5E STEM Unit Digital Logic Gates

2-3 Weeks

Authors

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SUBJECT/GRADE LEVEL

Subject Area: Science, Career Innovations, STEM
Focus: Digital Logic
Grade Level: High School

Materials

- (attached) teacher pay teachers ; Informational technology career activities set
- Laptops for each student with internet
- Headphones for each student
- Student Handouts
- Slide Presentation

STANDARDS

Next Generation Science Standards

- HS-ETS 1- 2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
- HS- ETS 1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

Mathematics Standards | Common Core State Standards

- 5.NBT.2 Explain patterns in the number of zeros of the product when multiplying a number by powers of 10, and explain patterns in the placement of the decimal point when a decimal is multiplied or divided by a power of 10. Use whole-number exponents to denote powers of 10.

English Language Arts Standards | Common Core State

- Integrate and evaluate content presented in diverse media and formats.
- Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations.

Career Innovations

- CCP.23 Design, develop, and present computational artifacts such as mobile applications that

address social problems both independently and collaboratively.
- 12.03 Express an understanding of basic terminology used in programming (e.g., algorithm, binary, code, block-based, objects, functions)

LESSON OBJECTIVE(S)

Students will utilize digital logic to solve problems from a list of scenarios.
Students will gain a useful initial acquaintance with the basis of binary numbers, and by inference how computers work.
Students will make a connection between digital logic and career pathways.
Students will develop programs that respond to input and create dance animations with code.

CAREER CONNECTION(S)

Mentor Background: Dr. Oluseyi (Seyi) Ayorinde, Electrical Engineer, is the team lead for the Silicon Technologies team at the DEVCOM Army Research Lab. He is currently working out of the west coast office in Playa Vista. He received his PhD in Electrical Engineering from the University of Virginia, where he explored generating and configuring custom, sub-threshold FPGA hardware, as well as designing accelerators for ultra-low power Systems-on-Chip (SoCs). He is currently focusing on development of low-power digital circuits for various applications. Dr. Ayorinde has taped out 8 chips, three of which were specifically designed to accelerate AI/ML algorithms for edge processing. Dr. Ayorinde has also been called on as a subject matter expert for numerous DARPA Microsystems Technology Office (MTO) programs focused on integrated circuit design. His research interests include Machine Learning Acceleration, Digital ASIC design, and Low-Power FPGA hardware design
https://www.seyiayorinde.com/bio

STEM Careers:

Digital logic is a common part of electrical engineering and design courses.
Digital electronics use binary strings of 0 and 1 to send signals through a system. Some examples of digital electronics include mobile phones, computers, sound systems and consumer electronics. A wealth of career options exists working with such systems. Some job titles in this field include sound engineering technician, engineering technician or electronic home entertainment equipment installer and repairer.

ENGAGEMENT

Student Handout **Slide Deck**

Brief Description: This activity engages student's prior knowledge with digital logic gates with images and a notice and wonder chart. This lays the foundation for the lesson with the scenario of the mystical bank heist hacking. This portion is approx 20 mins

Procedures:

Students are introduced to the phenomenon of logic gates with the Bank Heist scenario. They are given the initial prompt (with details of the heist--give them this first) and images of binary code, a truth table, and logic gates (give them these separately after the prompt). The logic gates are some basic examples

to introduce the topic and they will learn more complex ones as the lesson progresses. Have students complete the notice and wonder chart in the handout. There are guiding questions listed below to help with students who need additional prompting and ELL students.

Scenario

The Bank of Rivendell has received a heist demand! They are being hacked and if they do not hand over 600 million gold coins and a second breakfast the Shire will be turned into swampland and no longer habitable. The bank manager has determined where the hack is and desperately needs your assistance with thwarting the hackers by using your hacking skills…..Can you out hack the hackers????

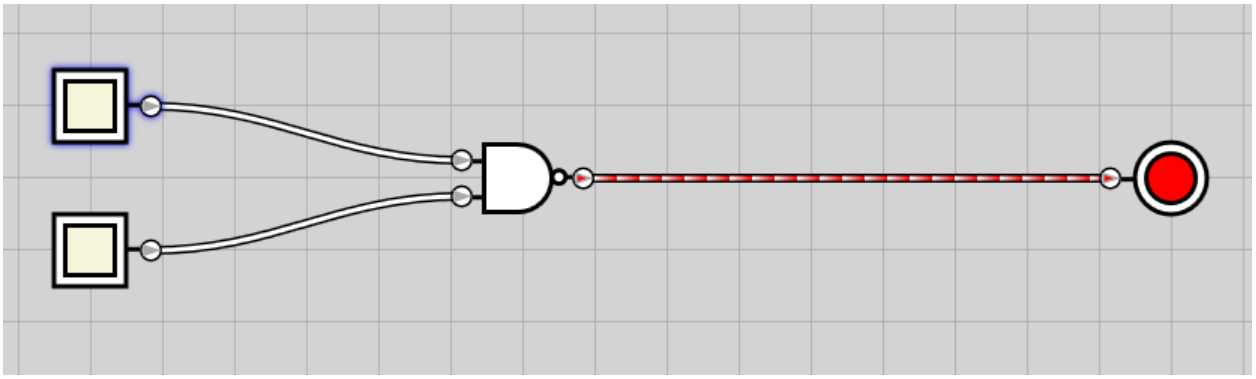
Binary Code that was found

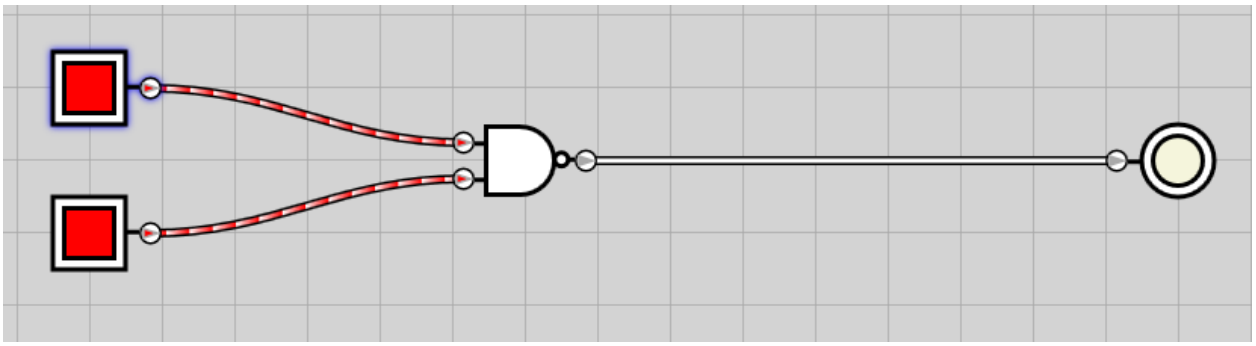
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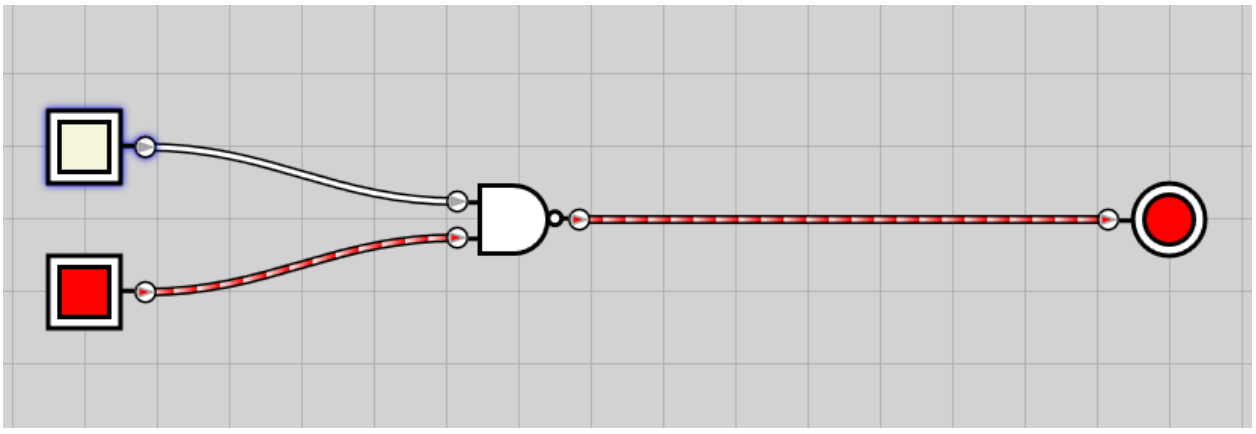
Truth Table

A	B	C
0	0	1
0	1	1
1	0	1
1	1	0

Images







Have students complete a notice and wonder chart based on the three pieces of information given.

Allow for small group discussion and then whole group discussion about what they notice and wonder about. Use the guiding questions or elbow partner if needed (this is a good modification for ELL students).

Guiding questions

1. Where have you heard the term binary before?
    a. What does it usually relate to?
2. What does a truth table look like to you?
3. Where have you seen images similar to these before?
    a. Think back to previous classes or lessons

Lead the class with “We need to stop the hackers, but we need to learn more about these images and ideas to do so. Are you up to the challenge? Let’s learn how to out hack the hackers with digital logic gates!”

EXPLORATION

Brief Description:

1. Video that discusses the introduction to digital logic and circuits. They will take notes to share with a neighbor to get a better understanding of digital logic or review what they may already know.

   Introduction to Digital Logic

2. Video explaining some career options that deal with digital logic. They will watch the video career video then watch the "hour of code" video then play around with "the hour of dance" activity to learn more about how they can use digital logic to design a dance. One site has a lesson plan in itself for dance hour/hour of code and the dance party has levels of building code to advance for a dance party.
   Digital Logic Design Careers
   Hour of Code Is Here
   Dance Party - Full Activity
   Hour of Code - Dance Party

3. Extra practice on coding Blockly Games

Procedures:

1. Students will watch the video link above by the #1. They will take notes throughout the video then when time is called by the teacher, they will turn to a neighbor and discuss what they learned/experiences/found out new/already knew/interesting aspects, etc.
   Time frame would be approximately 20 to 45 mins. Video is 12:50 minutes, time to stop the video to take notes, then time for each to discuss findings.

2. Students will watch the video link about digital design careers, link beside the first #2 link, to get an understanding of the types of jobs possible. They will then watch the video, 'the hour of code" introduction, second #2 link. The teacher can follow the procedures from the third #2 link which has them discussing coding, practicing coding and then starting designing/coding their dance then carry it out/show their work. The fourth #2 link has more practice of coding if they need to practice with it before coding and sharing their final dance party. (approx. 45-60 mins.)

Link to to use filter music for dance party if you need: Spotify Playlist (all ages).

EXPLANATION

Brief Description:

Moore's law will be researched and discussed by watching a video and brainstorming driving questions of what Moore's law is and how it is driving technology.

Hour of Code/dance Party activity/lesson will give students interactive experience to practice code building and to carry out dance move animation video to share with their classmates.

Procedures:
The class will watch this short video about Moore's Law: What is Moore's Law?

Driving Question Board-Students will be asked what questions this law evokes? We will make a list of 4-6 questions and then students will work alone or with a partner to see what other information they can find on Moore's Law that might help to answer their questions.

We will come back together as a group to discuss our findings.

Dance Party Code - Code.org Dance Party

The students will click on create at the top right of page and scroll to click on Dance party. They can change settings to already set up codes or create some of their own following the different tabs until they are ready to run their code and make any changes needed. (1 hour)

Code.org Dance Party Dance Party tab in the center of the page can be used to code a start to finish dance party to share with the class. (1 hour)

Either site can be used or both for more practice and experience.

ELABORATE

Brief Description: Students will learn about the abundance of jobs in digital logic and the predictions for the future of the workforce.

Procedures:
As a class, we will look at this resource shared by Open Road and discuss what it means for the future of our workforce and economy.

CHIPPING IN: THE U.S. SEMICONDUCTOR INDUSTRY WORKFORCE AND HOW FEDERAL INCENTIVES WILL INCREASE DOMESTIC JOBS

Students will work in small groups to skim this file for pertinent information. They will be given a piece of chart paper to create bullet points of the most important information that they take away from the document.

Rebuilding our Semiconductor Workforce

When time is up, each group will present their findings to the class.

We will watch these short videos that elaborate on the types of jobs available and what each field focuses on.

Job Descriptions Note-taker

Students will pick an activity from the Choice Board to complete- Choice Board

EVALUATION

Brief Description:

This portion consists of three sections of summative assessment:

1. The first portion is on the information technology career handouts will help students work in groups or individually to evaluate many different jobs that include technology and computers along with coding.

2. The second portion is the Dance Party/Hour of Code activity final dance product will be shared by each student then each student will provide feedback on each dance as well as feedback about their own experience.

3. The final summative assessment will be to crack the code from hackers. Students will look at a truth table and then use logic.ly to assemble the logic gate to stop the hackers.

Procedures:

The Informational Technology Career packet can be used for extra time activities or to extend the lesson/unit to more fully add the career aspects to the unit. Students will use computers for some sections and only will need the handouts themselves for some to solve logic puzzles and match up careers with the explanation of that career to check for understanding. (1 hour)

Results for information technology careers | TPT

(If using this student packet option, it will need to be purchased at TPT for $3.00)

Dance Party final dance each student created will be finished and shared with the class. At the end of all sharing their dance, notes can be used for verbal discussion to share feedback on what they learned coding the dance and what they noticed about other students' work/dances. (2 hours)

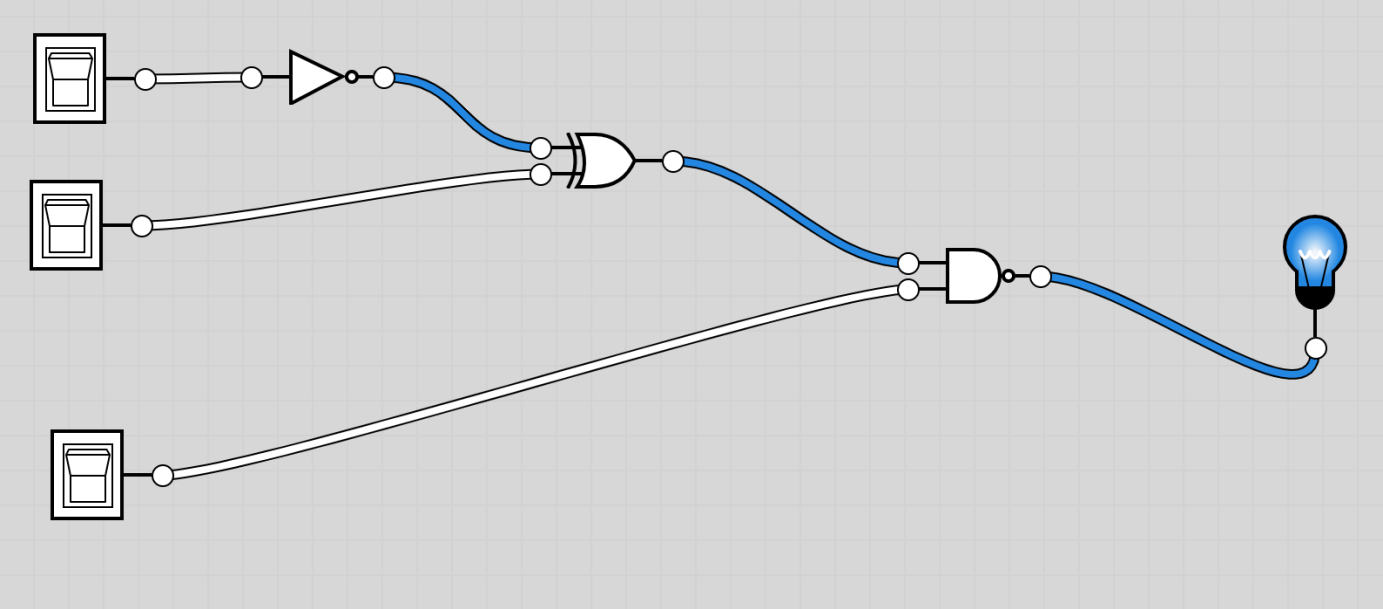
Students will use logic.ly to assemble the three part logic gate circuit according to the truth table below. They will drag and drop the inputs, gates, and outputs, then connect with wires. They then can check the truth table that is created to see if it matches the truth table supplied. If it matches, they then can screenshot their circuit and insert it in their worksheet. They have outhacked the hackers!!! (approx 1 hr)

Here is the Truth Table

TruthTable

In 1	In 2	In 3	Output
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

This is what the circuit should look like if they complete the truth table correctly:



REFERENCES

- https://www.techopedia.com/definition/27425/digital-logic
- https://learn.org/articles/What_Career_Options_are_in_the_Field_of_Digital_Electronics.html
- https://www.teacherspayteachers.com/
- https://learn.sparkfun.com/tutorials/digital-logic/all
- http://teachers.egfi-k12.org/category/lessons/grades-9-12-lessons/
- https://curriculum.code.org/hoc/plugged/8/#dance-party1
- Spotify Playlist (appropriate for all ages).
- Logic.ly
- https://blockly.games/