Lesson 1: What do I see?

I. Overview
In this opening lesson, students are introduced to the driving question of the unit by examining differences in individual perception of color with a paint chip sorting activity. In small groups, students take turns sorting paint chips into color categories, recording the results, and then graphing the data to interpret differences. Students then develop a model of what they think contributes to the perception of color and light and individual differences in perception. This model can be used by students to generate questions and by teachers to evaluate student’s current thinking. In future lessons, students will revise their models as their understanding of light and sight develops.

Connections to the driving question
This lesson introduces individual differences in perception and the unit’s driving question, “Do you see what I see?” Use the models and questions generated by students during this lesson to motivate investigations throughout the unit.

II. Standards

National Science Education Standards
- Science as inquiry. Identify questions and concepts that guide scientific investigation. Formulate and revise scientific explanations and models using logic and evidence. (9-12 A)

Next Generation Science Standards

Scientific Practices
- Asking Questions (Activity 1: Paint Chip Activity)
- Developing and Using Models (Activity 2: Initial Model of Perception)
- Data Interpretation and Analysis (Activity 1: Paint Chip Activity)

Crosscutting Concepts
- Patterns (Activity 1: Paint Chip)
- Cause and Effect (Activity 2: Initial Model of Perception)

III. Learning Objectives

<table>
<thead>
<tr>
<th>Learning Objective</th>
<th>Assessment Criteria</th>
<th>Location in Lesson</th>
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### Observe and describe variations in visual perception

Students’ observations and descriptions include identification of the different color sorting patterns seen in class

### Analyze data to identify color sorting patterns

Student data analysis includes
- creation of appropriate graphs
- interpretation of graphs based on the identified trends

### Explain individual variations in visual perception and the underlying biology might be due to several factors such as culture, experience, gender, or genetic differences

In groups and in whole class discussion, students provide explanations based on evidence from prior knowledge, data collected through the class activity and/or experience

### Develop a model of perception

Students work in groups to draw a diagram, flow chart, or illustration that reveals their current understanding of sight, light, and perception

<table>
<thead>
<tr>
<th><strong>IV. Adaptations/Accommodations</strong></th>
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<tbody>
<tr>
<td>Do the paint chip activity during class with physical paint chips or with the digital version, available on the Project NEURON website at <a href="http://neuron.illinois.edu/games/paintchip">http://neuron.illinois.edu/games/paintchip</a>.</td>
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<table>
<thead>
<tr>
<th><strong>Safety</strong></th>
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<tr>
<td>There are no additional safety concerns for this lesson.</td>
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<th><strong>V. Timeframe for lesson</strong></th>
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<tr>
<td><strong>Opening of Lesson</strong></td>
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<tr>
<td>- Introduction to color – 5 minutes</td>
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<tr>
<td><strong>Main part of lesson</strong></td>
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<tr>
<td>- Activity 1: Paint Chip Sorting activity – 25 minutes</td>
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<td>- Activity 2: Initial Model of Perception – 10 minutes</td>
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<td><strong>Conclusion of Lesson</strong></td>
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<td>- Introduction to unit and Colorblind Interview reading – 5 minutes</td>
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<th><strong>VI. Advance prep and materials</strong></th>
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<tbody>
<tr>
<td><strong>Activity 1: Paint Chip Sorting</strong></td>
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**Materials:**
Each group of students will need:
• One set of paint chips with ~40 different colors (all paint chip sets need to be the same)
• Stopwatch
• One Paint Chip Sorting data table (U1_L1_StudentSheet_PaintChipDataTable.docx)
  o Digital version: Paint Chip Data Table (U1_L1_GraphingTool_PaintChipDataTable.xlsx)
• One Color Sorting Grid (U1_L1_StudentSheet_PaintChipSortingGrid.docx)

Preparation
• Have a variety of paint chips from a local hardware or paint store representing different shades of primary (red, blue, green), secondary (purple, orange, yellow) and tertiary (green-blue, brown, grey) colors.
• These chips need to be cut into multiple chips and sorted so that each paint chip set has one chip of each color.
• Place each set of paint chips, cut and numbered in a small plastic sandwich bag so that each group of students has one set. It is important that all groups within a class have the same paint chip set for later discussion.

Activity 2: Initial model of perception

Materials
Each group of students will need:
• A large piece of paper or small white board
• Markers or colored pencils

Preparation
None

Homework and Assessments
• Reading from the next lesson, “Interview with a Colorblind Person” (U1_L2_Reading_ColorblindInterview.docx, or the extended version U1_L2_Reading_ColorblindInterview_Extended.docx).

VII. Resources and references

Resources
• The materials for this lesson can be downloaded for free from the Project NEURON website: http://neuron.illinois.edu/do-you-see-what-i-see/lesson-1
• The digital version of the paint chip activity can be found on the Project NEURON website: http://neuron.illinois.edu/games/paintchip
VIII. Lesson Implementation

Opening of Lesson: Introduction to color
Ask students to say out loud names of different colors, and write these on the board. Students will list common categories such as blue, red, yellow, green, etc. Encourage students to continue listing colors or shades or variants of colors they have previously listed. Students might come up with names of colors such as turquoise, lime, teal, etc. Using this list, have students group these colors into six (6) main “color groups” that they see each day (brown, yellow, red, orange, green, blue, for example).

Activity 1: Paint chip sorting activity
Tell students that they will be doing a color sorting activity using the colors identified in the introduction as “color groups.” Place students in groups of 3–4, and distribute the materials for each group (see Materials and Preparation): set of paint chips, stopwatch, data sheet, and color sorting grid.

Have one student from each group fill out the Paint Chip Data Table (U1_L1_StudentSheet_PaintChipDataTable.docx) with the names of the group members and the color group names (all student groups should have the same color groups, so that class-wide comparisons can be made later). An example is shown below:

<table>
<thead>
<tr>
<th>Color Groups</th>
<th>Tommy</th>
<th>Chandana</th>
<th>Sahid</th>
<th>Sara</th>
</tr>
</thead>
<tbody>
<tr>
<td>blue</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>green</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>yellow</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>red</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>brown</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>purple</td>
<td></td>
<td></td>
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</table>

Another student can write the color groups into the color sorting grid so that there is one color group assigned to one space. During the activity, the paint chips will be sorted into the different spaces. An example is shown below:

<table>
<thead>
<tr>
<th></th>
<th>BLUE</th>
<th>RED</th>
<th>GREEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>BROWN</td>
<td></td>
<td>YELLOW</td>
<td>PURPLE</td>
</tr>
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</table>

After explaining the activity, ask students if they think there will be differences in how the colors are sorted among individuals or groups.
- If they expect to see differences, what type of differences might they see?
- Why they think that they might see differences? For instance, females may sort differently than males.

When the students are ready, students can start the paint chip sorting activity. These are the rules:

1. Mix the chips beforehand; a student cannot study, presort, or look through the pieces.
2. Each student gets one minute (timed with the stop watch) to sort the paint chips into the color group spaces.
3. Once a chip has been placed, it cannot be moved.
4. After the minute is up, the number of paint chips in each space is recorded in the data sheet.
5. If there are unsorted chips at the end of the minute, those chips are not included in the final count.

**Teacher Pedagogical Knowledge**
The paint chip activity attempts to assess students’ immediate perception. Having only a minute to complete the activity causes students to make decisions quickly based on their initial sense of the colors. In addition, restricting time to one minute will most likely enhance the differences in perception amongst students and groups giving more weight to the example of individual differences in perception.

After completing the color sorting activity and entering the data into the table, students analyze their data looking for differences and similarities in how colors were sorted. Depending on time, students may graph their data (*U1_L1_GraphingTool_PaintChipDataTable.xlsx*) or just discuss general differences or similarities between individuals.

**Teacher Pedagogical Content Knowledge**
A possible extension activity is for students to compare colors across groups. This additional data analysis will allow students to confirm or deny their initial predictions. An array of data from the entire class can initiate full class discussion and allow students to notice patterns not previously recognized in the small groups.

Additionally, a whole class data set can be created using a common data table where each student is a row. This data set can then be used to compare across groups or classes. If possible, students can enter their data into an electronic spreadsheet so that graphs can easily be created throughout this discussion. If possible, present the spreadsheet via a projector.
After analyzing their data, have students come back together as a whole class. Have a whole class discussion using the following prompts to help students generate questions about:

- What were some of the differences or similarities among group members in color sorting?
- Were there any expected or unexpected patterns?
- Why do you think there were similarities or differences in sorting colors?
- This classroom is a limited subset of the global population. If you wanted to make an investigation into how humans (in general) perceive color...
  - What additional information would you collect about the people?
  - What factors may play a role in the perception of colors?

This is an opportunity to have students write down their own questions in a journal or on a sheet of paper to hang in the classroom throughout the unit. Making connections between lesson content and student-created questions will help motivate learning.

### Scientific Practices: Asking Questions

The paint chip activity prompts students to ask questions about perception. Encourage students to seek patterns and generate questions from unexpected results or in order to seek new information. Students can record their questions in a journal or on paper that can be hung on classroom walls for future reference and revision. This inquiry will drive student motivations throughout the unit and help them generate a model of perception in the next activity.

### Activity 2: Initial Model of Perception

Use the discussion following the Paint Chip Sorting activity to help students build an initial model of color perception. Hand out paper or small whiteboards and markers or drawing utensils to each of the groups.

### Teacher Pedagogical Knowledge

Asking students to develop an initial model is a good way to evaluate students’ current knowledge and understanding of a particular scientific topic. This can be used throughout the unit to make connections to students’ experiences or identify and correct misconceptions. Later, students will revise their models to incorporate evidence and scientific concepts learned in subsequent lessons.

Students will work in their small groups to build a model of what they think affects or contributes to color perception in humans. Encourage students to think about perception in different ways. It may be useful to pose these questions as students develop their models:
• How do I perceive color?
• What is perception?
• What are the factors that “cause” perception to occur?

After students have spent five to ten minutes working on their models, have a student representative from each group present their models and describe

• What does your model include?
• What did you not include in your model, and why?
• What types of knowledge would you need to have in order to complete your model?

### Scientific Practices: Developing and Using Models

In this activity, the students’ initial model can consist of drawings, analogies, and flow charts or diagrams. In science, models are used to represent systems, generate questions, and communicate ideas. Students will be able to evaluate their model and identify the gaps in their knowledge by visualizing the parts of their model that they cannot describe or show well.

Once most groups are done making their models (5 minutes), ask one student from each group to show and describe their group’s model to the rest of the class.

**Conclusion of Lesson**

Using both the paint chip sorting and model building activities, tell students about the upcoming unit. They will be examining over the next few weeks the science behind how and why animals (including people) perceive color in different ways. As they learn more about vision, sight, and light, they will be able to answer the driving question of the unit “Do you see what I see?”

In future lessons, students will begin to explore the different factors that affect color perception, including

• Structures within the eye, including rods and cones
• Genetics
• Language and culture
• The environment
• Evolutionary pressures, including natural and sexual selection

Finally, introduce the homework reading (“Interview with a Colorblind Person”) by revisiting the paint chip sorting activity and telling students that some differences in color perception are caused by the eye not being able to distinguish certain colors. Ask students:
• Have you heard of colorblindness?
• Do you know anyone who is colorblind?
• What do you think it is like to be colorblind?

Tell students they will read an interview with a colorblind person, who shares her history and experience as a colorblind person. Hand out the reading “Interview with a Colorblind Person” (U1_L2_Reading_ColorblindInterview.docx). If students are familiar with Punnett Squares, the extended version of the interview (U1_L2_Reading_ColorblindInterview_Extension.docx) includes more details on genetics and hereditary probability.

**Assessments**
Save students’ initial models (hang them around the room for the duration of the unit, take photos, save hardcopies, etc.) so students can revisit and revise them in subsequent lessons. The models can also be used as artifacts to assess student learning and understanding.