Lesson 1.4 - Smart Lighting Systems

Overview

During this lesson, students will gain understanding of how smart lighting works in the context of an energy efficient city grid. Students will integrate and exhibit learning by replicating components of a smart lighting system.

Key Information

Level 1: (Ages 8-9) US Grades 2 or 3

Time: 45/90 minutes

Warm-Up	5 minutes
Mini-lesson	10 minutes
Worked Example	7 minutes
Challenge 1	7 minutes
Challenge 1 - Debug	5 minutes
Challenge 2	7 minutes
Tidy Up / Exit Ticket	4 minutes

Lesson Topics

- **Science**
  - Light and shadows
- **Design and Technology**
  - Analysing problems, designing solutions, multiple solutions to a problem, sketching and design
  - Design purposeful, functional, appealing products for themselves and other users based on design criteria
- **Math**
  - The logical notion of Boolean states (on/off)
- **Computing**
  - Boolean states (true/false)

Learning Objectives

- ***As a result of this lesson, students will be able to***
  - Describe the purpose and basic function of smart grids including real world examples and applications
  - Replicate a smart lighting system
  - Describe what makes a smart lighting system *smart*
  - Conduct basic scientific investigation into a topic

Materials

- SAM Labs Kit
- SAM Labs Student Workbook

Warm Up – Scientific Investigation — 5 minutes

What is a smart grid?

Objective: Students investigate smart city grids and their benefits.

Procedures: In small teams, students identify what they know and what they want to know on the topic of smart grids. Students may want to know real world examples, facts and or the benefits/downsides of smart grids. Recording the information in the second column, students use it to guide internet searching or to identify useful texts (in the classroom/library). Students complete the final column with the information they learned while researching. To guide students' research, the teacher can provide the class with inquiry questions in column 2. All information is recorded in a **K-W-L** chart in student workbooks or as a whole class when students share. Students share group findings to close out the warm-up.

What do you **K**now about the topic?	What do you **W**ant to know?	What did you **L**earn?

Link forward: The teacher identifies electricity, specifically lighting, as an important feature of a 'smart' city grid. The teacher refocuses learning to lighting within smart city grids.

Mini-lesson — 10 minutes

What is smart lighting? What makes it 'smart'?

Objective: Students learn about smart lighting grids and what makes them energy efficient.

Procedures: With a focus on smart lighting grids, the teacher reiterates key learning from the warm-up. The teacher looks to establish the importance of electricity to our lives. The teacher might say something like: *how is electricity used in this classroom, in your home, in our city?* The teacher then compares a smart lighting system with a typical lighting system (used in some classrooms, homes and cities). Through the example, the teacher mentions three important facts about smart lighting: 1) smart lighting is *smart* because it is designed to be energy efficient; 2) the use of automatic light dimming and; 3) daylight and occupancy sensors reduce energy consumption.

At the end of the mini-lesson, students match or define keywords in their workbooks.
(2 minutes)

Sample photo ideas: Light sensor, occupancy sensor, solar-powered light.

Keywords

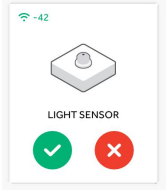
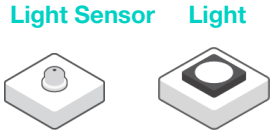
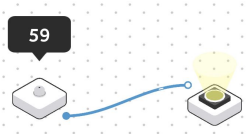
- Grid
- Electricity
- Dim
- Sensor
- Efficient
- Consumption

Let's Discuss: *What is a key difference between smart lighting and regular lighting systems? In your workbook or with a partner, record, discuss, or share one example of how smart lighting reduces energy consumption.*

Link forward: The teacher prepares students to recreate two features of smart lighting, light dimming and occupancy sensors. (*If you have taught 'Design a Habitat' previously, there is a nice link between the lighting system students designed for their sea turtle habitats and this lesson*)

Worked Example — 7 minutes

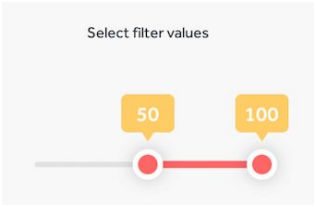
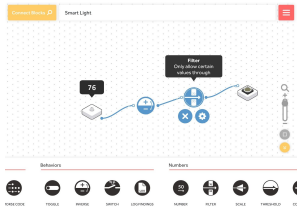
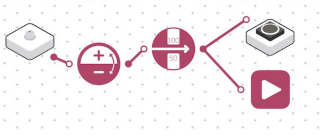
Design a smart light system that responds to the amount of light in the environment

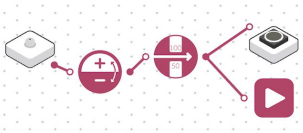
Instructions	Workspace	Notes for Teachers
Step 1. Turn on and pair: • 1 Light Sensor block • 1 RGB LED block		*Teacher says, "One of the things we learned about smart lights is that they often have sensors which respond to the amount of light in the environment. This is exactly like our Light Sensor."*
Step 2. Drag the Light Sensor and RGB LED blocks onto the canvas.		*Teacher says, "Notice the number (48) above the Light Sensor. This is the value of the light in the room. The Light Sensor spans 1-100; 1 is very dim and 100 is very bright. The Light Sensor can also act like a button… what do you think the difference is between how a button and a sensor function?"*
Step 3. Connect the Light Sensor and RGB LED blocks		
Step 4. Put one or two fingers over the Light Sensor. *This should dim the RGB LED slightly.*		*Teacher says, "When the light value changes, the RGB LED responds by dimming… hmmm. We want the light to increase as the light value decreases. Equally, we want the light to decrease as the light value increases. This means it is responding to the light in the environment."*

Step 5. Put your entire palm over the Light Sensor and cover it completely. *This should turn the RGB LED off.*		*Teacher says, "If we cover the Light Sensor completely, further decreasing the light value, the light turns off completely… that means if it's dark out, the light won't come on! We need the opposite to happen… How can we fix it? Can you scroll through the Toolbox and identify a block that might help… Any ideas?"*
Step 6. Find the Inverse function from the Toolbox and add it between the Light Sensor and RGB LED.		*Teacher says. "Locate the Inverse function in the Toolbox. What does Inverse mean? (Inverse means opposite in position, direction, order, or effect). What happens after we add the Inverse function? What's different?"*

Challenge 1 — 7 minutes

Design a smart lighting system that has an occupancy sensor and an alert

Instructions	Workspace	Notes for Teachers
Step 1. Find the Filter function from the Toolbox and add it between the Inverse and RGB LED.		*Teacher says, "We already have the Inverse function which allows the light to turn on if it's dark (light value is high) and off if it's light (light value is low). Let's add the Filter function which means the light will turn on and off based on a certain set of values."*
Step 2. Open the Settings icon on the Filter function and set the filter values to 50-100.		*Teacher says, "Let's set the values to 50-100 (You may have to adjust the values based on the amount of light in the classroom). This means if the light value is within this range, the light will be off. If the light value is lower than 50, it will turn off. Now occupancy sensors detect motion in the space. They way they do this is through body heat sensors called passive infrared sensors."*
Step 3. Very slowly, bring your hand closer and farther away from the Light Sensor.		*Teacher says, "Let's see if our mock occupancy sensor works... We'll know it works if when we get closer to the light it turns on and when we move farther away it turns off. "*
Step 4. Let's add an alert.		*Teacher says, "Let's add an alert to our system. Find the Sound Player and add it to the Filter function."*
Step 5. Open the Settings icon on the Sound Player and choose a sound for your alert.		*Teacher says, " Choose a sound for your alert."*

Step 6. Try it! Does the Sound Player play?		*Teacher says, "Give it a try… Does the alert sound? (Teacher should anticipate this won't work… The teacher can elicit solutions from the class) Let's debug it. What could be going wrong?*

Checks for understanding: *In what way does our system replicate an occupancy sensor? Why is an occupancy sensor 'smart'?*

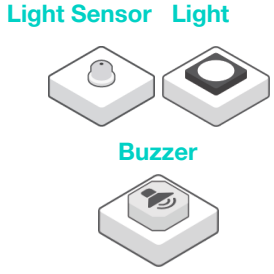
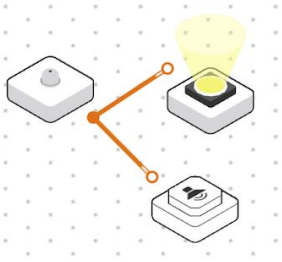
Challenge 1 - Debug it — 5 minutes

Why isn't the Sound Player working?

Instructions	Workspace	Notes for Teachers
Step 1. Find the Toggle function and add it between the Filter and Sound Player function.		*Teacher says, "The reason the Sound Player isn't working is because it needs to be turned on. It's not turned on automatically by the Filter function because the Sound Player respond to Boolean True or False... Let's find the Toggle function from the Toolbox and add it. "*
Step 2. Try it!		*Teacher says, "When the value of the Light Sensor is '0' it will turn on the RGB LED and sound the alert. Can you think of another way to achieve the same result?"*

Challenge 2 — 7 minutes

Design a smart lighting system that responds to the amount of light in the environment, has a mock occupancy sensor and a alert.

Instructions	Workspace	Notes for Teachers
Step 1. Drag the Light Sensor block, RGB LED block and Sleeping Buzzer onto the Workspace.		*Teacher says, "Which of these blocks are inputs and outputs… how do you know? We are going to explore another way to create a smart lighting system that dims automatically, has a mock occupancy sensor and an alert which could be useful if we wanted to know if someone was in the classroom when they shouldn't be."*
Step 2. Connect the RGB LED and the Buzzer to the Light Sensor.		*Teacher says, "Okay, notice here that the RGB LED is the only output affected by the value of the Light Sensor. Why is that? (It's because, in this system, the Buzzer respond to Boolean true / false not the 0-100 values of a Light Sensor). How can we make a system that turns on the RGB LED and sounds the Buzzer when someone is near?"*

Step 3. Find the Filter function and add it to the between the Light Sensor, RGB LED and Buzzer. Set the filter values to 0-30.		*(The filter values may need to be adjusted depending on the amount of light in the classroom.) Teacher says, "Adding the Filter function will turn the RGB LED on but not the Buzzer… do you remember why? What block could we add to turn on the Buzzer?"*
Step 4. Find the On/Off block and add it between the Filter and Buzzer.		*Teacher says, "Let's try the On/Off block. This turns sensors into buttons. That's helpful to know when we are connecting to outputs (like Buzzer/Sound Player) that respond to Boolean true/false."*
Step 5. Now, try it! *(Replace the Buzzer with Sound Player to see if they work interchangeably.)*		*Teacher says, "Let's try the system… Does it work? Can you turn to a partner and explain each step of the system? For example, first, the Light Sensor detects the amount of light in the environment… then, the data is conveyed through the Filter function which says only values between 0-30 will turn the system on..."*
Extension Ideas: • Can you find another way to sound an alarm? • Can you add 2 DC motors to the system, as if to power a machine (like an air conditioner or heater) when the system turns on? • Can you build a lighting system that is solar-powered?		

Checks for understanding: *What does the On/Off block do? In this system, why do we need Toggle to turn on the Buzzer or Sound Player?*

Tidy Up / Exit Ticket: 4 minutes

Reinforcing the learning objectives of the lesson, students can reflect on key takeaways by completing and submitting an exit ticket.