COLOR VISION (OR SEEING COLORS)

Objective: Differentiate between color addition and color subtraction.

Ever wonder how all the colors of the rainbow come from normal sunlight? After all, your elementary school art teacher told you that if you mix all of the colors of the rainbow you end up with a dark, muddy brown mess. Which is right? Which is wrong? Or are rainbows and paints following different rules?

General: Play with the simulation for a few minutes. (Not more than 5.)

1) What do you think the moving, colored dots represent?
2) What do you think the colored cloud above the man's head represents?

Color addition:

3) What color does the man perceive when the red light is turned up to full intensity?
4) What color does the man perceive if the light is turned up to just ¼ of full intensity?
5) Form a hypothesis to explain these two results:
6) Attempt to confirm your idea. Explain how you attempted this:
7) Return the red to full intensity. Based on what you know from elementary school art, what color would you expect if you were to add green at full intensity?
8) What color is actually seen when green is added at full intensity?
9) Form a hypothesis to explain the results from the previous two questions:
10) What color is perceived when red and blue are viewed at full intensity?
11) What color is perceived when green and blue are viewed at full intensity?
12) Pause for a moment. Based on the results so far, what color would you expect when red, green, and blue are all viewed at the same time?
13) Now try the experiment at full intensity?
14) Do these last few experiments have more to do with rainbows or paints? Why?

Red, green, and blue are commonly referred to as the primary additive colors and are used in TV screens and computer monitors. Addition of varying amounts of these primary additive colors generate the enormous variety of colors that can be displayed. You can see these primary colors by placing small lenses on the screen (i.e. sprinkle a few small drops of water on the screen. Please do no spit on the screens, I have a little water for you to use if you wish.)

15) Approximately how much of each color should be mixed to generate brown?
red ________ green ________ blue ________
16) Approximately how much of each color should be mixed to generate purple?
red ________ green ________ blue ________
17) Approximately how much of each color should be mixed to generate orange?
red ________ green ________ blue ________
18) What is different between these results and what you learned in art about color mixing?

In elementary school art you learned about mixing pigments. The primary subtractive colors are cyan, magenta, and yellow. These are exactly the colors you found by mixing any two primary additive colors at full intensity (Questions 8, 10, & 11). These colors still do not quite match your elementary school education; however, how many 1st graders know cyan and magenta? You are, nevertheless, quite familiar with these colors as they are used as pigments in every color ink jet printer to produce photo quality color images. Pigments produce colors by removing select wavelengths of light from the incident beam.

Color subtraction:

19) Select the single bulb tab from the top and change your beam from photons to a solid beam. What color is the incident light?

20) What color does the man perceive with a yellow filter?

21) Turn your beam into photons. Explain why the man perceives yellow using the words absorb and transmit.

22) Before making any further adjustments hypothesize what color the man will see using any color filter.

23) Test your hypothesis. Is it accurate? If not, revise.

24) Return your filter to yellow, make your beam solid, and select a monochromatic bulb type of yellow. What color does the man perceive?

25) Change your beam to photons and explain why this is the case.

26) Before making any more changes, hypothesize what might happen if the filter is changed to red.

27) Do the experiment. Is your hypothesis confirmed? If not, revise your hypothesis.

28) Return both your light and filter to yellow. Hypothesize what might happen if the light is changed to blue.

29) Do the experiment. Is your hypothesis confirmed? If not, revise your hypothesis.

30) Return both the light and filter to yellow. Hypothesize what might happen if the filter is changed to light orange.

31) Do the experiment. Is your hypothesis confirmed? If not, revise your hypothesis.

32) Generalize your hypothesis. In other words, what will happens when the filter and bulb colors are nearly the same? What will happen when the bulb colors are very different?

33) Play with the program to test your hypothesis. Revise if necessary.

34) After experimenting with the program, what insightful question would you have future students answer? (Be sure to provide your answer as well as the question!)