**Attachment #6**

**Lockerly Arboretum**

***Angiosperms and Gymnosperms***

Aslan Leiby-Redden

***Goals:***

* To have individuals understand the difference between gymnosperms and angiosperms.
* To give individuals the opportunity to work with Brock Microscopes.
* To give individuals the chance to examine different species of plants.
* To have individuals understand how gymnosperms angiosperms produce seeds.

***Outcomes:***

* SWBAT differentiate between gymnosperms and angiosperms.
* SWBAT identify a monocot from a dicot.
* SWBAT explain how gymnosperms and angiosperms spread their seeds.
* SWBAT explain how gymnosperm and angiosperm seeds are produced.

***Participant Pre-requisites:***

* This activity is geared toward individuals with no background in angiosperms and gymnosperms
* The focal age group for the activity is elementary-middle school

***Resources:***

* Site:
  + An outdoor area with naturally growing angiosperms and gymnosperms.
* Time:
  + 1.5 Hours
* Materials:
  + Angiosperms
  + Gymnosperms
  + Diagram of flower parts
  + Display of monocots and dicots
  + Display of seed types
  + Bucket for Collecting
  + Brocks Microscope
  + Dissection Trays
  + Tweezers
* Definition & Identification Tips:
  + Angiosperms- Flowering Plants
    - Ex. Sunflowers, Lilies, Orchids, Roses, Oaks, and Maples
    - The seeds of an angiosperm develop inside the plants ovary, or outer area around the seed. Once the ovary matures, it develops into a fruit which is produced to either protect the seed or assist the seed with germination.
    - Angiosperm seeds are spread by wind, animal ingestion or getting stuck on animal’s fur.
  + Gymnosperms- Non-flowering Plants
    - Ex. Pine Trees, Spruce Trees, and Fir Trees
    - Gymnosperms develop seeds through the use of pollen cones and pine cones. The pollen from the pollen cone disperses into the wind and flies into the pine cone. The pollen begins to fertilize the seed without the protection of the ovary, gymnosperm also means naked seed. The seed develops a wing on the bottom of it to assist the seed with germination via wind.
    - Gymnosperms rely on wind for germination.
  + Monocot- A type of angiosperm that has seeds that develop one leaf when they sprout.
    - If the plant has already flowered, look at the veins underneath the leaf of the plant. If the veins run parallel to one another and the flower contains 3 peddles, the plant is usually a monocot.
  + Dicot- A type of angiosperm that has seeds that develop two leaves when they sprout.
    - If the plant has flowered, the veins on the leaves will have a network pattern and there will be 4-5 peddles on the flower, then the plant is usually a dicot.

***Management Safety:***

* Make sure participants have the knowledge to properly identify poison ivy.
* Chose a spot on the property that has a diverse selection of angiosperms and gymnosperms nearby.
* If the group is large enough, and staff is available break the participants apart two groups.
* Identify boundaries around the property to the participants to make sure they will not go out of sight during their time collecting examples.

***Methods:***

INTROCUCTION

1. Upon arrival, collect different angiosperms and gymnosperms around the outdoor area being used.
2. While collecting angiosperms, be sure to collect a diverse selection of monocots and dicots. Focus on collecting angiosperms that still contain seeds.
3. Find gymnosperm cones that contain seeds.
4. Place the collected items in a bucket and continue to prepare for participant arrival.
5. Place the bucket and the Brock Microscopes in a shady area on the property, this activity will be outside for the full hour.
6. When participants arrive, briefly walk around the property to locate trees that are angiosperm and gymnosperm
7. Ask the participants to identify the difference between the two trees.
8. If a participant mentions that one tree has flowers and the other does not, try to use their answer to help interlude the participants into the lesson.
9. Identify and explain the difference between angiosperms and gymnosperms. Inform the participants that gymnosperms have been around since the prehistoric times, much longer than angiosperms. Angiosperms evolved from gymnosperms as a way to produce and spread seeds more efficient and effectively.
10. Walk the participants over to a shady spot where the bucket of collected items is.
11. Have everyone sit down in a way that all participant can see and hear you.

GYMNOSPERMS

1. When focusing the discussion on gymnosperms, being the conversation with asking the participants to help you define what a gymnosperm is from the early conversation.
2. Reiterate the definition of gymnosperm to the participants and name examples of trees that are gymnosperms.
3. Once you have mentioned pine trees, distribute the pine cones collected at the beginning of the activity to the participants.
4. Show participants how to locate the seeds inside the pine cone, and then tell the participants to try and find as many seeds in their pine cone as possible. Pass out dissection trays for the participants to put their seeds on. They will also use this as their slide for their microscope.
5. Allow participant to use the Brock Microscope to examine the seeds or pine cone that they have.
6. While participants are using the microscope, discuss the seeding process used by gymnosperms
7. Point out the wing like structure of the seed and ask participants why they believe the seed developed this wing. Begin a discussion on the different ways seeds are dispersed.
8. Show participants the display of seeds and discuss the multiple kinds of seeds that can be produced.

ANGIOSPERMS

1. Turn the focus of the activity to angiosperms; distribute angiosperms collected at the beginning of the day to the participants.
2. Use the flower diagram to show the participants where the ovary of the flower is located. Ask the participants to point out where the ovary of their flower is.
3. Explain that the ovary is where the fruit of the plant is developed. Non-flowering plants do not produce fruit because their seeds do not develop inside an ovary, which is also why non-flowering plants are called gymnosperm which means naked seed.
4. Allow the participants to dissect their flower with the tweezers.
5. Have them locate the seeds within the ovary.
6. Tell the participants to use the Brock Microscope to examine the seeds and the different parts of the flower.
7. While participants are examining the flowers, explain the seeding process used by angiosperms.
8. Discuss with the participants the similarities and differences of both the flowering and non-flowering seeding processes.

MONOCOTS & DICOTS

1. Show participants the veins of both monocots and dicots, ask the participants to explain the difference between the vein patterns.
2. If a participant identifies the fact that one leaf has straight and parallel veins, use that answer to begin explaining the difference between monocot and dicot angiosperms.
3. Use the monocot and dicot display to help elaborate on monocot and dicot identification.
4. Have participants identify which family the flower they were examining belongs to.
5. Once the participants have a general understanding of gymnosperms and angiosperms, break the participants into pairs and ask them to locate gymnosperm and angiosperm (monocot and dicot) around the activity area.
6. Each pair should bring back three examples, a gymnosperm, monocot, and dicot.
7. The pairs will then get the opportunity to present their findings and explain their reason why they think the plants are monocots, dicots and gymnosperm.
8. After the last participant has presented, ask them to put their findings in the bucket and wait for participant departure.

***Assessment of Student Learning:***

* During the discussion on gymnosperms, participants are able to define what a gymnosperm is. Participants will be able to explain what makes angiosperms and gymnosperms different.
* When discussing the seeding process, participants will be able to explain that angiosperms use a protective layer around their seeds, while gymnosperms are considered to be naked.
* After participants return from collecting their flowers, examine their selection and have them identify which kind of plant they located. Based on their answer, you can determine if the individual successfully determine angiosperm from a gymnosperm and monocot from dicot.
* When the display of fruit is shown to the participants, ask them why some fruits are fleshy and sweet compared to others. Based on their answers you can determine if they have the information to answer the question correctly.

***Adaptations:***

* If participants are having trouble grasping the scientific terms behind the activity, revert to the common terminology. This will change the focus of the activity from vocabulary words to the environmental science topic.
* For participants who seem to need a challenge, use the microscope and tweezers to dissect the flower in a way that you can see its insides. Use the dicot flower model and challenge the participants to locate the different plant parts that they are seeing.
* To make this activity appropriate for younger age groups, leave out all scientific terminology and focus on hands on learning and physical examples. Refraining from asking complex questions that require detailed observations.