Reflection of Light and Mirrors

Student Alternative Conceptions (Misconceptions) Addressed by the Lesson:
1. Sight "comes from our eyes" with or without the need for a light source.
2. There is no pattern for how light reflects off an object.
3. We see simply because light is reflected off the surface of an object.
4. These alternative conceptions of students result from others, possibly more basic conceptions (e.g. You can see in the dark. Reflected light is not important in seeing images.) and lead to more complex alternative conceptions, misconceptions, relating to real and virtual images and the functions and characteristics of lenses.

Lesson Goal: Students will investigate light reflection in mirrors and determine how light is transferred to the eye.

Prerequisites: Students are familiar with the concepts of *plane mirror*, parts of the human *eye*, and lab safety procedures with mirrors and light sources.

National Standards Addressed: 4F Physical Setting, 9C Mathematical World, 11C Common Themes, 12B Habits of Mind (from *Benchmarks*)

Special Needs Accommodation: Students with vision impairments will have to use raised print drawings of the activities, when possible. Also, they will need detailed explanations of what has occurred with the images in the mirrors in each phase of the learning cycle.

Exploration - Begin Lesson

Objective: Students will make predictions and then test them regarding the size of a mirror and the distance needed to the full length of a person standing in front of it.

Materials: For each group:

Mirrors (one 12-20 cm & one 100 cm.)	Worksheet #1 & 2
Graph paper	Meter stick
Rulers (30 cm)	Colored pencils
Protractor	

Procedure:

A. Place the students in lab groups of four and assign roles or ask student groups to decide on roles: materials manager, task coordinator, spokesperson, and a data recorder. All members will be observers.
B. Show the students a mirror.

Students as Individuals:

C. 1. State the key questions: *"How large does a mirror have to be in order for you to see your whole body in it?"* and *"Does the distance you stand from a mirror make a difference? How?*
2. Have the individual students predict the results, write them down, and illustrate their results in a drawing on worksheet #1.
3. Ask the students to discuss their individual predictions in their groups.

Students in Groups:

D. Ask the groups to perform the following activity, discuss the results in a group, and write down what they find. Students should record their data in a form that will show their results clearly on group worksheet #2. The data should be recorded in a data table and in a descriptive narrative.
   1. Begin by asking the question: "What is the length of a mirror needed to see your whole body?
   2. Allow the groups to begin their investigation of the question in 1.
   3. When groups have a result challenge them with the question: "Does the distance you are from the mirror make a difference in the size needed to see your whole body?"
   4. Have the groups continue their investigation of the questions in 1 and 3.

E. Ask each group to discuss the results of Activity D and their individual responses to Activity C above.

F. Have students turn in their individual responses on worksheets #1 & 2.

Evaluation: Evaluate worksheets #1 and #2. Each student will have completed predictions for the two key questions. Students' predictions should be evaluated for their prior knowledge. The instructor should monitor student participation in the group by observing if the groups started quickly, stayed on task while working and whether each person performed their assigned role in the activity.

Invention - Continue Lesson

Objective: The students will relate their findings in the exploration to a description of the way in which we see light in a mirror.

Materials: for each group:

Graph paper	Protractor
Ruler (30 cm)	Meter stick
Colored pencils	Worksheets #3 & 4
Mirrors (three 5 cm, one 20 cm and one 100 cm)	Light source with slit

Procedure:

A: Continue the student group structure used in the exploration.

B. Have the spokesperson from each group present their results to the questions above, relating their investigation results to their original predictions.

C. The instructor should discuss the various students results found as a whole class, illustrating the responses on the board. Ask students to provide evidence for their ideas as to why their results may not have met the original predictions made on Worksheet #1.

D. Ask the students to solve the following problem and determine a "rule" which will always make them successful. *Set up two mirrors and a 3x5 card in the front of a light source in such a way that when the light is turned on the beam will bounce off mirror one to mirror two and on to the 3x5 card.* See worksheet #3. More difficult problems should be given to groups who solve the first problem quickly. Have groups report results to the class through a spokesperson.

E. Provide a geometric explanation demonstrating the results the students found in D, if not presented in C above, using the concepts of light rays, reflection, plane mirror, how light

enters the eye and images formed in a mirror. Answer any questions the students may have with these concepts and their relationships.

F. Again ask the groups the following thought questions: *"Does the size of the mirror used make a difference in how much you were able to see?" and "Does the distance you stood from the mirror have an effect on the size of the image?" and "How does this relate to the rule you just discovered?* Ask the groups to investigate and discuss these questions again using the available materials on group worksheet #4.

G. Have the groups report on the results of the questions investigated through a spokesperson.

H. Provide a geometric explanation of the results of viewing self in a mirror, if not presented clearly by the student groups. Use a handout, video, laserdisc or software pertaining to the eye and how we see to reinforce the concepts. A combination of the above would be most beneficial.

J. Closure: Provide an explanation of light as reflected from plane mirrors.

Evaluation: Evaluate Worksheets #3, 4 and 5. Each group of students will have completed all procedures for the invention activities. Their worksheets should be evaluated for their completeness in attempting to explain the phenomena using the new information. Additionally, monitor participation in the group by observing if the groups stay together on task, and whether each performed their role in the activity.

Expansion - Complete Lesson

Objective: The students will explain what is happening when observing light from a Reflectance Box.

Materials: For each group:
Reflectance box
Worksheet #5
Graph paper
Colored pencils

Procedure:

A. Place the students in groups of four, and assign the roles of materials manager, recorder, group leader, and reporter.

B. Describe for the students the materials and instructions needed for student groups to carry out the activity of using the Reflectance Box.

C. State the key questions: "What happens to the light in the mirror as it is turned?" and "Why does this happen?"

D. Have the groups perform the following activity:
1. Place the mirrored, three-sided pyramid in the Reflectance Box.
2. Start with a flat side facing the student viewing the pyramid in the box.
Be sure that there is enough light entering the box to see a reflection.
3. Have one of the members of the group rotate the pyramid slowly from the hole in the back of the box. Repeat this so that all members of the group have both viewed, and rotated the pyramid.

E. Have the groups record their observations on worksheet #5 and relate them to the question in C.

F. Have the student groups report, discuss, and show diagrams of light rays of their responses to worksheet #5 with the class.
G. Ask the students to describe and explain how two of the following devices work - periscope, reflecting telescope, rear view mirror, putting on makeup, dentist's mirror, or security mirror. Have the groups write down their answers to turn in.
H. Summarize the results of the lesson by describing some of the alternative conceptions the students demonstrated for how light is reflected by a mirror and the activities experienced during the lesson.

Evaluation: Have the students work in their groups to come up with an answer to the following questions: "How can this technique be used to determine the distance to the moon?" Their answer should be evaluated for their correctness at explaining the phenomena observed in the expansion using the information at their disposal. Additionally, you should monitor their participation in the group by observing if the groups stay together on task, and each person performed their role in the activity. In addition, monitor groups to see if they review what to do before starting and that they talk anout each students' ideas and why it may or may not work, but don't criticize the person.

Sample Quiz item:

Design, describe, and illustrate a way to observe a person coming down a hall without being seen using only mirrors.

Name _____

Worksheet #1

Make these predictions by yourself. Write them down and illustrate your predictions in a drawing below.

1. How large does a mirror have to be in order for you to see your whole body in it?

2. Does the distance you stand from a mirror make a difference? How?

Abbreviated versions of student worksheets.

Name _____ Group Name _____

Worksheet #2

Perform these investigations with your group. Describe the investigation plan and the results and illustrate your investigations in a drawing below.

1. How large does a mirror have to be in order for you to see your whole body in it?

2. Does the distance you stand from a mirror make a difference? How?

Name _____ Group Name _____

Worksheet #3

Perform these investigations with your group. Describe the investigation plan and the results and illustrate your investigations in a drawing below.

1. Set up two mirrors and a 3x5 card in the front of a light source in such a way that when the light is turned on the beam will bounce off mirror one to mirror two and on to the 3x5 card. Describe what you did to solve the problem. Draw your trials and your successful attempt. What is the "rule" for success?

2. Make up a more difficult problem to solve using the same rule.

3. Describe the rule for reflection from mirrors.

Name _____ Group Name _____

Worksheet #4

Perform these investigations with your group. Describe the investigation plan and the results and illustrate your investigations in a drawing below.

1. Does the size of the mirror used make a difference in how much you were able to see?

2. Does the distance you stood from the mirror have an effect on the size of the image?

3. How does this relate to the mirror rule you just discovered?

Name _____ Group Name _____

Worksheet #5
Reflectance Box

Perform these investigations with your group. Describe the investigation plan and the results and illustrate your investigations in a drawing below.

1. What happens to the light in the mirror as it is turned?
   a. Place the mirrored, three-sided pyramid in the Reflectance Box.
   b. Start with a flat side facing the student viewing the pyramid in the box. Be sure that there is enough light entering the box to see a reflection.
   c. Have one of the members of the group rotate the pyramid slowly from the hole in the back of the box. Repeat this so that <u>all</u> members of the group have both viewed, and rotated the pyramid.
2. Why does this happen?

References

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