Learning Outcomes for GSUSA Camp Activities

By the end of our activities during Astronomy Camp, you should be able to …

Entire Camp

1. **Stimulate girls' interest in science, astronomy, and the night sky.**
2. **Demonstrate confidently how scientific reasoning is used in our daily lives using real examples.**
3. **Convey that science is exploration, not memorizing facts and figures.**
    a. Research is "to boldly go where no *one* has gone before," not looking up everything known about a topic.
4. **Recognize "pseudoscience" and explain how it differs from authentic science using examples.**
    a. Encounter and address misconceptions.
5. **Integrate STEM thinking, and language, into ALL your troops' activities.**
    a. Explain why "STEM" is a unifying idea, not separate subjects.
    b. Develop your own activities to emphasize the techniques of scale-modeling and classification.
6. **Inspire others to overcome anxieties about science, technology, engineering, and math.**
    a. Look at these topics as universal tools rather than subjects only smart people understand.
    b. Convey that no group in society is inherently better or worse at thinking about and doing STEM work.
    c. Women have always been involved with STEM. Their contributions have not always been recorded or recognized and so it may *appear* that they have only recently started "making their mark."
7. **Integrate numerical thinking, and language, into ALL your troops' activities.**
    a. Demonstrate through personal example that the language of numbers, and proportional thinking, are vital tools in all aspects of life.
8. **Show how "powers of ten" language is essential for good citizenship and for success in careers.**
    a. Describe how powers of ten can characterize our world in both large and small scales.
    b. Remember the common prefixes associated with powers of ten.

Icebreaker

Objective: Engage in problem-solving while meeting each other.

Activity**:** *Recipe of the Universe*

1. Engage in a problem-solving activity.
2. Meet each other personally.
3. Introduce different types of celestial objects.

Conducting a Star Party

Objective: Know how to organize and conduct a successful star party.

Activity: *How to Lead a Star Party*

1. Write down your "learning goals" for leading a star party.
2. Plan ahead:
    a. Find an optimum location for a star party in your local area.
    b. Determine what girls/families should take away from the star party.
    c. Assemble the resources you need (satellites, night sky objects, telescopes, location, people).
    d. Decide what resources do you need and have available.
    e. Locate additional resources: People, equipment, ideas, ….
    f. What are your backup activities in case weather or equipment does not cooperate?
3. Organize such an event for your troop(s) and camps.

Objective: Know how to build, and be comfortable using, your own planisphere.

Activity: *Build and Operate Your Own Planisphere*

1. Build your own planisphere.

2. Find the North Star on your planisphere and in the night sky.
    a. Using your planisphere, describe why some constellations never set below the horizon.
    b. Find a "circumpolar" constellation in the sky
3. Choose five new constellations and locate them on your planisphere at different times of night.
    a. Observe these constellations at three different times of night.
    b. Do your predictions of the night sky match your observations?
    c. Observe these constellations on consecutive nights. Do they rise at the same time?
4. Explain why all celestial objects rise in the eastern half of the sky and set in the western half.
    a. How are star charts the same/different from your planisphere?
5. What is the difference between a constellation and an asterism?

Objective: Know at least one story about the night sky and how to relate it to your planisphere.
Activity: *Sky Stories*

1. Recite one story about the night sky for your troops when you return home.
    a. Can you find that particular constellation in tonight's sky?
2. Locate Nancy's and Larry's compilation of stories for each month.
3. Combine use of your planisphere with your story.

Orrery

Objective: Explain, and understand, the relative distances and motion of planets in our Solar System.
Activity: *Simulate the motions of planets in the night sky over time.*

1. Explain why planets are not always found in the same constellation.
2. Explain why some planets "appear" to move in the sky faster than other planets.
    a. Which planets appear to move fastest and why?
3. What are the relative distances of objects in our Solar System?
    a. Are planets that we can see at night always on the same side of the Sun?

The Power of "Phases"

Objective: Explain why the Moon has "phases", why they change from day to day/night to night, and the implications for our planet/culture.
Activity: *Observing Phases of the Moon and Venus, by Eye and Through Telescopes.*

1. Act out how the Sun shines on the Earth and Moon to create phases.
2. Explain why the moon has "phases" and why they change from day to day/ night to night.
3. Determine if planets in our Solar System, and exoplanets in other systems, might show phases.

Viewing our Origins: The Nature of Light

Objective: Explain the difference between heat, light, and temperature, and the utility of IR light in our society and environment.
Activity: *IR Camera, Video Clips, and Electromagnetic Spectrum*

1. Explain why, or why not, you can see any objects in a completely dark room.
    a. Is there any light in a completely dark room?
2. Describe some objects that emit infrared light.
3. Explain why even familiar objects emit light our eyes cannot see.
    a. What types of light do these objects emit?
4. Explain two benefits/uses of infrared light in society.
5. Why type of light will JWST detect and why was it built to do this?

Objective: Be able to build a spectrometer and explain what spectroscopy is/what it measures.
Activity: *Build A Spectrometer and Examine Light Sources*

1. Explain that the colors we see are part of a broad spectrum of light reaching our eyes, only a portion of which is sensed. Which portion?

    a. What are three other types of light we experience on a daily basis?
2. Define the idea of a "spectrum" using words, numbers, and graphing.
    a. What does "spectroscopy" measure?
3. Explain why astronomers use the technique of "spectroscopy."
    a. What spectroscopic instruments are on JWST?
4. Engage your troops in build and using spectrometers for measurements of their surroundings.

How Light Behaves

Objective: Understand the relationship between time and the speed of light.

Activity: *Lookback Time*

1. Integrate the concept of time into your explanations of the night sky.
    a. Which naked-eye objects can you see by eye with the shortest look back time; farthest?
    b. Which telescopic objects can you see with the shortest look back time; farthest?
2. Explain "light-year," "light-minute," etc. and how to convert between them.
    a. Explain why do objects nearest to us are seen almost instantaneously.
    b. Relate light time to sound time when measuring the distance to a lightning strike.
3. Explain why astronomers want to measure objects as far away as possible.

Objective: Understand why a source of light appears fainter with increasing distance.

Activity: *Visualize How Light Expands as it Travels Away*

1. Explain conceptually why and how an object's brightness becomes fainter with distance.
2. Explain why sound behaves similarly.
3. Explain why astronomers require large telescopes.

Telescopes

Objective: Explain why astronomers build large telescopes and how they collect light.

Activity: *What Big Eyes, You Have*

1. Explain the primary reason why astronomers need to build large telescopes
    a. Incorporate numbers into your explanation.
2. Explain how telescopes collect light.
    a. Convince another person why "area" is an important property of a telescope mirror.
    b. Why is the term "light bucket" relevant to telescopes?
3. Draw a diagram showing how telescopes focus light.

NIRCam and JWST: Go Girl Scouts!

Objective: Understand the purpose and mechanics of a camera and relate it to JWST.

Activity: *Dissect a Disposable Camera*

1. What is the fundamental purpose of a camera? What does it measure?
2. Explain how simple principles of mechanics and optics are identical in NIRCam and everyday cameras.
    a. How are our eyes the same and different from a camera?
3. Discuss three reasons why JWST must operate in space.
4. Understand why JWST and its instruments are expensive

Our Solar System

Objective: Experience the concept of "models" and decide to incorporate some in your troop's activities.

Activity: *Various Models on Display to Try Out*

1. Explain the overall properties of the planets and their relative locations, orbital periods, and orbital speeds.
2. Select the two models as an activities best fit for your troops.
    a. What do these models teach?

    b. How will you incorporate numbers into the models you choose?
    c. How can you use the idea of lookback time to measure distances in the solar system?
3. Use numbers, and different units, to characterize our Solar System.
    a. Become comfortable using light-minutes, light-hours, light-years.
    b. How far away is our Sun in light-units and miles?

Origin and Nature of Planetary Systems

Objective: Construct a own scale model by yourself and learn about "Exoplanetary Systems."

Activity: *Design a Scale-model of a Known Extrasolar Planetary System*

1. Be able to incorporate "proportional thinking" into the construction of a realistic scale model.
    a. By-product: Compare and contrast the Solar System with other planetary systems.

Origin and Nature of Stars

Objective: Practice the techniques of classification using the properties of stars as examples.

Activity: *Classification of Stars with Flashcards*

1. Experiment with organizing stars by distance, brightness, size, mass, temperature.
2. Explain how science uses "classification" techniques to understand underlying principles and patterns.
3. Describe stars using numbers.
4. Explain the properties of stars using an analogy to people.

Nighttime Observing

Objective: Use different observing tools to explore, and explain, the 'geography' of the night sky.

Activities: *Observations by Naked Eye, Binoculars, Galileoscopes, Telescopes*

1. Locate a bright star or star cluster, a planet, and a nebula using each of the above pieces of equipment.
    a. Prepare a written description and drawing for each observation of an object.
    b. Explain how the different telescopes function.
    c. Which piece of equipment was "best" for each object?
2. Explain "light pollution" and how it affects the night sky.
    a. How do nearby lights affect our vision at night?
    b. How does light pollution affect animals at night?
    c. How might the phase of the Moon affect your star party?
3. Draw a diagram of our Solar System showing the relative positions of the planets we see tonight.

Origin and Nature of Galaxies

Objective: Practice the techniques of classification using galaxies as examples.

Activity: *Classification of Galaxies with Flashcards*

1. Write down a "recipe" of a galaxy like the Milky Way.
    a. Is there a different recipe for other galaxies? What is it?
2. Describe a galaxy using numbers.
3. Explain how science uses "classification" techniques to understand underlying principles and patterns.
4. What aspects of JWST will enable astronomers to determine how galaxies formed and evolved?

Origin of Our Universe

Objective: Understand the evidence that our Universe, including space/time, has a finite age.

Activity: *Hubble's Law: Measure the Expanding Universe Using a Copy Machine*

1. Explain how "proportional thinking" is useful in daily life using familiar examples.
2. Explain why astronomers **must** use infrared light with JWST to understand the origins of our universe.
3. How will JWST help us understand the history of the universe?

Observing with the 61″ Telescope

Objective: Experience a research observatory and apply the concepts we have learned in this workshop.

Activity: Use the 61-inch Kuiper telescope on Mt. Lemmon to observe objects in the night sky.

1. Explain the basic operating principles of a telescope.
    a. How does each letter in STEM apply?
2. Why do astronomers continue to need larger and larger telescopes?
    a. How is the 61-inch better than the 11-inch telescope?
    b. How is the 61-inch worse than the 11-inch telescope?
    c. Why are small telescopes still useful and important?
3. Explain and view one reason why JWST needs to be above Earth's atmosphere.
4. Locate objects in the night sky approximately using the ideas of RA and DEC and your planisphere.
5. Explain the challenges of operating a telescope like JWST remotely.