Stars: 6
  - Shape: Throne (chair)
  - How to find on the umbrella: Follow the 0-hour rib along its left side up towards the north pole. About halfway up, you will find a star that is the bottom right leg of the throne. From there, follow the lines that form the seat and the other leg of the throne. Continue up for the back of the throne.
  - Other constellations nearby: Cepheus on the right.

- **Little Dipper**
  - Main Stars: 7
  - Shape: Seven stars in a continuous line, forming the shape of a dipper. It's the same shape as the Big Dipper, only much smaller.
  - How to find on the umbrella: Follow the 18-hour rib up to the north pole. There is no star marked for the north pole; it is the top of the umbrella. The next star is hidden under the rib of the umbrella. Find a line that comes down from the North Pole and forms the handle of the dipper. Follow along to find the five remaining stars of the Little Dipper.
  - Other constellations nearby: Draco's tail surrounds the Little Dipper

- **Big Dipper**
  - Main Stars: 7
  - Shape: Seven stars in a continuous line, forming the shape of a dipper. It's the same shape as the Little Dipper, only much bigger.
  - How to find on the umbrella: Follow the 12-hour rib up towards the north pole. About halfway up, you will find the star in the position of the bottom left corner of the dipper. From there, follow the line that goes up and to the left, and you will be at the tail of the Big Dipper. Now that you are at the end, go back the way you came and continue to trace the entire shape.
  - Other constellations nearby: The last two stars in the Big Dipper point to the north star

Accessibility Considerations:

1. Allow sufficient time for tactile exploration of the umbrella sky before beginning whatever lesson you will be teaching.
2. Although it was not the original intent of the design, many BVI students find it helpful to explore the constellation shapes from the outside of the umbrella. This surface is unobstructed by the inside ribs.
3. Whether the student has low or no vision, you will need to explain that sighted individuals see the sky as a dome.

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 Bensel, Neal Boys, Tim Fahlberg, Kristin Grender, David Lockett, Matthew McCutcheon, Caroline Odden, Michael Prokosch, Kara Rowbotham, Rick Sanchez, and Barbara Stachelski. IDATA Student collaborators in the U.S. include Evan Blad, Naleah Boys, Ellen Butler, Jayden Dimas, Riley Kappell, Joseph Murphy, Logan Ruby, Alex Scerba, Charlize Sentosa, Meg Sorensen, Remy Streichenberger, Trevor Warren, and others. IDATA Undergraduate Mentors include Tia Bertz, Katya Gozman, Chris Mathews, Kendall Mehling, Andrea Salazar, Ben Shafer, Alex Traub, and Sophia Vlahakis. Special thanks to the IDATA external advisors including Nic Bonne, Al Harper, Sue Ann Heatherly, Russ Laher, Luisa Rebull, Ed Summers, and Kathryn Williamson.