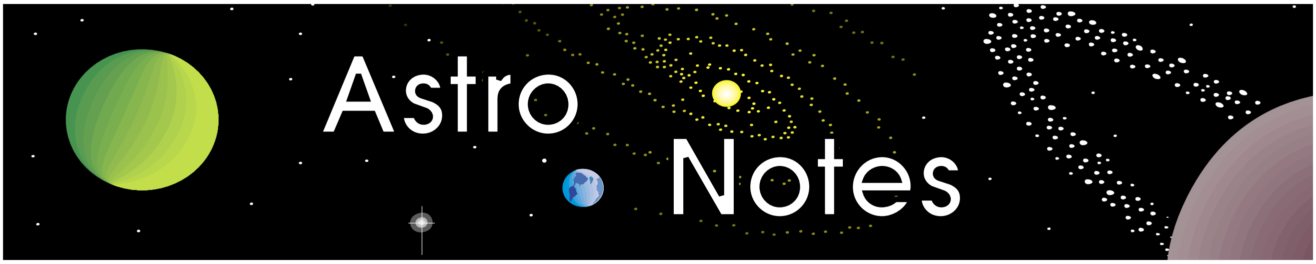


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# Kinesthetic Astronomy: The Sky Time Lesson

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Everyday association with time in our modern age involves watches, clocks, and calendars rather than the astronomical motions that were the original bases for timekeeping. However, the lesson described here has shown that through a series of simple body movements, students young and old can gain insight into the relationship between time and astronomical motions of Earth (rotation about its axis, and orbit around the Sun), and also about how these motions influence what we see in the sky at various times of the day and year. The "Sky Time" lesson leads learners (sixth grade to adult) to experience kinesthetically which way Earth must turn for the Sun and stars to rise in the East; why the Sun is higher in the sky in summer; why we see different stars at different times of year; and why we'll see essentially the same stars tonight that people in China living at a comparable latitude will see just 12 hours later. The lesson also offers excellent re-enforcement for a deeper understanding of seasons.

The lesson takes one to three hours, depending on the prior knowledge of the learners. The technique involved requires a group of 12 to 40 participants in a space where they have room to stand in a circle with arms outstretched to the sides. The only "equipment" needed is a central object to represent the Sun. The Sky Time lesson plan begins with a discussion of learners' prior knowledge and then explores kinesthetically the astronomical meaning of a day and a year. Teaching basic astronomy through choreographed body movements and positions provides educational sensory experiences that successfully confront several common misconceptions. We offer here an excerpt that addresses the astronomical meaning of a year.[1]

**Participants try out the Sky Time Experiment at a recent American Astronomical Society meeting.**

## Excerpt from Sky Time Kinesthetic Astronomy Lesson

**1.** Have students arrange themselves in a circle around a central object or location representing the Sun. Each student should have room to rotate with arms outstretched. Tell them to imagine they each represent Earth, with their head as the North Pole.

**2.** Remind students that Earth's North Pole does not point straight up and down (relative to Earth's orbital plane about the Sun) but is tilted 23.5° from the vertical so that it points at a star called Polaris (the North Star). Polaris is very distant from our Sun, so declare a remote location in the learning environment to be Polaris. (The more distant the object designated Polaris, the better.) While still in a circle about the symbolic Sun, ask all students to bend at the waist so that their North Poles (their heads) are tilted in the direction of Polaris.

**3.** Find someone who has a birthday that day or sometime soon, and enquire: "How many trips around the Sun have you made in your life?"

**4.** Ask the students to remain tilted as they make one counterclockwise *orbit* around the Sun. (Watch out for "wobbling" students and insist that they maintain their tilt consistently toward Polaris.)

**5.** After one orbit is completed, ask "How many times does Earth *rotate* around its axis during one *orbit* around the Sun?" (365 times; one rotation = one day). Now have students try to rotate their bodies counterclockwise around this *tilted* axis; i.e., while their heads remain pointed at Polaris. (This is actually physically challenging because you must bend forward and backward at the waist to keep your head oriented properly as you spin around.)

**6.** Ask students to stand still and maintain their tilt. Now ask the person who thinks her upper body (Northern Hemisphere) is tilted most directly *toward* the Sun to raise a hand. Then ask the person who thinks his upper body is tilted the most directly *away* from the Sun to raise a hand.

**7.** As the students with hands raised stay in place, ask the others to look at them, and query: "What time of year is it when Earth is in these positions in its orbit about the Sun? [Guide students to discover that the student tilted toward the Sun marks the first day of summer (summer solstice), and the student tilted away from the Sun marks the first day of winter (winter solstice). *Emphasize that both students are still tilted toward Polaris even though their orientations relative to the Sun are different, depending on their orbital position.]*

**8.** Ask all students to face directly toward the Sun (noon). Ask them to tilt their "North Poles" away from the Sun as if in winter (back bends away from Sun). Then ask, "Do you have to look higher or lower in the sky to see the Sun?" (lower). Next ask all students to tilt toward the Sun as if in summer (forward bends toward the Sun). Then ask,"Do you have to look higher or lower in the sky to see the Sun?" (higher). This step can lead to or follow up a more detailed discussion of seasons.

**9.** Ask students for the dates of summer and winter solstice (June 21 for summer solstice—the longest day of the year; and Dec. 21 for winter solstice—the shortest day of the year in the Northern Hemisphere). Select students with birthdays on or near these dates to be Mr. or Ms. Summer and Mr. or Ms. Winter and have them move to the appropriate orbital position.

**10.** Ask students for the dates of the first day of spring and the first day of fall (spring equinox is around March 21 and fall equinox is around Sept. 21; "equinox" means equal day and night). Then ask them to interact with neighboring students to predict (without saying out loud) the positions of people who represent Earth's position around the Sun on these dates.

**11.** Ask who has a birthday on or near the spring equinox and have this student stand where he/she thinks spring belongs. Ask the student to explain why. Next, ask a student with a birthday on or near the fall equinox to stand where he/she thinks fall belongs. Again, ask for an explanation.

**12.** Engage students in a discussion to work out any discrepancies and set up the four seasonal positions of Earth around the Sun, complete with dates for the winter and summer solstices and the spring and fall equinoxes. (As an option, provide the "season" students with a sign labeled with title and date.)

**13.** Ask the "equinox students" to join the summer and winter solstice students in pointing their North Poles (heads) toward the symbolic Polaris. Ask all students to notice that the equinox students point neither toward or away from the Sun.

**14.** Now ask all students to go stand in the approximate position of Earth's orbit around the Sun on their birthday. (This should help make the connection between a personally significant time of year and the position of Earth in its orbit around the Sun.)

**15.** Ask all students to face directly away from the Sun (midnight). In turn, ask students on opposite sides of Earth's orbit to report what they see out in from of them (students see different objects). Ask: "Why do we see different stars in the night sky at different times of year?" Guide students to discover the correct answer (because at different times of year the night side of Earth faces out in different directions in the Galaxy).

The Sky Time lesson can be enriched by having students use planispheres in Step 15 to determine which particular stars we see at different times of the year. The assessment activity asks students to combine their understanding of the astronomical meanings of a day and a year to address the question of whether people in the United States will see the same stars as people in China see tonight.


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### Reference


1. For the full Sky Time lesson description and up-to-date information on the development of other kinesthetic astronomy lessons, follow the "Curriculum" button on the Space Science Institute's website at www.spacescience.org, and look for "Kinesthetic Astronomy."