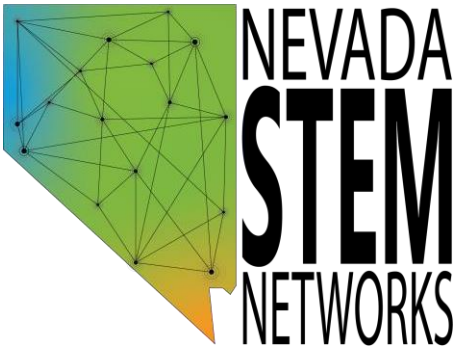
Infrared Camera
&
Shade Structure
Activity Guide



UNLV | Howard R. Hughes College of Engineering

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Image: https://pixabay.com/photos/the-thermal-imaging-camera-3756103/

Infrared Camera & Shade Structure Activity Guide Overview

Introduction:

The Infrared Camera & Shade Structure Activity Guide is to be used with K-2 grade students to teach Physical Science using energy, light waves, and different material properties. These lessons will lead students to use the Engineering Design Process to build structures with certain materials that can keep areas shaded.

Prerequisite:

The Tech Trekker kit will supply an infrared camera and non-consumables such as: different types of fabric, mesh, and screens. In order for students to build their structures using different materials, some ideas for supplies from teachers or schools are: ***straws, popsicle sticks, cardboards, plastic wrap, aluminum foil, parchment paper, construction paper, clay, Play-Doh (or other modeling compound), etc. These items can be used to create different shade structures, and students can test to see if they create significant shade using an infrared camera.***

Recommended Plan:

This UNLV Tech Trekker can visit the school for up to 3 days. It is recommended that the Tech Trekker team comes out on Days 1, 3, and 5 of this unit. The Tech Trekker team is able to come throughout the day on each of these days. This will allow teachers to share the lesson with their entire grade level, so all students can use the infrared camera.

Understanding that all schools teach science during different times and in different ways, it is recommended that teachers stay in contact with the Tech Trekker team to use these resources to best fit their instruction. It is recommended to spend less than 2 weeks on this unit, so that other schools can use this Tech Trekker kit.

It is recommended that students have some sort of science notebook to keep track of their sketches and observations. Grade level writing standards should be implemented throughout all observations. Students can work in partners, small groups, or as a whole group, depending on grade level and class ability.

Acknowledgements: This unit was created by Kim Adams, Michael Steele, and Rebecca Kober, elementary educators in the Clark County School District, with assistance from Dr. Erica Marti and Paul Oko.

NGSS/NVACSS Standards

Kindergarten-PS3 Energy

K-PS3-2. Use tools and materials to design and build a structure that will reduce the warming effect of sunlight on an area.

1st grade-Waves: Light and Sound

1-PS4-3. Plan and conduct an investigation to determine the effect ofplacing objects made with different materials in the path of a beam of light.

2nd grade-Structure and Properties of Matter

2-PS1-2. Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.

K-2.Engineering Design

K-2-ETS1-1. Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

**K-2-ETS1-2. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

K-2-ETS1-3. Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

Science and Engineering Practices

Asking Questions and Defining Problems

K-2- ETS1-1. Asking questions and defining problems in K–2 builds on prior experiences and progresses to simple descriptive questions.

Ask questions based on observations to find more information about the natural and/or designed world.

Define a simple problem that can be solved through the development of a new or improved object or tool.

Developing and Using Models

K-2-ETS1-2. Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or story board) that represent concrete events or design solutions.

Develop a simple model based on evidence to represent a proposed object or tool

Analyzing and Interpreting Data

K-2-ETS1-3. Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.

Analyze data from tests of an object or tool to determine if it works as intended.

Disciplinary Core Ideas

ETS1.A: Defining and Delimiting Engineering Problems

K-2- ETS1-1. A situation that people want to change or create can be approached as a problem to be solved through engineering.

Asking questions, making observations, and gathering information are helpful in thinking about problems.

Before beginning to design a solution, it is important to clearly understand the problem.

ET S1.B: Developing Possible Solutions

K-2-ETS1-2. Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people.

ET S1.C: Optimizing the Design Solution

K-2-ETS1-3. Because there is always more than one possible solution to a problem, it is useful to compare and test designs.

****Crosscutting Concept - Structure and Function**

K-2- ETS1-2. The shape and stability of structures of natural and designed objects are related to their function(s).

****K-2-ETS1-2. The CCC can be used as extension lessons for students as they complete their final model design. Further discussions should include the shape of the model design and how it could be changed, and if the shape would make a difference.

Common Core State Standards Connections: ELA/Literacy

W.K.7 - Participate in shared research and writing projects. (K-PS2-1)

SL.K.3 - Ask and answer questions in order to seek help, get information, or clarify something that is not understood. (K-PS2-2)

Common Core State Standards Connections - Mathematics

K.MD.A.2. - Directly compare two objects with a measurable attribute in common, to see which object has "more of"/"less of" the attribute, and describe the difference. (K-PS3-1), (KPS3-2)

2.MD.D.10. - Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems using information presented in a bar graph. (K-2-ETS1-1), (K-2-ETS1-3), (2-PS1-1), (2-PS1-2)

Infrared Camera & Shade Structure Lesson Guide

	Time	**Summary**	**Focus Question**	**Activity**	**Assessment**
Day 1 Introduction to focus problem and infrared camera technology	35-45 minute session	Students observe the warming effect of the sun through the infrared camera and their senses to identify the problem of overheating on the playground.	How can you reduce the warming effect from sunlight on an area?	Students will observe and contrast the warming effect of the sun on shaded to unshaded areas by recording data from the infrared camera and from peer discussion to interpret meaning.	Science Journal observation
Day 2 Build structures	35-45 minute session	Students will discuss, predict, plan, and build a shade structure.	What materials will work best to reduce the warming effect of sunlight?	Students will discuss, plan, and build structures to test different materials.	Science journal prediction and diagram
Day 3 Test structures	35-45 minute session	Students will test their structures using the infrared camera outside.	Which materials worked best to reduce the warming effect of sunlight?	Students will complete the testing and outcomes	Check of focus questioning and student observation
Day 4 **Improve design, gallery walk**	35-45 minute session	Students will walk through to see their peers' designs. They will then improve their designs.	How can you improve your structure design?	After looking at the results and reflecting on their own designs, students will improve their structures by changing material attributes.	Science journal entry: I claim that I can improve my structure design by _____. This will work because_____.

Day 5 **Test revised design**	35-45 minute session	Students will test their improved structures using the infrared camera outside.	How did you improve your design and how did it work?	After making design structure revisions, students test and contrast data from infrared cameras.	Science journal entry: I improved my design by _____. We can reduce the warming effect of the sun by _____. This works because _____.

Day 1 - Introduction to Focus Problem and Infrared Camera Technology

Standards (NGSS/NVACSS):

K-2.Engineering Design

K-2-ETS1-1. Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

Objectives:

- Students will observe and record the infrared sensor readings of a shaded and an unshaded area.

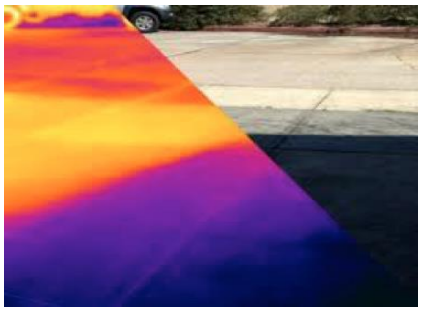


IMAGE: RHETT ALLAIN https://www.wired.com/2014/04/the-world-looks-different-when-you-see- in-infrared/
This is a composite image showing both a visible light image and an infrared camera image. Notice that the part of the sidewalk in the shade is much cooler than the part in the sunlight. If you look closely, you can see that part of the shadow near the sunny part is also warm. This is because the shadow just moved over that part and it hasn't cooled off yet.

Vocabulary:

Infrared Camera
Temperature
Observation
Warming Effect
Reduce
Area
Sensor
Material
Shaded
Unshaded
Infrared Wave
Electromagnetic Spectrum

Materials:

Provided by Tech Trekkers:	**Provided by teacher:**
Infrared Camera and monitor	Science journal

	Crayons Projector Shaded and unshaded areas outside

Focus Question:

How can you reduce the warming effect of sunlight on an area?

Procedures:

1. As a whole group, take students outside to lead an activity and discussion on playing outside in the sun vs. playing in the shaded play area. Tell students to stand in an unshaded area. Next, have students move to a shaded area. Partners will discuss the following **phenomena**: What did you feel in the shaded area vs. the unshaded area? Why do you think there is a difference between playing in the shade vs. in the sun? Identify the problem with playing in the sun and the benefits of playing in the shade.
2. After discussion, students will watch a demonstration of the infrared camera. Have students touch an area in the sun and show the area using the infrared camera (save still image). Next, have students touch an area in the shade and show the area using the infrared camera (save still image). Students will turn and talk: I observe that the infrared image of the area in the shade is_____, but the infrared image of the area in the sun is_____.
3. Take students to a shaded area (if possible), or to the classroom to record their observations of the phenomena from the still images in their science journals. Students will color the shaded and unshaded infrared images. Project the still images, then have students (based on grade) record their responses from the sentence stem (step 2), or use adjectives to describe the unshaded and shaded images (hot, cool, warm, etc.)
4. Lead a discussion to interpret the meaning of what the different colors represent. Check for understanding as partners discuss (Why are the colors different?).
5. Select a few students to share out their observations.

Teacher note/resources:

The brighter colors (red, orange, yellow) indicate hotter or warmer temperatures meaning more heat and infrared radiation is emitted. The darker colors (green, blue, purple, and sometimes black) indicate cooler temperatures meaning less heat and infrared radiation is emitted.

https://www.flir.com/discovered/rd-science/how-do-thermal-cameras-work/
https://www.howtogeek.com/294076/how-does-thermal-inaging-work/
https://electronics.howstuffworks.com/gadgets/high-tech-gadgets/nightvision2.htm

Assessment:

- Students will answer the focus question independently in their science journals. Use the attached rubric to assist with grading.

Day 2 - Build Structure

Standards (NGSS/NVACSS):

K-PS3-2. Use tools and materials to design and build a structure that will reduce the warming effect of sunlight on an area.

1-PS4-3. Plan and conduct an investigation to determine the effect of placing objects made with different materials in the path of a beam of light.

K-2-ETS1-2. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

Objectives:

- Students will use information from the infrared camera to develop structures using different materials to best reduce the warming effect of sunlight on the area.
- Students will use the Engineering Design Process** to sketch and plan their structures.
- Students will plan their investigations and build structures to determine which materials are best at reducing the warming effect of sunlight on an area.

****Teacher links to information on the engineering process:**
https://pbskids.org/designsquad/parentseducators/workshop/process.html
https://www.eie.org/overview/engineering-design-process
https://stemactivitiesforkids.com/2016/02/25/690/
https://start-engineering.com/start-engineering-now/2019/4/3/8-great-videos-to-teach-the-engineering-design-process

Vocabulary:

Infrared Camera
Temperature
Observation
Warming Effect
Reduce
Area
Sensor
Material
Shaded
Unshaded
Structure
Compare
Brainstorm

Design
Test
Redesign
Problem
Solution

Materials:

Provided by Tech Trekkers:	**Provided by teacher:**
Infrared camera - recommended on days 1, 3, and 5 Different types of fabric, mesh, screens	Straws/popsicle sticks Clay/Play-Doh Materials to build their shade structure (see examples below) such as: aluminum foil, parchment paper, plastic wrap, cardboard, mesh, etc. Science journals

Focus Question:

What materials will work best to reduce the warming effect of sunlight?

Procedures:

1. Class will review vocabulary and previous lesson with the infrared camera.
2. Class will discuss findings of the infrared camera and discuss the **problem** that comes with building a shade structure that cools an area.
3. Class will discuss what materials have been used to build the school and the playground shade structure, and why they may have been chosen.
4. Students will make predictions about which material they think will work the best for keeping the area under the shade structure cooler.
5. Students will **brainstorm**, plan, **design**, and sketch their structures with their partners.
6. **Students will have time to **build** their shade structures.

**Teachers should use their own discretion as to the number of students who work together to build their structures. This could also be a whole group, teacher-led structure building lesson depending on student ability.

Assessment:

- Students sketch and record predictions in their science notebooks. See attached rubric on page 22.

pascettisteel.com

klenepipe.com

thesunshadecompany.com

Day 3 - Test Structure Models

Standards (NGSS/NVACSS):

K-2-ETS1-2. Developing and Using Models

Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or story board) that represent concrete events or design solutions.

Develop a simple model based on evidence to represent a proposed object or tool.

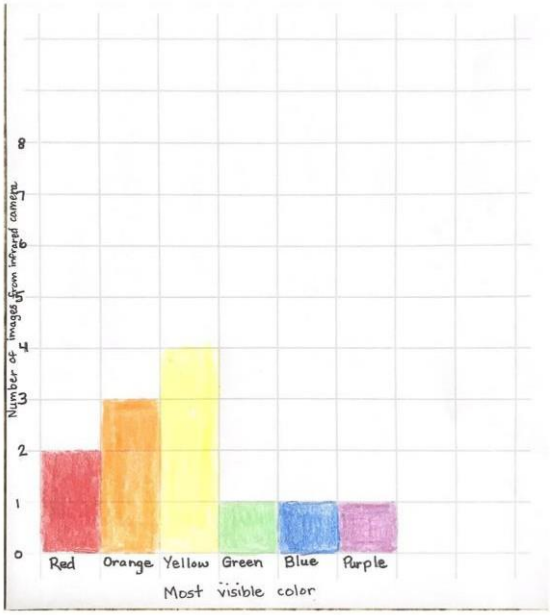
K-2-ETS1-3. Analyzing and Interpreting Data

Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.

Analyze data from tests of an object or tool to determine if it works as intended.

Objectives:

- Students will test their structure for efficiency in reducing the warming effect of sunlight.
- Students will observe infrared camera still images from their structure and record information/data in their science journals based on the ability of their structure to reduce the warming effect of sunlight.
- Students/teacher will complete a whole group graph to illustrate the color and temperature results of all structures.



See example of a graph to the left. This graph is based on a class of 24 students working in pairs. Temperatures could be added to the x-axis (most visible color) depending on the capability of the infrared camera being used. Title should be added and done as students learn about creating graphs. Graphs can change as grade level increases. **Graph should be based on grade level standards for graphing and interpreting data.**

Image:

Vocabulary:

Infrared Camera
Temperature
Observation
Warming Effect
Reduce
Area
Sensor
Material
Shaded
Unshaded
Structure
Compare
Brainstorm
Design
Test
Redesign
Problem
Solution

Materials:

Provided by Tech Trekkers:	**Provided by teacher:**
Infrared camera - recommended on days 1, 3, and 5 Different types of fabric, mesh, screens	Student structure models Crayons/pencils Graphing papers if students are replicating whole group graph Science journals

Focus Question:

What did you learn from testing your structure model?

Procedure:

1. Students will take their structures outside to a particular area in the sun.
2. All students will set their structures up so the infrared camera can get images of all the structures. Be sure to adjust the camera so it is pointed at the surface under the shade structure in order to get an accurate image of the cooling effect.
3. In the classroom, on a projector, the students will observe images of their structures and record information in science journals.
4. Students/teacher will complete a whole group graph recording results (see graph example above). Using the thermal imaging capabilities of your infrared camera, you can make the graph using colors and/or temperatures (as shown in the example below).

Assessment:

- Based on science journal recordings. See attached rubric on page 22.

Day 4 - Structure Improvements and Peer Review

Standards (NGSS/NVACSS):

K-2-ETS1-2. Developing and Using Models

Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or story board) that represent concrete events or design solutions.

Develop a simple model based on evidence to represent a proposed object or tool.

K-2-ETS1-3. Analyzing and Interpreting Data

Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.

Analyze data from tests of an object or tool to determine if it works as intended.

Objectives:

- Students will discover ways to improve their design after viewing their peers' designs.
- Students will continue using the Engineering Design Process by sharing what worked and didn't work, and deciding how to improve designs.

Vocabulary:

Infrared Camera
Temperature
Observation
Warming Effect
Reduce
Area
Sensor
Material
Shaded
Unshaded
Structure
Compare
Brainstorm
Design
Test
Redesign
Problem
Solution

Materials

Provided by Tech Trekkers:	**Provided by teacher:**
Infrared camera - recommended on days 1, 3, and 5 Different types of fabric, mesh, screens	Straws/popsicle sticks Clay/Play-Doh Materials to build their shade structure such as: foil, parchment paper, plastic wrap, etc. Science journals

Focus Question

How can you improve your design?

Procedure

1. Students will review previous lessons, and review graphs and data collected from the investigation.
2. Students will conduct a gallery walk to observe other teams' structures. Class can come together to discuss what observations were made during the gallery walk. Teacher will lead class discussion regarding how structures are similar and different, and discuss ideas with students concerning size, height/length, shape and materials. Teacher should allow students to make suggestions for design improvements, and compile a whole group list of ideas for students to refer to. Students will discuss which design worked best to keep the area under the shade structure coolest and why?
3. Students will improve their designs and be given the opportunity to test them in the following lesson. Students can refer to their previous sketches and the infrared photos taken to assist in design improvements.

Assessment

- Science journal entry: I claim that I can improve my structure design by _____. This will work because_____. See attached rubric on page 22.
- Possible assessment for older students: a science journal entry reviewing if their predictions were correct or not. See attached rubric on page 22.

Day 5 - Test Improvements

Standards (NGSS/NVACSS):

K-2-ETS1-2. Developing and Using Models

Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or story board) that represent concrete events or design solutions.

Develop a simple model based on evidence to represent a proposed object or tool.

K-2-ETS1-3. Analyzing and Interpreting Data

Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.

Analyze data from tests of an object or tool to determine if it works as intended.

Objectives:

- Students will test their improved designs using the infrared camera.
- Students will give reasons to support their claims about how to reduce the warming effects of different areas.

Vocabulary:

Infrared Camera
Temperature
Observation
Warming Effect
Reduce
Area
Sensor
Material
Shaded
Unshaded
Structure
Compare
Brainstorm
Design
Test
Redesign
Problem
Solution
Claim
Reason

Materials

Provided by Tech Trekkers:	**Provided by teacher:**
Infrared camera - recommended on days 1, 3, and 5 Different types of fabric, mesh, screens	Straws/popsicle sticks Clay/Play-Doh Materials to build their shade structure such as: foil, parchment paper, plastic wrap, etc. Science journals

Focus Questions

How did you change your design? Did it work to make the area under the structure cooler? Explain how you know it worked better.

Procedure

1. Students will be given an opportunity to retest their improved designs using the infrared camera outside. Time may be needed to allow the shaded area to cool before testing. During this time hold discussions about differences in the structures, predictions, or notebook observations. Review the vocabulary words they have learned throughout the unit.
2. Students will record their findings in their science journals.
3. Students will complete the assessment for the lesson and the unit.

Assessment

- Science journal entry: I improved my design by_____. We can reduce the warming effect of the sun by_____. This works because _____. These sentence starters can be printed for students to glue in their journals to complete.
- Bring the unit full circle to answer the original focus question and phenomena: How can you reduce the warming effect from sunlight on an area? Why does this work?

Extensions

1. Collaborate with the art specialist to have lessons on cool and warm colors.
2. Use a 3D printer to print different color/shape structure covers based on a discussion of design changes.
3. Print the pictures from the infrared camera images of the whole class for each student to keep.
4. Conduct further discussion/investigation concerning which structure would allow ice to melt the slowest.
5. Conduct further discussion/investigation on colors of clothing and if/why they make a difference when playing in the sun.
6. Use Legos to have students build structures that focus on stability, strength, and purpose.

Additional Resources:

1. https://science.nasa.gov/ems/07_infraredwaves

2. https://www.sciencedaily.com/releases/2015/11/151111172514.htm For background information -This is an article about a study of hot playground temperatures.
3. https://mysteryscience.com/watching/mystery-5/sunlight-warming-engineering/129
4. https://www.newschannel10.com/story/38537570/sun-makes-playground-equipment-too-hot-to-handle/ For background information - This news report interviews children about the hot temperatures on a playground. It could be used as part of the phenomena starter at the beginning of this unit.

Science Journal Entries Rubric

Content and Organization	Developing Skills	Meets Standards	Exceeds Standards
I stated my claim.	1	2	3
I gave a reason for my claim, using the word "because" to show my reasoning.	1	2	3
I stayed focused on the task.	1	2	3
I drew a picture to support my claim and reasoning.	1	2	3

**Based on students' ability, this rubric can be adjusted for whole group or partner participation. Some students may need more support than others, based on ability and grade level.