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Here's Lookin' at You, Kids!

SUMMARY

With the increase in digital image technology, cameras are becoming increasingly present in modern society. When developing and improving cameras, scientists and inventors have used the human eye as a model. Although the basic steps of camera function are similar to the human eye, there are marked differences. In this activity, students will compare and contrast cameras with the human eye, investigating the digital camera's sensitivity to light and color. Students will then discuss how technological advances in this field have impacted the way people live and project how continued advances will impact the future.

SUBJECTS

Life sciences (biology, physiology)
Technology (digital imaging)
Social Science (current events, ethics, sociology)

Grade levels 9 through12

TIME REQUIREMENTS

2 class periods of 50 minutes each

STANDARDS

Content Standard A:
Science as Inquiry
As a result of activities in grades 9-12, all students should develop understanding about scientific inquiry

- Scientists usually inquire about how physical, living, or designed systems function. Conceptual principles and knowledge guide scientific inquiries. Historical and current scientific knowledge influence the design and interpretation of investigations and the evaluation of proposed explanations made by other scientists.

- Scientists rely on technology to enhance the gathering and manipulation of data. New techniques and tools provide new evidence to guide inquiry and new methods to gather data, thereby contributing to the advance of science. The accuracy and precision of the data, and therefore the quality of the exploration, depends on the technology used.

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Content Standard C:
Life Science
As a result of their activities in grades 9-12, all students should develop understanding of Behavior of Organisms

- Multicellular animals have nervous systems that generate behavior. Nervous systems are formed from specialized cells that conduct signals rapidly through the long cell extensions that make up nerves…In sense organs, specialized cells detect light, sound, and specific chemicals and enable animals to monitor what is going on in the world around them.

- Behavioral biology has implications for humans, as it provides links to psychology, sociology, and anthropology

LEARNING OBJECTIVES

To compare and contrast functionality of the human eye with a video camera
To discuss the social implications of the increasing presence of surveillance cameras in today's society.

Before beginning the activity

Students should be familiar with the parts of the human eye and the parts of a camera and their respective functions. This lesson could be used after students have learned the anatomy of the human eye or the senses. If teachers choose to use the lesson at a different time, a review of the eye parts and an elaboration of the camera components may be necessary. When reviewing information about human vision, include the role of the human brain in interpreting images from the eye. Students can either make their own drawings or label the Human Eye and Camera Diagrams sheet.

Students should also be familiar with the function of digital cameras. For more information, see the Content Information section or refer to a Web resource listed below.

MATERIALS FOR EACH GROUP

Copies of Here's Lookin' at You, Kids! Activity sheets
Webcam connected to computers and/or Video cam-corder hooked up to a television as a monitor
One remote control device for each camera set-up

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A variety of objects for students to test such as scraps of fabric, pictures, pieces of plastic, color filters, fluorescent objects, glass, paper, piece of a black garbage bag, and sunglasses (or polarizing filter), fresh flowers (such as daisies).

PROCEDURE

1. Set up each station with a camera, monitor, remote control device and materials to test. (Teacher note: although Webcams are becoming less and less expensive, many schools have very few. If this is the case, this activity could be used as a station, with student groups rotating through.)

2. Check Webcams and remote control devices to make sure all are working properly before the lesson begins.

3. Provide each station with a variety of colorful objects and other items listed in the materials section.

4. Have students hold up a colored object to the Webcam (or cam-corder) and record whether the color appears exactly the same on the monitor or whether it appears different. Students should test at least 5 brightly colored objects noting if the color appears the same or different (shade, intensity).

5. Using the color filters or polarizing filter (sunglasses), instruct students to investigate how color appearance changes in the camera compared to your eyes. Test at least three filters and record your findings.

6. Have students point the remote control device at the Webcam and push some command buttons. Students should note what they observe on the monitor.

7. Students should then test several objects as filters for the remote control device by placing the object (such as a piece of black garbage bag) in between the remote control device and the Webcam, noting their findings.

8. Finally, instruct students to test the Webcam sensitivity with the flowers. Observe the flower colors carefully with your eyes and also with the camera. Are there any differences in shade or pattern? Record your findings.

Teachers can use the following guide for evaluating student responses: Suggestions for evaluating answers to Here's Lookin' at You , Kids!

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SOCIAL SCIENCE/CURRENT EVENTS

Advancements in the field of digital imaging have increased the presence of cameras in our lives. They are not only used at weddings, birthday parties, and special events, but also for anti-theft protection in stores and home and business surveillance. Many people feel that this increased use of cameras is an invasion of privacy and a violation of rights.

Using the questionnaire provided, instruct students to poll 10 people about their feelings regarding cameras and compile the responses. Based on the answers to these questions, have the students discuss how the use of cameras is affecting the way people live and how they make decisions. How do the students feel this will affect their lives in the future?

WEB RESOURCES

At their own pace, students can explore more about surveillance technology and privacy issues on the Springboard Web site "Research" area. They can also vote in a poll concerning privacy and watch a video about the latest surveillance technology used at the Superbowl. Send them to: http://www.pbs.org/springboard

Find information on eye anatomy and function at: http://www.exploratorium.edu/learning_studio/cow_eye/index.html. This Web site includes a tutorial for eye parts, and a virtual cow's eye dissection.

Explanation of how a digital camera works is explained at:
http://www.howstuffworks.com/digital-camera3.htm

Information on insect vision and ultra-violet patterns in flowers can be found at:

http://vertigo.derby.ac.uk/BiologicalImaging/Shows/fys97/Eddie/biology.html
http://www2.odn.ne.jp/~cca00630/ultravioindex.html
http://gears.tucson.ars.ag.gov/ic/vision/bee-vision.html

Finally, the students can visit the Springboard Web site (http:///www.pbs.org/springboard) to vote in the poll asking: "Do you feel technology is putting your own privacy at risk?"

Background information on the electromagnetic Spectrum including diagrams is located at:

http://science.nasa.gov/newhome/help/glossfig1.htm
http://www.geo.mtu.edu/rs/back/spectrum/

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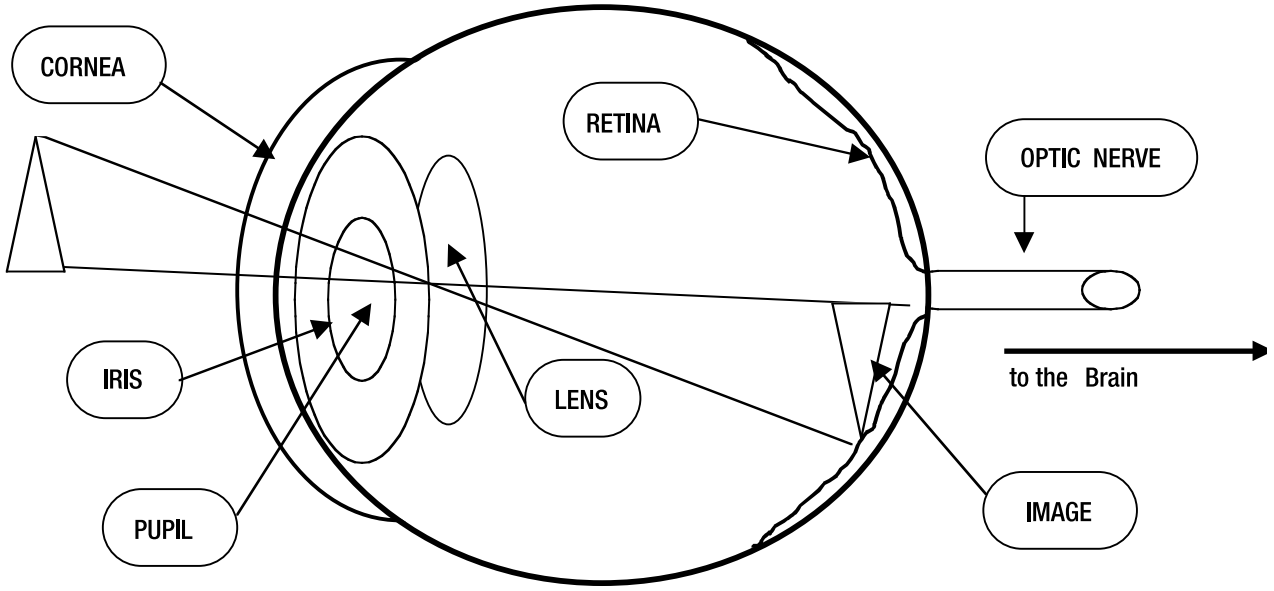
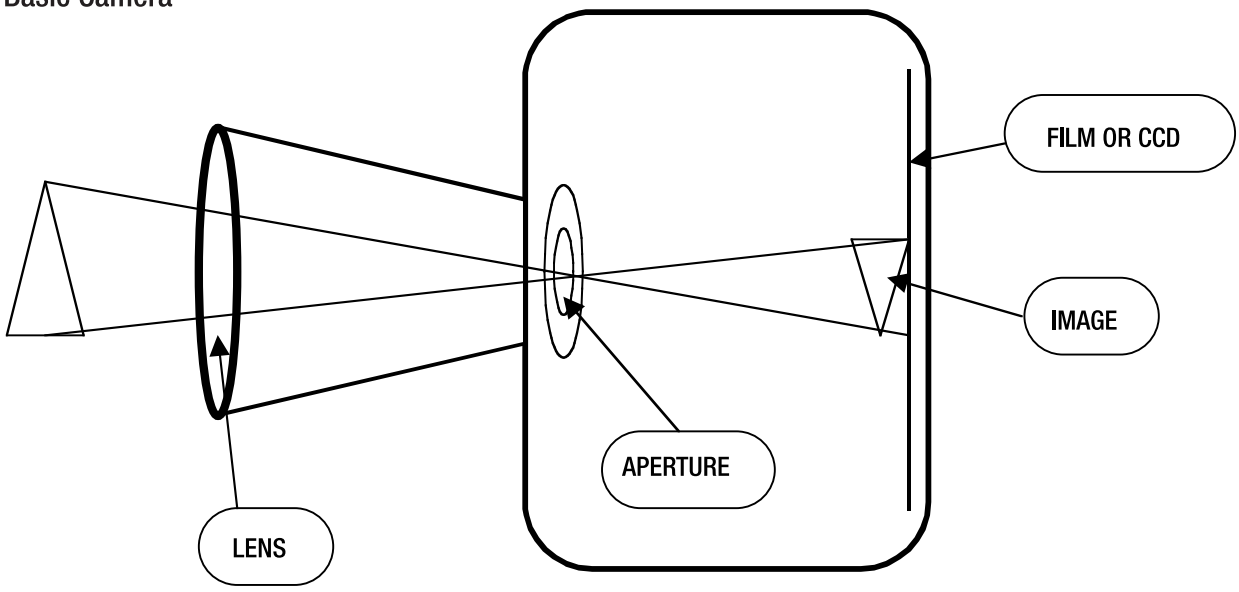
CAMERA AND EYE DIAGRAMS WITH LABELS

Human Eye



Basic Camera



TEACHER GUIDE: SUGGESTIONS FOR EVALUATING ANSWERS TO HERE'S LOOKIN' AT YOU, KIDS!

Eye and camera diagram.

Students should have parts of each diagram labeled and functions of each piece noted.

- Differences in the physical appearance of the camera and eye could include material, shape and location of the lens. Webcams often do not have the equivalent of an iris.
- For the observations on color and sensitivity, students could be graded on completeness of their findings and clarity of presentation (organization) or their data. Although the differences are subtle, students should find that digital cameras and the human eye have marked differences.
- In terms of color, students should note that color may be presented as a slightly different shade, brighter or darker. They might know or discover that color shade is often presented differently by the monitor, and that the monitor can be adjusted. Very bright colors and fluorescent colors may have marked differences in intensity.
- Students should discover that digital video cameras are more sensitive than the human eye to certain wavelengths of light. The CCD in a video camera can "see" the infrared light coming from the remote control device, while human eyes cannot. The CCD is also more sensitive to low intensity ultra-violet light. Students may find subtle shading on the flowers due to ultra-violet reflections called "nectar guides." These shading differences can be seen by pollinating insects, whose vision is more attuned to certain ultra-violet frequencies.

QUESTIONS

1. Which part of the camera was the main focus of testing in this experiment? CCD (a digital camera's equivalent of film)
2. What is the human eye counterpart to the camera component you tested? Retina
3. Which part of the whole process of "seeing" is missing from a camera? Why is this important or significant? The information sent by our eyes is interpreted in the brain; cameras do not have a counterpart to the brain. Images taken by a camera must be interpreted by a human brain in order to have significance to

people. Cameras can only extend human vision.

4. Either in a table or paragraph, students should provide clear understanding of the functions for each part of the eye and camera.

CONTENT INFORMATION

In a digital video camera, a CCD (charged coupled device) takes the place of film. Information is not stored on a CCD, but rather it is transferred to a monitor and/or to a storage system. CCDs can be thought of as an array of sensors that respond to specific frequencies of electromagnetic radiation (light). They are similar to a human retina in that they respond to light and then transmit the information. Unlike the retina that has unevenly space rods and cones for detail and color, CCDs are uniform in their design. The development, improvement and decreased cost of CCDs are responsible for video cameras becoming more inexpensive, accessible and common.
Questionnaire: Here's Lookin' at You, Kids!

Advancements in the field of digital imaging have increased the presence of cameras in our lives, extending our sense of vision, and capturing visual information in time. They are not only used at weddings, birthday parties, and special events, but also for store anti-theft protection and for home and business surveillance. Many people feel that this increased use of cameras is an invasion of privacy and a violation of rights.

Using the questionnaire provided, poll 10 people about their feelings regarding cameras and compile the responses. Be prepared to share your findings in a classroom discussion.

1. What is your gender?
2. What is your age?
3. Does your family own a video camera?
4. Does your family own a computer that is hooked up to the Internet?
5. Does your family own a Webcam?

The following questions should be answered on a scale of 1-5 (1 being strongly disagree (or "no") to 5 being strongly agree (or "yes"); 3 is neutral):

1. I enjoy being filmed.
2. I would use a video camera to film people who did not know they were being filmed.
3. If I were a business owner, I would use surveillance cameras as anti-theft protection in my store.
4. As a customer, knowing there are surveillance cameras filming me changes my actions in the store.
5. I would feel safer if there were surveillance cameras in my home.
6. I agree that schools and buses should have surveillance cameras in use in case of trouble.
7. I feel that video surveillance cameras should be made illegal.

BASIC CAMERA

With the increase in digital image technology, cameras are becoming increasingly present in modern society. When developing and improving cameras, scientists and inventors have used the human eye as a model. Although the basic steps of camera function are similar to the human eye, there are marked differences. In this activity, you will compare and contrast cameras with the human eye, investigating the digital camera's sensitivity to light and color.

GOAL

To discover similarities and differences with the human eye and digital video camera (or Webcam), especially in terms of the camera's sensitivity to light and color.

PROCEDURE

For each step of the procedure, note your observations and findings. Be specific and detailed with your observations, creating appropriate data tables to record and present information.

1. Observe the external parts of the video camera and note similarities to the human eye.

2. One at a time, hold up a colored object to the Webcam (or cam-corder) and record whether the color appears exactly the same on the monitor or whether it appears different (shade, intensity). Test at least 5 brightly colored objects, either provided by your teacher or of your own choosing.

3. Using the color filters or polarizing filter (sunglasses), investigate how color appearance changes in the camera compared to your eyes. Test at least three filters and record your findings.

4. Point the remote control device at the Webcam and push some command buttons. Carefully note what you observe on the monitor. Compare this to your own ability to see the remote control signal.

5. Test several objects as filters for the remote control device by placing the object (such as a piece of black garbage bag) in between the remote control device and the Webcam. Record your findings. Could the remote control beam still be seen through the object or not? Can you see through the object or not?

6. Test the Webcam sensitivity with the flowers. Observe the flower colors carefully with your eyes and also with the camera. Are there any differences in shade or pattern? Try viewing the flower with through the color filters. Record your findings.

QUESTIONS

1. Which part of the camera was the main focus of testing in this experiment?

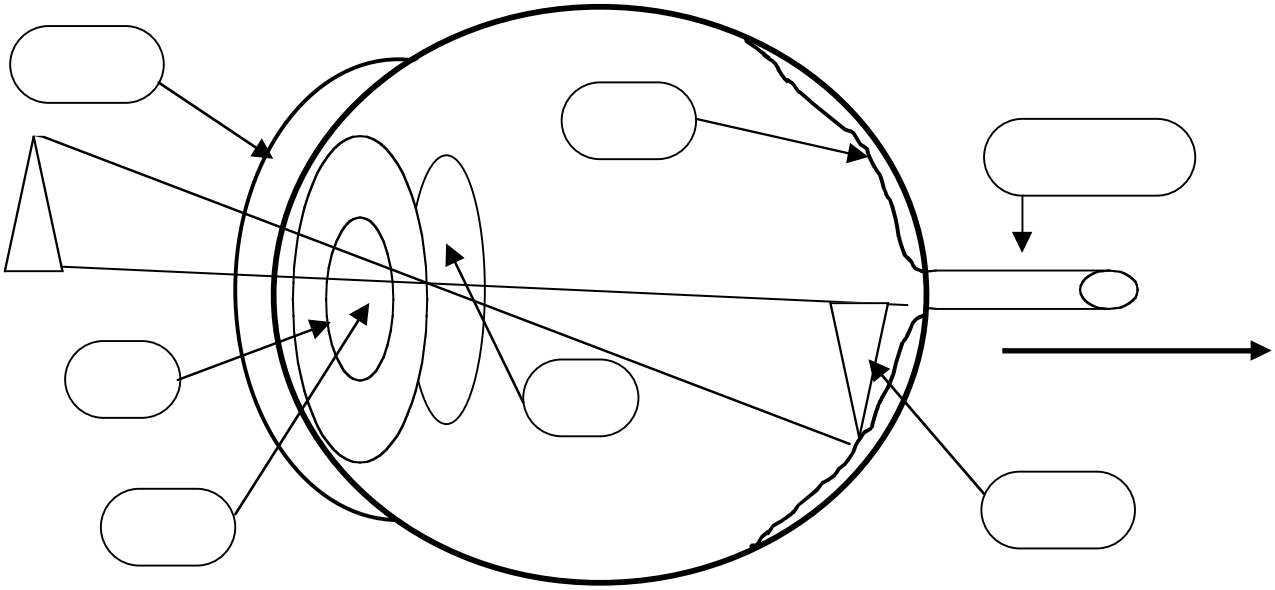
2. What is the human eye counterpart to the camera component you tested?

3. Which part of the whole process of "seeing" is missing from a camera? Why is this important or significant?

4. In a paragraph or data table, compare and contrast the whole process of human vision to camera function. Use previous knowledge and your findings from the activity in your answer.

CAMERA AND EYE DIAGRAMS

Human Eye



Basic Camera