Survivor Case Study: Instructor Guide

Prerequisite Knowledge

- Students need to have been introduced to basic sky motions - rising and setting of the sun and of the stars, annual motion of the sun, how to find the North Star using the Big Dipper, and how to use the altitude of Polaris to determine your latitude on Earth.
- One can use their fist held out at arm's length to measure angular distance on the sky. The top to bottom of your fist is ~10°, and one finger width is ~1°. It can be helpful to also teach some calibration example (e.g. Betelgeuse and Rigel in Orion are 18.5° apart).

Materials

- Several globes
- Several red flashlights
- Printouts of the activity sheet and map
- Optional: Small whiteboards and markers for students to work on - one per group

Facilitation Method

- Have students form groups of 2 - 4 (3 is most recommended).
- Hand out the overall goal: "Today we're going to drop you at a random location on the Earth ["in the northern hemisphere", if you want to keep it simple]. Based on observations of the sky over a period of 24 hrs, your challenge is to determine where you are on Earth (latitude, longitude) and, as close as you can, what date it is."
    - Let students know the tools that they do and do not have, as listed on the first page of the activity sheet.
    - Emphasize that the first 15 - 20 min will be time with their groups to brainstorm their plan for what observations they will want to make and how it will help them figure out where and when they are.
- While facilitating the groups, we recommend taking a relatively hands-off approach to allow the students to come up with the observations that might be useful. Give 15 - 20

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minutes for students to develop a plan. As you are listening in on student conversations, make a mental collection of observations the students would like to make. Encourage students to draw diagrams.

- Once most/all groups have completed an observation plan, allow students to observe the sky at your current physical location on the date in question for 24 hrs. This is an important step for helping students calibrate, orient, and sometimes for determining longitude or time of year (depending on the method that students choose to follow). Demonstrate motions and read off times based on the observations students requested (e.g. "We have a few groups who want to know what time the sun sets in our current location, so let's go to sunset.")

- Encourage students to get up and move around (especially because the dome is a finite size - they might even have to calibrate their angle measurements based on a known angle, the distance between Betelgeuse and Rigel, for instance.)

- Emphasize that there may be multiple ways to find the answer to the same problem.

- After students have had the chance to observe the sky for 24 hours in their current physical location, transport them to the new location (we highly recommend fading the projected sky completely black to transition so that students don't see clues from the motion of the sky.)

- Let student know that at this new location it is the same date in question and that they have 24 hours to observe. Remind them that one of their tools is to also be able to see the sky up to a month before the date in question and up to a month after the date in question.

- As was done for the first observing session, take note of what groups are requesting and help demonstrate the motion of the sky, stopping at requested times (sunrise, local noon, sunset, etc.) to read off the time from your initial reference point. For example, if you started by observing the sky in Boulder, CO, read all times in the new location according to what time a watch set to Boulder time would read.

- After students have finished their observations and there are no more requests, bring up house lights and give students time to calculate and map out where and when they think they are. Globes can be a useful tool for finding location and verifying that students go the correct easterly/westerly direction.

Investigation Pathways and Facilitation Strategies

We recommend that any facilitators who are not operating the planetarium software be intentionally not informed of the location and date of choice. This encourages facilitators to

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figure out the answer with the students rather than for the students, thereby helping to shift emphasis to the thought processes in arriving at the answer rather than the answer itself.

In figuring out the location and date, there are multiple ways to arrive at the answer. We recommend that the focus is placed on the process of arriving at the answer rather than getting a correct answer. Included below are several ways to determine latitude, longitude, and date:

1. Latitude

   Goal: Use altitude of the north star (altitude = latitude)

   Facilitation suggestions:

   - W*hat might be a useful reference point for determining our latitude? How we can find the north star via observations? Can we progress time to watch star motions?*
   - *What is the angle of the north star in the sky / what is the north star's altitude above the horizon? How can we measure this angle?* (Use hands to measure)
   - If you have laser pointers accessible, we recommend that instructors do not use the laser pointers. Instead, hand them to student groups for them to figure out where the north star is.
   - If students are having a hard time remembering how the altitude of Polaris and latitude relate, it can be helpful to have students consider the extremes: *Where would Polaris be if you were standing at the north pole? What is the latitude there? What about if you were at the equator?*

2. Longitude

   Goal: Compare absolute times of local noon, count the number of timezone changes, and determine if the shift is eastward or westward from the starting reference location. Absolute times of sunrise/sunset can often work, though this route is not as reliable times can vary also based on latitude. If students want to be more precise, 1 hr = 15 degrees of longitude (360 degrees / 24 hrs).

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Facilitation suggestions:

- Some students won't know where to start on answering the question of longitude. Questions that lead students to think about time zones can often be helpful: *Let's say you have a friend who lives on the other side of the country, but you want to give them a call at a certain time. What's something you might need to consider when setting up that call?*
- When considering how to figure out time zone differences: *What's a reference point we might be able to use?* (local noon is best, but sunrise/sunset can work to a reasonable degree for most scenarios). It may be helpful to remind students that they have an imaginary watch set to the time of their initial location.
- Students might instead choose to look for where certain constellations are just after sunset or what time a bright star passes the meridian as their reference point.
- If students want to be more exact in calculating how many degrees difference in longitude: *How far across the sky does the sun move in 24 hours?*
- It is often challenging to correctly determine if the time shift corresponds to a location eastward or westward of the starting location, especially if you are at a longitude near the opposite side of the world.
    - It can be helpful to walk students through a less extreme example (e.g. What if the clock read one hour ahead rather than 8 hours ahead...what direction would that mean?).
    - One other helpful method of determining this is to use a globe to demonstrate. Have one student hold the globe and another student a phone flashlight to represent the sun. Ask students: *What time it is for people on the Earth directly facing the sun?* (noon). *On the opposite side is midnight. Which way does the Earth rotate?* (You can help students figure this out by asking if the sun sets on the east coast before or after it does on the west coast.) *What time did our imaginary watch read when we were experiencing noon at the new location?* Have students orient the globe so that your reference location at approximately that time. *Which places on Earth are experiencing noon?* (anywhere on the line of longitude directly facing the sun). This will help confirm the correct eastward or westward location.

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3. Time of year

Goal: Compare the rising/setting location or maximum altitude of the sun to approximately determine the date

Facilitation suggestions:

- Students may feel initially stuck on this question. It may be helpful to remind them that one of their abilities is to see the motion of the sky up to a month prior to and after the date in question.
- If there are 12 hours of daylight: *What does it mean if there are 12 hours of daylight?* Note that there are two times of year this happens everywhere on Earth.
- *What do we know about the location of the sun during different times of the year?*
  - Does the sun rise due east, north of east, or south of east? *Without a compass, how could we determine cardinal points?* Rising/setting location indicates time of year relative to equinoxes.
  - *Over the course of a month, does the sun get lower or higher in the sky?* Indicates time of year relative to solstices.
- Students may try to figure out the time of year based on the constellations they see. If they know their constellations, it's possible to do it this way. Often, however, students may think of this idea and then realize that they don't know many constellations associated with different times of year. It can be helpful to let them know that they don't need to have memorized constellations to solve this question.
- Some students may try to measure the height of the sun. If they decide to go the route of calculation: Sun altitude range = 90 - latitude +/- 23.5 degrees.

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