**Unlocking Possibilities with Circuits and Code**

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**Unit Summary**

Computers and electronic devices touch virtually every aspect of our lives. This unit opens young students’ eyes to limitless possibilities unlocked by circuits and computer programs with a fun, engaging introduction to the fundamentals of computing, programming, and electronic design. Using the Intel® Galileo board, and by creating some very simple programs and circuits, students light up LEDs and create an operating traffic light.

**At a Glance**

* Grade: 3-5, 6-8
* Subjects: Science, Technology & Engineering, Visual Arts
* Topics: Computers, Electronics
* Higher-Order Thinking Skills: Analysis, Experimental Inquiry
* Key Learnings: Types and uses of electronic components
* Content Type: Unit Plan
* Time Needed: 1-2 hours
* Prerequisites: No prior knowledge or experience is necessary to complete the activities
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**Learning Outcomes**

* Students gain a hands-on understanding of what a computer is and how it works
* Students gain an appreciation for how engineers and computer scientists can create useful products by designing circuits and programs

**Things You Need**

* The Intel® Galileo board
* The Galileo’s power cable
* A USB cable
* An collection of LEDs: Red, Yellow, Green, and RGB
* A PC (with the Galileo IDE and ArduBlock)

**Standards Alignment**

This unit is aligned to Common Core National and Next Generation Science Standards.

* Engineering Design: define design problem, generate solutions, carry out tests and analyze resulting data
  + 3-5-ETS1-1, 3-5-ETS1-2, 3-5-ETS1-3
  + MS-ETS1-1, MS-ETS1-2, MS-ETS1-3, MS-ETS1-4
* ELA/Literacy: conduct short research projects, build knowledge through investigation
  + W.5.7
  + WHST.6-8..7
* Mathematics: operations and algebraic thinking; reason abstractly and quantitatively
  + 3.0A
  + MP.2

**Curriculum Framing Questions**

* **Essential Question**Why is technology important?
* **Unit Question**What do engineers do?  
  What do computer scientists do?

How do they use science in their jobs?

* **Content Questions**What is a computer?  
  What is a computer program?How do electronic devices “think”?

**Assessment Processes**

The opening discussion around the framing questions helps teachers assess what students may already know about computers, electronics, engineering, and computer science. During the activity, teachers may take notes with structured observations of students work habits, ideas, communication, and cooperation skills. Following the activity, teachers may use the wrap-up discussion as a final assessment of the unit.

**Instructional Procedures**

**Set the Stage**

Ask students the Essential Question. *Why is technology important?* Elicit student responses and engage in discussion about the benefits of technology in diverse scenarios of our daily lives.

Pose the Unit Questions. *What do engineers do? What do computer scientists do? How do they use science in their jobs?* Begin a class discussion about the importance of engineering and creating products that solve problems and help people.

Pose the Content Questions: *What is a computer? What is a computer program? How do electronic devices think?* Post a chart of the key concepts discussed. Explain to students that they will continue to examine and answer these questions in the activity.

**Introduce the Key Concepts**

Prior to beginning the activity, give the presentation, Galileo Workshop K10. It’s an engaging, interactive presentation, so be sure to have fun with it.

When introducing the Intel Galileo (on slide 4), extract the board and let the children touch it. Explain to them that this is a computer… but there’s no keyboard! Explain that a keyboard, a screen, and a mouse are not mandatory, they’re just an interface with a human. Computers can think, perform tasks, or communicate with other computers – all without having these things.

Put everything out on the table for the children to see: the Galileo board, the LED, the power cable, the USB cable, and the PC (with Galileo IDE and ArduBlock). Then walk them through how you connect it together before completing the presentation and demo of the LED example.

**Step 1**

Introduce the concepts of polarity, voltage levels (high = +5 volts, ground = 0 volts). Then ask one child to explain to you and the class how to redo the blinking LED example, but on a different pin. Have the child perform the modifications while you oversee and ensure no short circuits.

**Step 2**

Ask another student to explain a plan for how they would change the delay between blinks to one second on, half a second off. Allow them to make the changes.

**Step 3**

Have the class figure out how they would add one (or two) more LEDs and have them alternate blinking. Have a student try the suggested approach to see whether it works. Continue until the class gets it working.

**Step 4**

Tell the class you’re giving them a real engineering project: they have to design a traffic light. It must use three LEDs (one green, one yellow, one red). It must have different delays to allow the traffic to flow properly. The students must use step-by-step analysis to realize the traffic light.

**Step 5**

Have the class play with the RGB LED. Help them connect it to the PWM pins and play with the program to fade the different colors with different timings and watch the nice colors.

**Conclude the Lesson**

Lead the class in a discussion about what other things you can do with lights. What useful things could you make if you had sensors (like a microphone) and LEDs? A thermometer and LEDs?

Finally, lead debriefing session that revisits the Unit Questions. Then, as a final discussion topic, pose the Essential Question: *Why is technology important?*

**Differential Instruction**

**Resource Student**

* Allow more time as needed.

**Gifted Student**

* Have students research Ohm’s Law, and discuss its relevance to the activities.
* Challenge students to think of ways they could take the traffic light activity and turn it into a game. Have them create the ArduBlock program to create the game.

**English Language Learner**

* Pair the student with a peer in groups
* Allow more time on the visuals in the presentations
* Provide the student with Internet access and relevant sites in the student’s first language beforehand

Attachment: Accompanying presentation - UnlockingPossibilities.PDF