What's Way Out There?

Big Idea: The Hubble Space Telescope image "Hubble Ultra Deep Field" shows a variety of objects in the very distant Universe that can be systematically and scientifically counted, organized, and classified.

Computer Setup and/or Materials Needed:

a) Access to the image at: http://www.spacetelescope.org/images/screen/heic0406a.jpg
    That originated from http://www.spacetelescope.org/news/html/heic0406.html

b) Access to the *SkyWalker* website at:
    http://www.aip.de/groups/galaxies/sw/udf/swudfV1.0.html

c) Note: *There is no expectation that students have studied galaxies prior to completing this research project.*

Phase I: Exploration

1) Access the online Hubble Space Telescope Image at
    http://www.spacetelescope.org/images/screen/heic0406a.jpg
    You might be able to make it larger and smaller by "left clicking" on the image with your mouse. Most of these
    objects are galaxies far, far from Earth. However, a few objects are nearby stars, as indicated by "four points" on the image, like shown at left.

    How many stars can you find? _____

2) Again, most of these objects are not individual stars, but actually distant **galaxies**—*isolated collections of millions or billions of stars that look like a tiny dot or cloud*. Determine how many galaxies are found in the image. *One strategy to count the number of galaxies in the image is to just count the number of objects in ¼ of the image (the bottom left corner for example) and then multiply the number of galaxies times four to get the total number.*

   Total number of galaxies in this image? _____

3) Some of the galaxies are orange-red in color, while others are white, and others are blue. What is the most common color of galaxy in the image? *Precisely explain how you determined this*.

4) If we assume that all of the galaxies in this image have the same diameter, the ones that are close appear larger and the ones that are more distant appear smaller. Are most of the galaxies in this image relatively near or relatively far? What is your evidence?

Phase II – Does the Evidence Match a Given Conclusion?

5) Access the interactive Ultra Hubble Deep Field site through the the *SkyWalker* website at: http://www.aip.de/groups/galaxies/sw/udf/swudfV1.0.html

The green circle in the top left hand corner is a sort of "magnifying glass" that you can drag around that will let you look at close-up portions of the Hubble Ultra Deep Field. *Note that the picture is about 8 green circles wide and 10 green circles tall, for a total of about 80 green circles over the whole image*.

Make rough sketches of the five <u>closest</u> galaxies you can find in the image.

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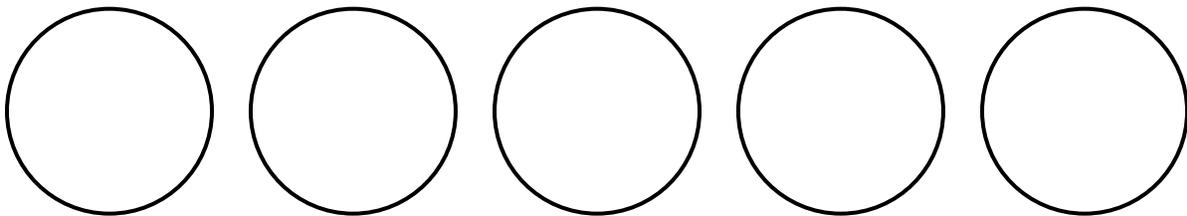
Consider the research question, "What is the most common type of nearby galaxy?" If a fellow student proposed a generalization that "**nearby galaxies are equally split between circular-round and elongated spiral shapes**," would you agree or disagree with the generalization based on the evidence you collected by counting how many of each shape you found? *Explain your reasoning and provide specific evidence either from the above tasks or from new evidence you yourself generate using the SkyWalker Web Site.*

Phase III – What Conclusions Can You Draw From This Evidence?

The Hubble Ultra Deep Field is one of most important images in astronomy because it shows some of the most distant galaxies in the Universe. What conclusions and generalizations can you make from the following data collected by a student by randomly positioning the green circle in an effort to determine WHAT IS THE GENERAL DISTRIBUTION OF GALAXY COLORS? *Explain your reasoning and provide the specific evidence you are using, with sketches or pie charts or graphs if necessary, to support your reasoning.*

GREEN CIRCLE SAMPLE NUMBER	NUMBER OF RED-ORANGE GALAXIES	NUMBER OF BLUE-WHITE GALAXIES
1	7	27
2	10	16
3	15	19
4	10	29
5	12	27

Data collected at http://www.aip.de/groups/galaxies/sw/udf/swudfV1.0.html

6) *Evidence-based Conclusion*:

Phase IV – What Evidence Do You Need To Pursue?

Imagine your team has been assigned the task of writing a news brief for your favorite news blog about the differences between the numbers of nearby and extremely distant galaxies in the Universe. Describe precisely what evidence you would need to collect, and how you would do it, in order to answer the research question of, "**Are there more nearby galaxies or extremely distant galaxies?**

7) *Create a detailed, step-by-step description of evidence that needs to be collected and a complete explanation of how this could be done—not just "move the green circle around and look at how many big and how many small," but exactly what would someone need to do, step-by-step, to accomplish this. You might include a table and sketches-the goal is to be precise and detailed enough that someone else could follow your procedure.*

Phase V – Formulate a Question, Pursue Evidence, and Justify Your Conclusion
Your task is design an answerable research question, propose a plan to pursue evidence, collect data using the interactive *Ultra Hubble Deep Field* site (or another suitable source pre-approved by your lab instructor), and create an evidence-based conclusion about the characteristics of galaxies in our Universe, which you have not completed before.

Research Report:

8) Specific Research Question:

9) Step-by-Step Procedure, with Sketches if Needed, to Collect Evidence:

10) Data Table and/or Results (use additional pages if needed):

11) Evidence-based Conclusion Statement:

Phase VI – Summary   **PRINT YOUR NAME**_____

12) Create a 50-word summary, in your own words, that describes the characteristics and distribution of galaxies in our Universe. You should cite specific evidence you have collected in your description, not describe what you have learned in class or elsewhere. Feel free to create and label sketches to illustrate your response.