Unit 1 - Digital Information

Unit Overview

Students explore the way computers store and represent complex information like numbers, text, images, and sound. The unit begins with students investigating what it means to represent information, and challenges students to design their own representation systems. Students then learn the ideas behind real-world systems used to represent complex information. Later lessons focus on the challenges that arise from digitizing information, such as the need to compress it, or questions of intellectual property. The unit project emphasizes the profound impact digital information has on modern life.

Unit Philosophy and Pedagogy

- **Establishing a Strong Classroom Culture:** This unit is designed to be hands-on, collaborative, and exploratory. A major focus of the unit is building a positive classroom culture in which students work together, explore problems, and communicate about their thinking. Most lessons either feature physical manipulatives or a digital widget, and the bulk of lesson time should be spent with students exploring these tools together to develop an understanding of the concepts they highlight. The course intentionally does not start with programming since, in many classrooms, some students have experience with programming and others do not. Choosing to begin with digital information and the internet lets you build community in the room while exploring a topic that is likely to be accessible to all students. The supportive and inclusive classroom environment built in this unit should help set a positive tone that can be carried through the school year.
- **Empowering "Deciders":** An important goal of the course is not merely to teach students technical knowledge, but to put those skills to work in meaningful ways. This unit builds towards the unit project, which provides an opportunity for students to be "deciders" about the impacts of computing on modern life. Other units will emphasize empowering units as "creators."

Major Assessment and Projects

The unit project asks students to consider and debate issues that arise in modern society due to the digitizing of information. Students will analyze an article that addresses the intersection of digitizing information and current events. They will evaluate what data is being digitized and evaluate the benefits and harms caused by making this information digital. Students will also complete an end-of-unit assessment aligned with CS Principles framework objectives covered in this unit.

AP Connections

This unit and its associated project help build towards the enduring understandings listed below. For a detailed mapping of units to Learning Objectives and EKs, please see the "Standards" page for this unit.

- DAT-1: The way a computer represents data internally is different from the way the data is interpreted and displayed for the user. Programs are used to translate data into a representation more easily understood by people.
- IOC-1: while computing innovations are typically designed to achieve a specific purpose, they may have unintended consequences

This unit includes content from the following topics from the AP CS Principles Framework. For more detailed information on topic coverage in the course review **Code.org CSP Topic Coverage**.

- 2.1 Binary Numbers
- 2.2 Data Compression
- 5.5 Legal and Ethical Concerns.

Week 1

Lesson 1: Welcome to CSP

Unplugged

Welcome to Computer Science Principles! Groups make a “rapid” prototype of an innovative idea and share it. Students watch a brief video about computing innovations.

Lesson 2: Representing Information

Design a device for sending information across the room using common household supplies.

Lesson 3: Circle Square Patterns

Develop a system for creating and ordering patterns of shapes.

Lesson 4: Binary Numbers

In this lesson, students will practice representing numbers in binary (base 2), transitioning from the circle-square representations they made in the last lesson. Students will create and use a "Flippy Do", a manipulative which helps students convert between binary (base 2) and decimal (base 10) numbers. They will practice converting numbers and explore the concept of place value in the context of binary numbers.

Lesson 5: Overflow and Rounding

Unplugged | Concept Invention

Explore the limitations or representing numbers with bits.

Week 2

Lesson 6: Representing Text

Group Problem Solving

Develop a system for representing text using bits based on what you already know about representing numbers.

Lesson 7: Black and White Images

Concept Invention | Widget

Learn how computers represent black and white images using bits.

Lesson 8: Color Images

Concept Invention | Widget

Learn how computers represent color images using bits.

Lesson 9: Lossless Compression

Widget

Learn how computers can decrease the number of bits used to represent a piece of information.

Lesson 10: Lossy Compression

Widget

Learn how information is represented using fewer bits when it's OK for some of the information or details to be lost.

Week 3

Lesson 11: Intellectual Property

Unplugged | Concept Invention

Learn about how people can own digital information and the ways they can share access to their creative digital works.

Lesson 12: Project - Digital Information Dilemmas Part 1

Unplugged | Concept Invention | Project

Read about a current event or societal challenge created by the digitization of information.

Lesson 13: Project - Digital Information Dilemmas Part 2

Unplugged | Concept Invention | Project

Share the results of your reading and discuss with classmates the overall impacts of the digitization of information.

Lesson 14: Assessment Day

Unplugged | Concept Invention | Project

Assessment day to conclude the unit.

Lesson 1: Welcome to CSP

Overview

Welcome to Computer Science Principles! The first lesson is about getting students excited about the course and connecting their own personal interests to computer science. Students are asked to share something they know a lot about and teach it to a small group. Groups make a “rapid” prototype of an innovative idea and share it. Students watch a brief video about computing innovations. The lesson ends with students logging into the Code.org CSP course web site, and answering a brief prompt about what “computer science” means to them.

Purpose

This activity plants the initial seed for students to think about the ways in which they might be able to solve some problems relevant to their lives with technological innovations.

Agenda

Tech Setup

- **Before your first class**
- **Join Section**

Warm-Up (15 mins)

- **Teacher Message**
- **Important! Have your students take the CSP Pre-Course Survey!**
- **Topic Brainstorm**

Activity (20 mins)

- **Identify impacts and prototype an innovation**
- **Brainstorm Technological Innovation**
- **Rapid Prototype one idea**
- **Share Prototypes**

Wrap-up (10 min)

- **Welcome students to the course**
- **Assessment: Check For Understanding**

View on Code Studio

Objectives

Students will be able to:

- Communicate with classmates about computing innovations in their lives.
- Describe positive and negative effects of computing innovations.

Preparation

- [ ] Procure poster paper for sharing innovations
- [ ] Queue up CS is Changing Everything video
- [ ] Setup section in Code Studio for this course
- [ ] Have student sign-up link ready to share

Links

Heads Up! Please make a copy of any documents you plan to share with students.

For the Teachers

- **CSP Unit 1 - Digital Information** - Presentation
- **Code Studio Teacher Dashboard Video Tutorial**
- **How to Administer a Locked Assessment**

For the Students

- **Personal Innovations** - Activity Guide
  Make a Copy ▾
- **Computer Science is Changing Everything** - Video (**download**)
- **Personal Innovations** - Rubric
  Make a Copy ▾

Teaching Guide

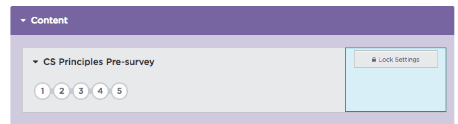
Tech Setup

Throughout the year, in order for you to be able to see student work, and for students to be able to connect to each other on tools like the Internet Simulator, all students need to be in the same section on Code Studio. To see assessments and answer keys that Code.org provides, you also need to be a "verified teacher".

Before your first class

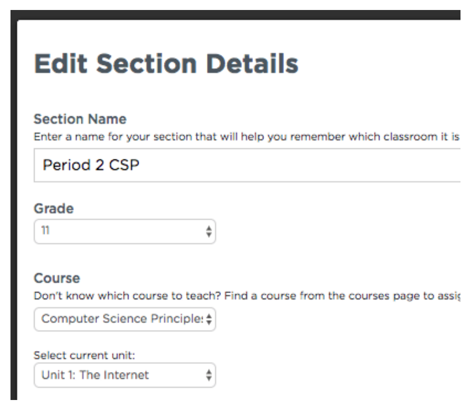
Do This: Ensure you are registered on Code Studio as a "verified" teacher account

- Anyone can create a teacher account on Code Studio, which means that we need an extra layer of authorization to allow CS Principles teachers to see assessments, answer keys, and any other collateral that students should not be able to trivially get access to. If you attended a Code.org 5-day workshop during the summer, you should already have this access.



- To check if you have access:
  1. Navigate to the **Unit 1 overview page**
  2. Do you see the CS Principles Pre-course Survey at the top of the unit overview page?
  3. If not, you need to verify your teacher account. Please fill out **this form**. Note that it can take 5-7 business days to become a verified teacher, so please do this step early!
- If you are *not* a verified teacher account, you can still create a section for your class, but you will not be able to administer the pre-course survey on the first day.

Do This: Create a class section on Code Studio.



- You can either...
  - Go to the **Code.org How-to Video Playlist** for a video walkthrough of these steps and more on navigating your Code.org account.

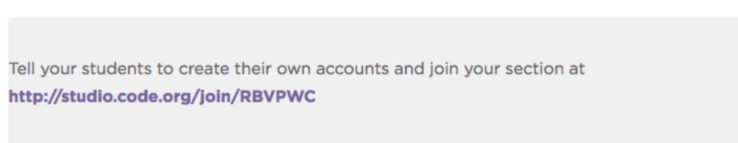
  Or...
  - Follow these steps to create a section:
    1. Navigate to the **My Dashboard**
    2. Click 'New section' under 'Classroom Sections'
    3. Choose 'Email Logins'
       - If logged on through Google you can choose to sync to your Google Classroom.
    4. Give your section a name, and choose the most appropriate grade level of students in your class
    5. Set the course to be "CS Principles"
    6. Set the unit to be "Unit 1: Digital Information"
    7. *If you're NOT using Google Classroom:* Once the section is created, click the name of the section to show the unique "join link" for your section.

Join Section

NOTE: the following steps are only needed if you are not using Google Classroom

Do This:

- Have students create a Code Studio account at **https://studio.code.org** if they don't already have one
- Share the section Join URL with students and tell them to navigate to it to join your section. It will look something like what's shown at right.



- You can confirm that a student successfully joined your section by having the section progress page on the Teacher Home Page open and hitting refresh as students join.
- Students should also see a small green bar at the top of their page that says 'You've successfully joined ...'

Teaching Tip

The slide icon indicates that there is a slide in the unit slide deck that corresponds to this activity or prompt.

- Have students navigate to the course on the home page.
- From the *student's* homepage at **studio.code.org** they should see a "tile" for Computer Science Principles. Click 'View course', then go to Unit 1.
- Once students are looking at the Unit 1 overview page, they will be ready to take the CSP Pre-Course survey

Warm-Up (15 mins)

Teacher Message

Remarks

> - Welcome to Computer Science Principles! This year we're going to learn a lot about computer science, but before we begin, we want to learn a little bit about you and your thoughts on computer science in general. Let's take the CSP Pre-Course Survey.

Important! Have your students take the CSP Pre-Course Survey!

Do This: Students can find a link to the survey in Code Studio as the first item on the Unit 1 overview page. To ensure that students only take the survey at the appropriate time, it is "locked" and unviewable by them until you "unlock" the survey. The **How to Administer a Locked Assessment** document provides details on how to do that when you are ready. Note that the instructions for administering an assessment and a survey are the same.

Topic Brainstorm

Remarks

> One thing that makes this class unique is that you have to invent solutions to problems and create things all the time, both alone and with others. Everyone has a unique and creative perspective they bring to the table.
>
> Let's start by seeing how creative we can be right now!

Do This: Take out a journal or a piece of paper.

Prompt: What's something that you know a lot about? Something that you could teach somebody?"

Discuss: With a partner or a small group:

- introduce yourself
- explain the thing you know a lot about
- tell the group something interesting about that topic

Activity (20 mins)

Group: Place students in small groups.

Identify impacts and prototype an innovation

Remarks

> People seem to say that technology is all around us, that it affects everything we do. Is that true? Technological innovation is about recognizing a problem that needs to be solved, or recognizing something needs improving and then building a tool to solve it.
>
> **As a class we're going to see how innovative we can be. We're going to do something called "rapid prototyping."**
>
> "Prototype" is a fancy word that means a simple sketch of an idea or model for something new. It's the original drawing from which something real might be built or created.

Brainstorm Technological Innovation

Do This: Go around the group, and for each individual's area of interest:

1. Identify some way that technology is used with, or affects that thing
2. Make a suggestion for either:
   - a way that technology might be improved to make it better, faster, easier to use
   - a creative or innovative new technology that might help solve some problem within that area, or at least make better

Everyone in the group should make suggestions for any of the areas of interest in your group.

Rapid Prototype one idea

Remarks

> As a group you have just brainstormed about the technology ideas at the table.
>
> Now, come together and get excited about **one** of them.
>
> As a group, nominate the idea you've discussed that you think would be the *most interesting* to everyone else in the class.
>
> **Start to sketch out that idea on a poster. Make a visual representation of your ideas.**
>
> - Remember this is a rapid prototype. Just something to quickly convey the idea.

Do This: As a group, nominate the idea you've discussed that you think would be the most interesting to everyone else in the class. Start to sketch out that idea on a poster. Make a visual representation of your ideas.

Share Prototypes

Share: Do a "Gallery Walk" or a whip around so that each student can see all of the other students' work.

- Put prototype posters on the wall
- Give students time to survey the various posters

Teaching Tip

"Why do the pre-course survey?"

- A major goal of CS Principles is to broaden participation in computer science.
- It is *crucial* therefore to have insight into students' attitidues and beliefs about computer science *before* the course so that we can measure the amount of change that occured *after* the course is over.
- Please note that this survey is **anonymous for students**
- Completing it also helps us understand important improvements we can make to the curriculum to improve the teacher and student experience.

Please help by having your students contribute to this vital dataset. Their voices make the difference!

How much time does it take?

- The survey is roughly 40 quick response items. We expect it to take 5-10 minutes to complete. You might consider administering it on an admin day at school, or as an early homework.
- Because it is a pre-course survey it is important that students take it as early in the course as possible, before they have had much (or any) exposure to the class so that we may accurately gauge changes in attitudes and beliefs caused by the course.

Thank you!

-- The Code.org Team

Teaching Tip

If students need help coming up with ideas, share these tips:

- This doesn't have to be a subject in school - it very well might not be.
- As a person, as an individual who is living and breathing in this world, there is something that you probably know a lot about - maybe you feel like you know more about than most people. What is that thing?

Wrap-up (10 min)

Welcome students to the course

Remarks

> - We are just starting this class, but you all bring passions and knowledge about things you care about. And whatever those things are it is likely (if not inevitable) that they involve computing technology in some way.
> - Everyone is unique, but we're all in this together.

Video: Play **Computer Science is Changing Everything - Video**
- The video is available for students in Code Studio as well.

Prompt: What are you excited to learn about in this course?

Teaching Tip

What you're trying to do here is get students to state something that they are interested in, but also know a lot about - something they might have insights into.

A big part of students' enthusiasm for sharing will come from your enthusiasm and genuine interest in getting to know them.

Students might need prodding: there is something that makes them interesting and unique. Something they like to do, have interest in, read about, have some expertise in, a hidden talent.

Teaching Tip

Keep things quick. If a group is worried about not being innovative enough, remind them that very small ideas can have big consequences. People once thought it was ridiculous that you would want to send a short text message to another person over a phone.

Alternatively, a group may have a great idea that they want to spend more time on. They can do that later. For now, just remind them it's a rapid prototype.

Teaching Tip

Take this opportunity to explain the importance of bringing individual interests and perspectives to this course. From day one, students should be thinking about how to apply the principles they learn to their own lives, and hopefully they will be excited to do so.

Assessment: Check For Understanding

Check For Understanding Question(s) and solutions can be found in each lesson on Code Studio. These questions can be used for an exit ticket.

Computer science has changed the way we communicate with each other, make art and movies, grow food, and even treat illnesses. Everyone can learn computer science and make a difference.

Still, we understand that taking a computer science course can be difficult at first. Here are a few student quotes describing their strategies and tips for taking this course. Please read the quotes carefully and respond to the prompt below.

Question: What are your own strategies and insights about how to learn best? And, how are they similar or different to the ones that you just heard about from other students?

Discussion Goal

Students can discuss in small groups and then share out with the whole class. It's ok if at this point students don't have an answer to this prompt.

Standards Alignment

CSTA K-12 Computer Science Standards (2017)

- **IC** - Impacts of Computing

Lesson 2: Representing Information

Overview

Using everyday materials, students create devices for sending information to a partner. Each group then uses its device to send an answer to a question. Following this, students modify their devices to answer more complex answers, responding with one of four possible messages, then one of eight possible messages, then one of sixteen possible messages.

Purpose

This lesson introduces the concept of sending bits of information from one place to another. While building and modifying their information sending devices students should eventually recognize that it's easier to invent a system of communication that used a combination of patterns with a simple device, rather than making a new, or increasingly complex device for each new problem. This lays the foundation for understanding how complex information is represented in computers using a combination of bits.

Agenda

Warm Up (5 mins)
Activity (35 mins)
- **Information Sending Devices**
- **Challenge #1:**
- **Challenge #2:**
- **Challenge #3:**

Wrap Up (5 mins)
- **Assessment: Check For Understanding**

View on Code Studio

Objectives

Students will be able to:

- Explain how the same piece of information can be represented in a variety of different ways.
- Use a device to represent different pieces of information
- Use patterns to represent information

Preparation

- [ ] Reusable and consumable supplies for the classroom, such as markers, small flashlights, noisemakers, bells, whistles, cups and string, straws, slinkies, blocks, or colored paper.

Links

Heads Up! Please make a copy of any documents you plan to share with students.

For the Teachers

- **CSP Unit 1 - Digital Information** - Presentation

Teaching Guide

Warm Up (5 mins)

Remarks

> A lot of people think that computer science is the study of computers, like the phone in your pocket or the computer on your desk. As we'll see this year, computer science actually has a lot more to do with information.

Prompt: What is your definition of information?

Discuss: Have students silently write their own definition, then share with a partner, and finally have some volunteers share with the room.

Remarks

> - There are many ways we can think about the word "information," but one possible definition we'll explore today is that information is the answer to a question.
> - We're going to investigate what it takes to send that information back and forth to one another.

Discussion Goal

Goal: More important than writing a formal definition of information is getting students discussing the term and its diverse forms. If students struggle with defining "information," modify the prompt by asking them to provide examples of information in their world such as texts, books, videos, music, conversations, etc.

Teaching Tip

Reminder: A slide icon indicates there is a corresponding slide in the unit slide deck.

Activity (35 mins)

Information Sending Devices

Group: Place students in groups of two.

Distribute: Materials for students to build their binary message devices (straws, scissors, etc.).

Remarks

> Today you are going to build your own device for sending and receiving messages which you will use to answer questions that you write.

Challenge #1:

Journal: Write down a question that has two possible answers.

Do This: Build a device out of classroom supplies to communicate the answer to your question.

- Rules:
  - No projectiles.
  - No language can be used.
    - For example: If my question is "Is your favorite color blue or green?" I can't write the words blue and green on my device.

Do This: After students have completed their devices, choose a few groups to demonstrate their device in action. Students stand on opposite sides of the classroom. One student asks the agreed upon question. The other student uses the device to communicate the answer.

Challenge #2:

Journal: Modify the answer to your question so there are now four possible answers.

Do This: Update your device to communicate one of four possible answers to your question.

Do This: Again, choose groups to demonstrate their updated devices.

Challenge #3:

Journal: Modify the answers to your question so there are now eight possible choices.

Do This: Update your device to communicate one of eight possible answers to your question.

- Consider:
  - Should you modify your device?
  - Can you use it in a different way?
  - Should you make a new device?

Demo: Do a final demonstration of devices before ending the activity.

Wrap Up (5 mins)

Remarks

> Let's wrap up by discussing how you designed your devices and what that means about the questions you can ask and the messages you can send.

Prompt: Think back to your simple two-option device from Challenge #1. Instead of changing your device and adding more options every time you added more answers, how could you simply modify the way you use your device with only two options?

Assessment: Check For Understanding

Check For Understanding Question(s) and solutions can be found in each lesson on Code Studio. These questions can be used for an exit ticket.

Question: Recall when you built your information sending device. Why did we decide to send a message as a sequence of two options rather than modifying our devices to represent more options?

For example: Modifications with two options

- bend straw forward once
- bend straw backwards once
- bend straw forwards twice
- bend straw backwards twice

vs.

Four options

- bend straw forward
- bend straw backwards
- bend straw to the left
- bend straw to the right

Standards Alignment

Teaching Tip

Challenge 1 - Question with 2 Answers: In this activity, avoid the urge to give students a pre-written question or answers without allowing them time to struggle with the challenge. Encourage students to write down in their journal how their device works.

- Example Question: Do you like strawberry or vanilla ice cream?
- Answer: strawberry (move my pencil up and down), vanilla (move my pencil side to side)

Challenge 2 - Question with 4 Answers: Some students may add new ways of answering a question. Others may notice that they can reuse their previous responses, sending those responses in sequences that produce new messages. Avoid the urge to tell them to reuse the device, instead allowing them to explore their own ideas.

Challenge 3 - Question with 8 or More Answers: At this point, students may start to realize that the way their device communicates information is not practical and could not be scaled up if there were for example, a thousand or a million possible answers.

Discussion Goal

Focus the discussion on why some groups created devices using unique options for each additional message, while other groups devised plans in which they reused the same device to create new combinations of the original two options.

Ultimately, groups begin to notice that, for example: instead of bending a straw in four different directions, they could simply bend the straw the same two ways multiple times.

- Sample Question: Do you like strawberry, chocolate, vanilla, or peanut butter ice cream?
- Answers: strawberry (bend straw forward once), chocolate (bend straw forward twice), vanilla (bend straw backwards once), peanut butter (bend straw backwards twice)

CSTA K-12 Computer Science Standards (2017)

- **AP** - Algorithms & Programming
- **DA** - Data & Analysis

Lesson 3: Circle Square Patterns

Overview

Students will create rules for ordering patterns of circles and squares. Students generate all possible messages with three place values, then create rules that explain how they ordered each message. Emphasis is placed on creating clear rules so that, if another group were to follow the rules, they would generate the same list in the same order. Using these rules, students then try to list all possible messages with four place values. As the lesson concludes, students share their rules with classmates.

Purpose

Eventually, students will need to understand the binary number system which uses 1's and 0's rather than circles and squares. This lesson acts as a bridge to the next lesson where binary is formally introduced and practiced. In wrestling with the challenge of describing the rules of ordering patterns of circles and squares clearly, students will be primed to see how the binary number system solves many of these problems. Students may discover a system that is equivalent to the binary number system, which is a feat worth celebrating, but it is not expected that every student uncovers the rules for binary in this lesson.

Agenda

Warm Up (5 mins)
Activity (35 mins)
- **Generate Patterns (5 minutes)**
- **Circle Square Activity (25 minutes)**

Wrap Up (5 mins)
- **Assessment: Check For Understanding**

View on Code Studio

Objectives

Students will be able to:

- Follow a set of rules for ordering sets of patterns
- Explain the challenges of creating a clear set of rules for ordering patterns

Preparation

- [ ] Have scissors ready for groups to create **Shape Cutouts - Resource** or have these pre-cut and prepared before class

Links

Heads Up! Please make a copy of any documents you plan to share with students.

For the Teachers

- **CSP Unit 1 - Digital Information** - Presentation

For the Students

- **Circle Square Patterns** - Activity Guide Make a Copy
- **Shape Cutouts** - Resource Make a Copy

Teaching Guide

Warm Up (5 mins)

Prompt: How many ways can you represent 7?

Discuss: Students should brainstorm individually before sharing in small groups. It is important to allow ample brainstorming time - students may generate familiar responses at first, but may stretch their thinking and get more creative with additional time. Some examples may include:

- Linguistic examples - "seven", "siete" (spanish), "sept" (french), "sieben" (german), etc
- Picture examples - dots, tallys, emojis, etc
- Math & Geometry examples - 5 + 2, 8 - 1, a seven-sided shape, etc

Discussion Goal

Goal: Introduce the idea that the numeral '7' is just one commonly used symbol to represent the number seven. There are many ways to communicate this same number that may use different symbols or representations, all of which are valid. Sharing the variety of responses helps motivate the following activity that asks students to discover a system for using the circles and squares to represent numbers, including the number 7.

After a short time, ask students to share some responses with the whole class. Use these responses to quickly generate a wide variety of representations.

Remarks

> There are a variety of ways we could represent the number 7 - we might use the numeral '7' or the word 'seven', but this might be different in other countries or other languages. Today we'll see how we might represent the number 7 using only two different shapes.

Activity (35 mins)

Generate Patterns (5 minutes)

Remarks

> In the previous class, we ended by deciding that one of the best way to use our devices was to limit them to two options, let's say: option 1 is circles and option 2 is squares. Now let's figure out how we can use these shapes to communicate lots of different pieces of information.

Prompt: With a partner, work out how many different pieces of information (made of up of circles and squares) you can represent with three place values. For example: `circle-circle-circle` and `circle-square-circle` can represent two different pieces of information.

Discuss: Give students time to work individually, then have them share with their neighbor and fill in any patterns they may have missed.

Do This: Confirm with the class that there are 8 possible patterns, but don't list all of them out. Ask students to share the 7th pattern in their list. Students will likely have different answers for this.

Remarks

> We agreed that there are 8 possible patterns we can make with 3 place valuse. But, not everyone wrote these patterns in the same order, which means we don't all have the same 7th pattern! Our goal is to create a clear set of rules where, if the class were to follow these rules, everyone should generate the same list of patterns in the same order.

Circle Square Activity (25 minutes)

Group: Place students in groups of 2, making one group of 3 if necessary

Distribute: Circle Square Patterns - Activity Guide - one for each group. Each group also gets the **Shape Cutouts - Resource** to use during the activity.

Challenge #1: Students again list all possible three place value patterns, but with an added focus on the order of their patterns.

Challenge #2: Students describe the rules or strategy they used to create their list. They are aiming for clear directions that can be followed by another group to reproduce their same list in the same order.

Challenge #3: Students extend their rules to generate all possible four place value patterns. This challenge has 2 parts: discovering all possible four place value combinations (there are 16) and extending the rules from the previous challenge so they work here as well. Most groups will need to change or add to their rules in order to accomplish Challenge #3.

Discuss: Select a few groups to share out their rules, highlighting groups with different strategies and rules they used for their lists. Emphasize the 7th item in each list, connecting it back to the warm-up activity as another way to represent the number 7.

Teaching Tip

Manipulatives: Students are given manipulatives to help visualize any rules they are using to move from one element of the list to the next. You might see students use all their manipulatives at once to create the different patterns, then discuss how to arrange them into an ordered list. You might see students representing one pattern at a time, then discussing the rules for "replacing" shapes to generate each of the next patterns. Students might not use the manipulatives at all, using pen & paper or whiteboards instead.

Many Possible Answers: It is okay for different groups to come up with different orders for their lists of patterns - this will help with the share-out discussion as you highlight different strategies.

Facilitating With Groups: You should act as a facilitator during this part of the activity, guiding students in describing the rules & strategies that they used to create their list. These strategies may be implicit and unconscious to the student, but you can ask questions to help students realize their own thinking that went into generating their list. Aim to help students clarify their thinking to make it easier for other groups to follow.

Group Dynamics: Be mindful of groups that appear to be dominated by a single student. Asking each student individually about their strategy can help bring students back together and reinforce the collaborative aspect of this activity.

Wrap Up (5 mins)

Remarks

> Congratulations! You just invented your own system for counting and we now have new ways to represent the number 7! This happens a lot as new technology is invented and fine-tuned - different technologies might count in different ways. Tomorrow we're going to learn about the counting system computers use to represent numbers!

Prompt: How is counting in this circle/square system similar to how we count in our regular lives? How is it different?

Teaching Tip

Goal: There are many ways to structure this discussion, especially if you have your own established share-out routines. Here are a few that could work for this particular discussion:

- Have each group trade with another group, and each group tries to re-create the original group's list. This strategy is useful if you have more class time than expected during the wrap-up.
- A group reads their rules while you and the rest of the class try to recreate the list
- A group reveals their list and the class tries to predict what the rules are, then the group shares their rules with the class
- You can name different strategies you've seen from groups as you've been circulating, then ask groups to give a thumbs-up if their rules involved that particular pattern. This strategy is useful if you're running short on time before the next part of the lesson.

Assessment: Check For Understanding

Check For Understanding Question(s) and solutions can be found in each lesson on Code Studio. These questions can be used for an exit ticket.

Question: How would you explain a number system to someone who had never seen numbers before?

Discussion Goal

Similar:

- It follows agreed upon rules

Different:

- Uses shapes rather than numbers

Standards Alignment

CSTA K-12 Computer Science Standards (2017)

- **DA** - Data & Analysis

Lesson 4: Binary Numbers

Overview

In this lesson, students will practice representing numbers in binary (base 2), transitioning from the circle-square representations they made in the last lesson. Students will create and use a "Flippy Do", a manipulative which helps students convert between binary (base 2) and decimal (base 10) numbers. They will practice converting numbers and explore the concept of place value in the context of binary numbers.

Purpose

This lesson is designed to give students as much time as possible using the Flippy Do to get comfortable with the relationship between binary and decimal numbers and the concept of place value.

Agenda

Warm Up (5 mins)
Activity (35 mins)
Wrap Up (5 mins)
Assessment: Check For Understanding

View on Code Studio

Objectives

Students will be able to:

- Represent decimal numbers using combinations of binary (base 2) digits 0 and 1
- Represent binary numbers using combinations of decimal (base 10) digits 0-9
- Explain how the position of each binary digit determines its place value and numeric value

Preparation

- [ ] Scissors (many pairs)
- [ ] Printed copies of **U1 L4 Flippy Do - Template**
- [ ] **KEY U1L4 Flippy Do Pt 1**

Links

Heads Up! Please make a copy of any documents you plan to share with students.

For the Teachers

- **CSP Unit 1 - Digital Information** - Presentation
- **U1 L4 How to Make a FlippyDo** - Teacher Guide Make a Copy

For the Students

- **U1 L4 Flippy Do** - Template
- **U1 L4 Flippy Do Pt 1 - Activity Guide** - Activity Guide Make a Copy

Teaching Guide

Warm Up (5 mins)

Prompt: Yesterday, you created your own number system using cicles and squares.

- What can we communicate using only two symbols? Is there a limit?

Discuss: Students should quietly write an answer, then share with a partner, then discuss with the whole class.

Discussion Goal

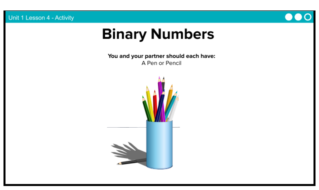
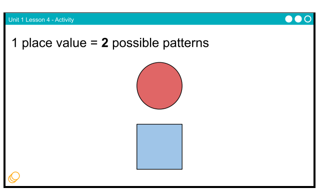
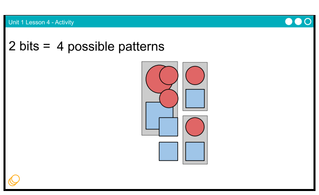
Goal: In previous lessons, students represented information using two options. This is a quick thinking question to tap into students' prior knowledge and experiences. Once students have mentioned a few of the points below, they can move on.

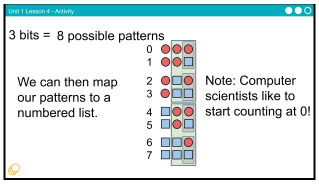
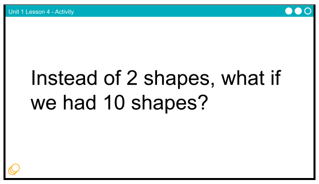
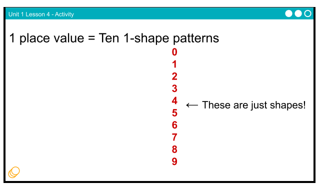
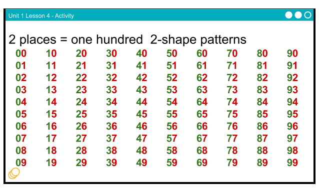
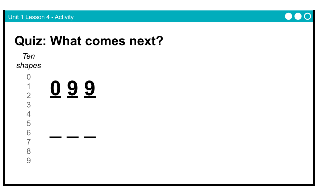
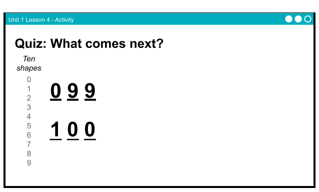
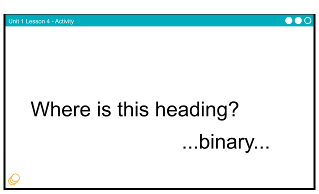
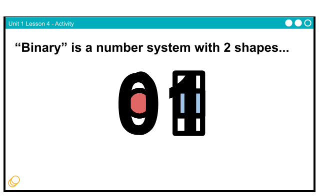
- The answer to a yes/no or true/false question
- Flipping a switch on/off
- Combinations of yes/no answers by using multiple symbols in a row
- We can keep adding more of the same symbols, so the only limit is how much space we have to write or store those symbols

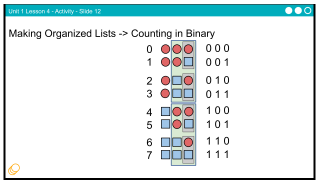
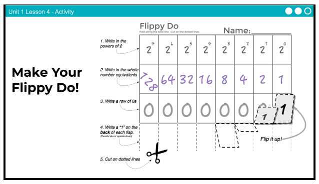
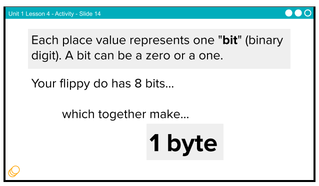
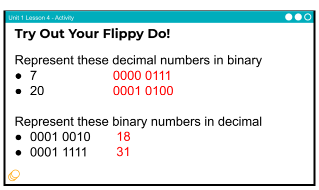
Activity (35 mins)

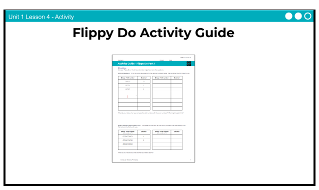
Display: Use the activity slides for this lesson to introduce students to the binary number system. Use the presenter notes as a guide to explaining how the shapes we used in the previous lesson relate to binary numbers. These slides use a lot of animations.

Look for this symbol on the slides to show when animation plays when presenting the slides: . Make sure to preview the slides before class.

Slides	Speaker Notes
	**Say:** Today we are going to explore how Binary Numbers work.
	**Say:** With only one place value, we only have two possible patterns: circle or square. **Click through animation** **Say:** I started with circle, but we could have easily started with square instead.
	**Click through animation** **Say:** With two place values, we can make two sets of the previous patterns. Then, insert circles in front of the first set and squares in front of the second set. This makes four possible patterns.

Slides	Speaker Notes
	**Click through animation** **Say:** For three place value patterns, we can make two copies of the two place value patterns. Then, just like we did before, fill in the first set with circles in front and the second set with squares in front. This makes 8 arrangements. **Note:** Computer scientists like to start counting at 0!
	**Say:** Instead of two shapes, what if we had 10 shapes?
	**Click through animation** **Say:** We could use more geometric shapes, or we could use letters, but the shapes we are used to are the numbers 0 through 9.
	**Say:** With two places, we have one hundred 2-shape patterns. These are the numbers 00 through 99. **Click through animation**
	**Say:** What happens when we count up to the last shape? **Do This:** Quick quiz! What comes after this number?
	**Say:** 100! When we run up to the last shape, 9, we roll over back to 0 and add one in the next place to the left. This is the place value that we have used all our lives.
	**Say:** Where is this heading? **Click through animation**
	**Say:** Binary is a number system with two shapes. **Click through animation**

Slides	Speaker Notes
	**Click through animation** **Say:** Instead of shapes, we use 0's and 1's. In this example, each pattern maps to a decimal number from 0 to 7.
	**Say:** For today's activity, you will be creating your own Flippy Do. This is a tool that will allow you to quickly and easily translate between the decimal number base we are used to as humans and the binary number base that computers use. **Distribute:** Hand out the Flippy Do templates - one per student. **Do This:** Lead students through completing their Flippy Do's using the slide as a guide.
	**Say:** Each place value represents one "bit" which is short for "binary digit". A binary digit can be a zero or a one. Your flippy do has eight "bits". **Click through animation** **Say:** Together, eight place values, or "bits", makes up one "byte". Since computers represent information digitally, the lowest level components of information are bits.
	**Do This:** Use your Flippy Do to try out these six problems. **Note:** It may be necessary to demonstrate how values can be calculated by flipping up a “1” for each value required to arrive at the sum of values equal to the decimal number. For example, To convert the decimal number 10, I would flip up a one in the 8's position, because eight can fit in 10 (The next bit to the left is 16, which is too big). Then I have 2 left. I flip up a one in the 2's position. This gives me the binary number "1010", which means 10 in decimal. If students are having a difficult time understanding the rules of the system, remind them of the concept of place value and relate to base 10.

Slides	Speaker Notes
	**Say:** Let's continue to practice with our own two number bases, decimal and binary. After you finish each of the four parts of the Activity Guide, I want you to check your work with your partner. Feel free to use your Flippy Do as you work. **Distribute:** Activity Guide **Note:** Encourage students to use their Flippy Do as a resource. • **Challenge 1 - All 4-bit Numbers:** Students should produce all binary numbers with a length of 4 bits, from 0000 to 1111. They should see that all odd numbers end in 1 and even numbers end in 0. Students may also notice that the binary digits increasingly “roll-over” to 1’s (from right to left) as numbers become larger and larger. • **Challenge 2 - Binary Numbers with Exactly One 1:** The goal here is for students to systematically find all binary numbers that have all zeros, except for one bit. Students should notice that the resulting decimal values are all powers of 2. • **Challenge 3 - Conversion Practice:** This section gives students more practice converting between number bases. The last two decimal numbers, 256 and 513, are too big to represent using the Flippy Do, however students should make the connection that more bits could be added to the left of the Flippy Do using increasing powers of 2. • **Challenge 4 - Putting it all Together:** The last four questions on the Activity Guide ask students to apply their understanding to new situations. The first two questions ask students to describe what happens to the value when 0’s are added to the left or right of a binary number. The last two questions ask students to think about how many bits are required to represent specific values in binary. **Note:** As you circulate, take an opportunity to be a Lead Learner. Help students discover the items below using the suggested questions: • **Reading a number vs. Placing a Number:** Do we fill in the places on the Flippy Do starting on the left or right? Does it matter? (Yes. If we have a 5-bit number, we actually use the 5 bits on the far right. If we were to use the bits on the far left, this changes the value of the number. This is similar to adding more zeros to a decimal number.) • **Highest value possible with a given number of bits:** What is the largest number we can make with 4 bits? Is the last number we can make always odd? (A meaningful pattern is that we can count as high as one less than the next bit on the left. If we have four bits, we can count up to the number 15, because the next bit has a value of 16.) • **Number of numbers we can make:** How many total unique numbers are possible with 4 bits? (This is a base 2 number system. With each new bit, we double the amount of unique numbers we can make. With four bits, we can make the decimal numbers 0 to 15 (0000 to 1111), for a total of 16 unique numbers.)

Wrap Up (5 mins)

Remarks

> It's important to know the differences between binary and decimal number systems. As a review, the decimal number system is base-10. There are ten different symbols used to represent numbers (0-9). The binary numbers system is base-2. There are two different symbols used to represent numbers (0-1). Using our Flippy Do, we can convert between Binary and Decimal number systems.
>
> While it is easier for humans to use the decimal number system in our everyday lives, we will see later in this unit how electrical signals inside computers can be best represented by using the the binary number system.

Prompt: Now that we've had a chance to practice, let's find out what we've learned and what we still have questions about. Write down:

- 3 things you learned today
- 2 things you found interesting
- 1 question you still have.

Journal: Add to your journal the vocab definitions for bit and byte.

Teaching Tip

Number Bases:

Number bases help us express data and reason about quantities. With ten digits on our hands and feet, the decimal (base 10) number base was natural for humans to develop. The ten symbols we use for this number base are the digits 0-9. For a computer, however, it makes more sense that data be represented in binary (base 2), as this can easily be interpreted with electrical switches set to two states: ON or OFF. The two symbols we use for this number base are the digits 0 and 1.

Both number bases take advantage of the concept of place value. In decimal, numbers are composed of powers of 10, increasing in value from right to left. Binary is similar, however we use powers of 2 (1, 2, 4, 8, 16, etc.). Expressed in binary, these values are 1, 10, 100, 1000, 10000, and so on. These make up the incremental place values in the binary number system.

Why Binary?

Students will see in a later lesson how computers use binary numbers as a representation of electrical signals on a wire. The wire is always set to one of two different options: on or off. Off can be reprsented with a 0 and on with a 1.

Discussion Goal

Goal: Use this exercise to help assess what students learned and what needs to be clarified. Some misconceptions can be visually clarified using the Binary Odometer Widget in the next lesson.

Assessment: Check For Understanding

Check For Understanding Question(s) and solutions can be found in each lesson on Code Studio. These questions can be used for an exit ticket.

Question: How many bits would be needed to count all of the students in class today?

Question: Each time we add another bit, what happens to the amount of numbers we can make?

Question: What are the similarities and differences between the binary and decimal systems?

Standards Alignment

CSTA K-12 Computer Science Standards (2017)

- **DA** - Data & Analysis

CSP2021

- **DAT-1** - The way that the computer represents data is different from the way that the data are interpreted and displayed for the user

Lesson 5: Overflow and Rounding

Overview

Students extend their understanding of the binary number system by exploring errors that result from overflow and rounding. They use the binary odometer widget and make a "flippy do pro" to practice binary-to-decimal number conversions which include fractional place values.

Purpose

This lesson introduces students to the practical aspects of using a binary system to represent numbers in a computing device. Students discover the limitations of creating numbers that are “too big” or “too small” to count. They learn that, while a number system is infinite, the physical representation of numbers requires place values -- which are finite, and limit the ability to represent numbers.

Agenda

View on Code Studio

Objectives

Students will be able to:

- Describe how to include fractions in the binary number system.
- Understand that overflow and roundoff errors result from real-world limitations in representing place value.

Preparation

- [ ] Print copies of the Flippy Do Pro, 1 per group
- [ ] Scissors

Links

Heads Up! Please make a copy of any documents you plan to share with students.

For the Teachers

- **CSP Unit 1 - Digital Information** - Presentation

For the Students

- **Flippy Do Pro** - Template

Teaching Guide

Warm Up (5 mins)

Prompt: Imagine you work at a local store. In the register all you have are nine $10 bills, nine $1 bills, and nine dimes.

- What's the largest amount of change that you can give someone?
- What's the least?
- What would you do if someone needed .07 cents in change?

Discussion Goal

Today we're going to explore what happens when you don't have the right "places" to store information. This can happen when you try to store very large numbers, very small ones, and everything in-between! The goal of the prompt is to understand the very real problem of making sure that enough place values are available to represent numbers.

- The largest amount of change you can give someone is $99.90.
- The least change you can give is $0.10.
- You can't give someone $0.07. You also can't give someone $1.25 in change (because you have no nickels!)

At both extremes of the number range, large and small -- and in between numbers -- you are unable to build some numbers because you don't have the place values to do so.

Activity (35 mins)

Group: Place students in groups of two. Groups will need one computer per group.

Teaching Tip

Students will tackle the problem of "running out of place values" when counting to bigger and bigger numbers. They will play with a digital odometer widget to explore what happens when you add one to the largest number you can represent in a number system.

Odometer Activity

Remarks

> We will start exploring large place values to see what happens when a big number gets too big. Go to the Binary Odometer Widget on Level 2 of the lesson on Code Studio.
>
> This is a widget that simulates a car odometer - a device that tracks how far the car has driven (in miles or kilometers). Explore the odometer to understand how it works.

Do This: Navigate to Level 2. Play with the odometer to figure out how it works.

Circulate: Give students two to three minutes to explore the odometer.

Remarks

> Now I'm going to give you a challenge to tackle with the Binary Odometer. Write your response in your journals.

Do This: Set the binary odometer to the highest number possible. Then let it run!

Discuss:

- What happens to the odometer reading?
- Does the odometer still show the distance driven by the car?

Flippy Do Pro

Remarks

> Now that you have started thinking about place value and overflow, we are going to work on a different problem. What happens when there aren't enough place values to represent a number? You will explore this with a new version of the Flippy Do, the Flippy Do Pro!

Distribute: Provide each group with a copy of the Flippy Do Pro Template and scissors.

Do This: Cut and fold your Flippy Do Pro following the guidance on the slide. Fill out all the numbers if they are not already done.

Remarks

> The Flippy Do Pro is similar to the one you made before. But this time, the Flippy Do Pro is already filled with binary place values assigned in a different way -- they include fractions.
>
> When using the Flippy Do Pro, the numbers on the left-hand side of the line are whole numbers and those on the right-hand side of the line are fractional numbers.

Flippy Do Pro Challenges

Challenge #1 - Smallest Number: Produce the smallest binary number possible with the Flippy Do Pro.

- The smallest binary number students produce is `000000.01` and this number has a decimal value of `0.25`.

Challenge #2 - Next Value: Increase the number made in Challenge #1 to the next possible value.

- The binary number students produce is `000000.10` and this number has a decimal value of `0.50`.

Challenge #3 - Got Quarters? Make the values 0.25, 0.50, and 0.75 one after another.

- The binary numbers students produce are `000000.01`, `000000.10`, `000000.11`. Note the pattern of changing a place value from 1 to 0 and then "carrying" the one.

Challenge #4 - Can't Make Change: Make all the fractional possible in binary using the Flippy Do Pro.

- There are no new values besides those made in Challenge #3 because there are no place values for representing other fractions.
- Note, if students need a concrete example for Challenge #4, have them try to make 39 cents in binary. It can't be done with the values they have available in the Flippy Do Pro.

Challenge #5 - Largest Number: What is the largest number (in decimal) you can make with the Flippy Do Pro?

- With all of the bits flipped to 1, the largest number you can make is 63.75. Note that this is smaller than the largest you can make with a traditional Flippy Do, which is 255. This is because we have shifted two bits to represent smaller numbers (0.5 & 0.25).

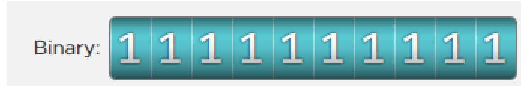
Challenge #6 - How Much Pie:

Challenge 6 contains a number of slides. Preview these slides before class to understand when to click through to the next slide.

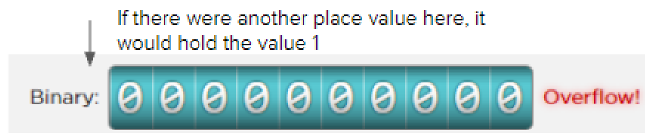
Discussion Goal

When the odometer turns over -- exceeds the number of place values it can physically display -- the odometer reading correctly shows all but one number in its place value positions.

For example:



After the odometer turns over:



As you can see, all the numbers should flip to 0 and the one of the left should flip to 1. But we are out of place values! So the numbers flip to 0, but nothing flips to 1. The number we are trying to represent does not fit in the number of bits we have available to accurately display it.

Like a bathtub that has reached its maximum capacity for holding water and is now overflowing, the odometer has reached its maximum capacity and has reached **overflow**.

Teaching Tip

- The Flippy Do Pro is still using 8 bits to represent a number. But this time, the place value of each bit has been assigned in a different way than in the previous Flippy Do or on the Binary Odometer. The bits have been "shifted" to the right two times. The value 1 (2^0) is no longer the smallest place value. The value of a bit just to the right of 1 (2^0) is 0.5, which is 2^-1. The value to the right again is 0.25 which is 2^-2.
- Students may struggle with negative exponents. What's more important than emphasizing the math is emphasizing the pattern of place values in the Flippy Do Pro. As you move left, the place value doubles. As you move right, the place value halves.
- Help students see that using the Flippy Do Pro is similar to using the Flippy Do. To form a value, flip the flaps up or down at the bottom of the device to create a sequence of zeros and ones. Note that the range of place values is limited by the largest bit value, 2^5 which is 32, and the smallest bit value, 2^-2 which is 0.25. As with the Flippy Do, adding together all the values for each place value containing a "1" produces the total value represented on the Flippy Do Pro.

This challenge is contained on a series of slides. Students use a Flippy Do Pro to determine how much pie is left at the end of dessert. With each slide, allow time for students to decide how to represent the amount of pie left as a binary number, then convert that to decimal and write it down in the journal. In this challenge it is expected that students will estimate and do some rounding when determining how much pie is left.

- Add all the decimal numbers up together. Compare with a partner and discuss.
- Show the example of one possible answer. Click to the next slide to show these totals added together.

Teaching Tip

When referring to the Flippy Do Pro, we are using a vertical line to indicate the difference between the fractional part and the whole part of a number being represented. Using language in a clear way can be tricky for this lesson because “decimal” can mean different things to students. For example, students frequently refer to a number as a “decimal” if it isn’t a whole number (ex. Students may call “1.23” a “decimal”) but here we want to stick with students thinking as a decimal number to be a “base 10” number. Therefore, we avoid using the word “decimal point” in the Flippy Do Pro and instead talk about the fractional part of the number and the whole part of the number. The purpose of doing this is to maintain using "decimal" to only refer to a "base 10" number. For your own personal knowledge, you can read more about "decimal points" and "binary points" on **Wikipedia**.

Remarks

> In our final challenge, your answer may be different than your classmates. It comes down to how you rounded - did you decide to round up or round down with the various amounts of pie. If we did not have to round, the answer would be exactly one pie left over. You may have come to the same conclusion by rounding - or not!

Prompt: Why is it a problem for a computer if your answers are different than others?

Discussion Goal

Goal: Computers rely on precision. Think of a calculator. We depend on 1+1 always equaling 2. Rounding is necessary because of the limits of bits, but can lead to errors.

Wrap Up (5 mins)

Remarks

> The most important takeaway from this lesson is to understand that bits can represent a limited amount of information.

Prompt:

- What does the binary odometer show about representing large numbers?
- What does the Flippy Do Pro show about representing very small numbers?
- If we had a big enough odometer or Flippy Do Pro, could we represent every possible number?

Journal: Students add to their journals the definitions for: Overflow Error and Round-off Error.

Discussion Goal

As students have seen, you can make “any number” in your head, but the tool you use to represent a number has limitations. It has a fixed number of place values it can show. The odometer keeps running after you move beyond its upper limit, but the largest place values cannot be displayed due to overflow error.

In the Flippy Do Pro, you assigned some of the bits to fractions, but you saw that you still couldn’t represent certain “small” numbers -- you could only show a number that was “close to” your target number. This is roundoff error, an error that occurs when bit arrangements can’t represent numbers as intended.

Ultimately, regardless of the size of our odometer or Flippy Do Pro, and how many bits we add to them, there’s going to be numbers that are too large, too small, or “in-between” the values we want to represent.

Assessment: Check For Understanding

Check For Understanding Question(s) and solutions can be found in each lesson on Code Studio. These questions can be used for an exit ticket.

Question: Modern car odometers record up to a million miles driven. What happens to the odometer reading when a car drives beyond its maximum reading?

Question: When using bits to represent fractions of a number, can you create all possible fractions? Why or why not?

Standards Alignment

CSTA K-12 Computer Science Standards (2017)

- **DA** - Data & Analysis

CSP2021

- **DAT-1** - The way that the computer represents data is different from the way that the data are interpreted and displayed for the user

Lesson 6: Representing Text

Overview

In this lesson, students create a system for representing text using only numbers while communicating with each other. They are only allowed to send numbers back-and-forth, so they must create a system to translate between number and character. At the end of the main activity they briefly review the ASCII system for representing text. The wrap up discussion emphasizes how all of the concepts thus far have ‘built’ on each other and introduces the concept of abstraction to describe this progression.

Purpose

After this lesson students will understand the ways the most common types of information, text and numbers, are stored using binary. More importantly they should understand the challenges or principles that led to the creation of these systems and that these systems are somewhat arbitrarily created to solve a shared problem. They work not because there was "one right answer" but because many people agreed to use them. The wrap up discussion begins to explore the concept of abstraction. This is a challenging concept to understand and one that students will return to many times throughout the course. In this context, we emphasize how common it is to send text messages to each other yet these messages rely on many smaller layers (like binary numbers and electrical signals) to truly function correctly.

Agenda

Warm Up (5 mins)
Activity (35 mins)
- **Challenge #1 - Spaces**
- **Challenge #2 - Punctuation**
- **Challenge #3 - Capitals and Numbers**
- **Challenge #4 - Review all symbols**
- **Introduce ASCII**

Wrap Up (5 mins)
- **Assessment: Check For Understanding**

View on Code Studio

Objectives

Students will be able to:

- Develop a system for using numbers to represent text
- Explain how bits are grouped to represent abstractions like numbers and text.
- Describe the challenges in representing text when using a fixed number of bits for each character

Preparation

- [ ] Decide how you will distribute challenge phrases to students
- [ ] Access to journals, paper, or other places that students can write down systems for the main activity.
- [ ] Optionally print copies of ASCII Reference Sheet or prepare to project it

Links

Heads Up! Please make a copy of any documents you plan to share with students.

For the Teachers

- **CSP Unit 1 - Digital Information** - Presentation

For the Students

- **ASCII Reference Sheet** Make a Copy

Teaching Guide

Warm Up (5 mins)

Remarks

> This list secretly represents four things we experience every year. This list is not complete - there are others that we could add to it.

Prompt: Brainstorm with your neighbor what you think this list represents. When you think you have an idea, come up with another item to add to this list and be ready to explain why it belongs.

- 1 1
- 2 14
- 7 4
- 10 31

Discussion Goal

Goal: Each item in the list represents a non-denominational holiday - New Years Day, Valentine’s Day, Independence Day, and Halloween. Students should be initially puzzled by what this list represents - it may be helpful to point out the format of the list (two numbers) and that this list happens throughout the year.

Alternate Discussion: This example could be adapted to fit your classroom or school environment in order to better help your students predict what the list represents. For example: a list of room numbers in your school that students can relate to, or a list of street addresses that have meaning to students. If you decide to adapt this example, make sure it still addresses the larger concept that this warm-up introduces: that numbers can be used to represent different types of information.

Activity (35 mins)

Remarks

> In our warm-up, we used numbers to represent certain type of information. In today's activity, we will also use numbers to represent something that computers use pretty frequently: text messages.

Group: Place students in pairs. Assign students to "Partner A" or "Partner B".

Distribute: Give each pair a few sticky notes.

Do This: Look at the samples on the screen. Using only numbers, you will need to communicate these samples to a partner. No letters or other characters (including spaces) allowed! Come up with a system that allows you to do this.

Teaching Tip

Most likely students will arrive at a system where they assigne each character to a corresponding number.

For example: a = 1, b = 2

If students are struggling, remind them to consider each character individually rather than the whole word at once.

Challenge #1 - Spaces

Do This:

- **Partner A:** Heads down!
- **Partner B:** On a sticky note, use your system to write the message: oh no

Do This:

- **Partner B:** Heads Up! Translate the message on the sticky note using your system.
- **Partner A:** Heads down!

Do This: Heads up! Check your answers. After students have checked, allow them time to update their system as needed.

Challenge #2 - Punctuation

Do This:

- **Partner A:** Heads down!
- **Partner B:** On a sticky note, use your system to write the message: Great!

Do This:

- **Partner B:** Heads Up! Translate the message on the sticky note using your system.
- **Partner A:** Heads down!

Do This: Heads up! Check your answers. After students have checked, allow them time to update their system as needed

Teaching Tip

The four challenges are designed to test the limits of the students' systems. For each challenge, after one partner has put their head down, click through to reveal the challenge to the the other partner.

After the partner has translated the message to numbers, they hand the sticky note to the other partner and put their head down. The other partner translates back to English.

After the challenge is done, give students a few minutes to update their systems as needed.

Be on the lookout for cheats in a system - students cannot use spaces (aside from between two numbers to differentiate that where one number stops and the other starts) or symbols - only numbers one after the other.

Challenge #3 - Capitals and Numbers

Do This:

- **Partner A:** Heads down!
- **Partner B:** On a sticky note, use your system to write the message: Free at 5?

Do This:

- **Partner B:** Heads Up! Translate the message on the sticky note using your system.
- **Partner A:** Heads down!

Do This: Heads up! Check your answers. After students have checked, allow them time to update their system as needed

Challenge #4 - Review all symbols

!**Do This:**

- **Partner A:** Heads down!
- **Partner B:** On a sticky note, use your system to write the message: Cya 2nite!

Do This:

- **Partner B:** Heads Up! Translate the message on the sticky note using your system.
- **Partner A:** Heads down!

Do This: Heads up! Check your answers. After students have checked, allow them time to update their system as needed.

Prompt: Find another group. Discuss with them the following prompts

- Compare your systems. How are they the same? How are they different?
- What's the minimum number of bits each of your system would need per character? How do you know?
    - Hint: Convert your largest number in your system into binary. How many bits does this number require?

Discussion Goal

- There's many possible systems and there's usually not a "right" one so long as everyone agrees.
- Adding more possibilities increases the risk of having too many characters to represent and not enough bits to do it. This is a practical example of the overflow and rounding issues from the previous lesson.

Discuss: Have groups compare with each other, then move to a full group discussion. Ask groups to share out what they discussed about their systems.

Introduce ASCII

Remarks

> You just invented your own scheme for representing text with numbers. Given we use text on our phones and computers all the time, we should assume there is a standard representation for most of the symbols you can type on an American keyboard. Today we're going to be looking at one called or ASCII (pronounced: “Ask-ee”) or the American Standard Code for Information Interchange

Distribute: Hand out copies of the **ASCII Reference Sheet** or project it. Quickly read the overview text at the beginning of the sheet.

Prompt: Compare ASCII to the system you developed.

- What's the same as the systems you created?
- What's different?
- What is most interesting or surprising about this system?

Teaching Tip

How familiar with ASCII?: Students should be aware that ASCII exists and see how its development mirrors their own experiences in the previous activity, but they are not required to memorize the ASCII table. If your students are able to quickly recognize the point of the ASCII table feel free to move on to the wrap up.

Discuss: Briefly discuss these prompts as a class. At this point the main features of the system should be familiar but use this discussion to reinforce previous points.

Wrap Up (5 mins)

Remarks

> Representing text is an example of **abstraction**, which is when we create simplified representations of something more complex. This lets us hide the details and instead focus on problems at a higher level.

Prompt:

- What problem were we trying to solve today?
- What detail from the last few lessons was hidden or out of focus?

Discussion Goal

Answers:

- Students should identify they were trying to send text messages.
- Students were using decimal numbers instead of binary numbers or AB patterns

Remarks

> Sending text messages is an example of **abstraction**. For a computer, each character is really just a number, which itself is really a binary number. It all comes back to zeroes and ones!

Prompt: What is another example of an abstraction in your everyday life? Something where you don't completely understand how it works but you can still use it with confidence?

Discussion Goal

Student answers will vary. Examples: driving a car, turning on the lights in your room, riding in an elevator, etc.

Assessment: Check For Understanding

Check For Understanding Question(s) and solutions can be found in each lesson on Code Studio. These questions can be used for an exit ticket.

Question: "The binary pattern `01000001` represents the number 65." Write a brief response explaining whether or not you believe this statement is always true. Explain your reasoning.

Standards Alignment

CSTA K-12 Computer Science Standards (2017)

- ▶ **AP** - Algorithms & Programming
- ▶ **DA** - Data & Analysis

CSP2021

- ▶ **DAT-1** - The way that the computer represents data is different from the way that the data are interpreted and displayed for the user

Lesson 7: Black and White Images

Overview

Students explore how black and white images are represented. Students use the black and white pixelation widget to represent each pixel of an image with black or white light. They learn how to sample an analog image using small squares of uniform size (each represented with a black or white value) and reflect on the pros and cons of choosing a smaller or larger square size when sampling.

Purpose

Throughout this unit, students gradually discover how to use bits to represent more complex data types. In this case, students work on representing images using sampling. Students quickly realize that very tiny sample squares are needed to approximate an image's curves and small details. The smaller we make each sample, the more bits are needed. Students must also wrestle with deciding whether each square should be a 0 or 1, as many squares have both white and black in the same square. They will have more control over the representation of each bit in the next lesson.

Agenda

Warm Up (5 mins)
Activity (35 mins)
- **Intro to the Pixelation Widget (10 mins)**
- **Sampling an Analog Image (20 mins)**
- **Challenges A & B**
- **Challenge C**

Wrap Up (5 mins)
- **Assessment: Check For Understanding**

View on Code Studio

Objectives

Students will be able to:

- Explain how bits can be used to represent the individual pixels of a black and white image
- Explain how sampling is used to create a digital form of an analog image

Preparation

- [ ] Practice using the pixelation widget
- [ ] Copies of **U1L7 Black and White Images - Activity Guide** for each pair of students
- [ ] **KEY U1L7 Black and White Images**

Links

Heads Up! Please make a copy of any documents you plan to share with students.

For the Teachers

- **CSP Unit 1 - Digital Information** - Presentation

For the Students

- **B&W Pixelation Tutorial** - Video (**download**)
- **U1L7 Black and White Images** - Activity Guide Make a Copy

Teaching Guide

Warm Up (5 mins)

Prompt: You recently did some online shopping and are expecting a package to arrive in about a month. The delivery service has a tracking system which reads the location of the package.

- How often would you want the location read? Every week? Every day? Every hour? Every minute? Be ready to explain your answer.

Discuss: Students should think for a minute, then share with a partner. Once students have shared, call on a few students to explain their answers with the class.

Discussion Goal

Goal: The goal here is for students to realize that, depending on the situation, we may want to take readings more frequently. Later in the lesson as students interact with the widget, you can help students make connections that the frequency of readings affects the digital representation that we obtain.

Remarks

> Thank you for sharing your insights. It seems to depend on the situation. Sometimes we want to take a reading of the location more frequently. Today, we're actually learning about how images are represented in computers, but let's keep in mind these ideas about how often to take a reading or measurement.

Activity (35 mins)

Intro to the Pixelation Widget (10 mins)

Display: Watch the **pixelation widget video**.

Level 3: Students will recreate the letter A using the black and white Pixelation Widget. They must first enter the correct binary numbers to represent the width and height of the image. Then, they will type the appropriate bit for each portion of the image ("0" for black, "1" for white).

Level 4: Students must find and delete the extra bit that is causing the image to be distorted.

Teaching Tip

Note: The video displays an old version of the Pixelation Widget. In the version your students will use, they no longer need to set the width and height using binary numbers - they can use the slider at the top. They may also note that the width and height is not displayed in their work space in binary numbers.

Also, while the video uses the word "metadata" to describe this information, students do not need to leave this lesson understanding metadata. Metadata will be covered in a later lesson.

Sampling an Analog Image (20 mins)

Remarks

> Now that you've had a chance to see how to set each pixel black or white, we are going to use the widget to represent an analog image using a process called sampling.
>
> What is an analog? It's a term used to mean something with continuous representation - such as a picture you draw on a piece of paper. Each pencil line smoothly connects to the next, no matter how much you zoomed in on the picture with a magnifying glass.
>
> When we represent an analog image digitally, we will have to make some choices on how to sample the image to get the smoothest representation possible while keeping in mind the number of bits it takes to build that image.
>
> What does it mean to sample? We are choosing how small to make section of the picture we look at when deciding whether to make it black or white. The smaller the sample, the more pixels required to represent that image. Larger samples require less pixels, but the image can become blurry.

Teaching Tip

Getting Familiar with the Pixelation Widget: Once most of the class has finished levels 3 and 4, you can move on. Encourage students who are finished to help those who haven't. The point of these two levels is to get students familiar with the tool and practice entering the bits.

> Try it out yourself!

Distribute: U1L7 Black and White Images - Activity Guide

Challenges A & B

Do This:

- Read values from Challenge A (black or white for each square) and input the values into the widget.
- After Challenge A, answer the questions on the activity guide
- Repeat for Challenge B.
- Answer the questions in the activity guide after each challenge.

Regroup: After students have finished Challenge A & Challenge B, discuss the challenges they encountered while completing the challenges. Then direct students on to Challenge C.

Teaching Tip

Questions to Ask as Your Circulate: Having students work from paper copies of the Activity Guide will reinforce the concept of taking readings from an analog image and make it easier to transcribe the bits into the widget. As students work, circulate the room and ask pairs of students questions about their process:

- How are you deciding whether each square should be black or white?
- Do you think this process will give a good representation of the image? Why or why not?
- What would you change about the sampling process to produce a better representation of the image?

Challenge C

Do This:

- Select your favorite company logo
- Decide how you are going to sample this logo - use one of the grids in your Activity Guide. Draw the logo.
- Recreate the logo in the Pixelation Widget on Level 7.
- Show it to a classmate. Do they recognize the logo? Make adjustments if needed. For example: You may need to increase the sampling.

Wrap Up (5 mins)

Prompt: In Challenges A and B, you and your partner practiced sampling the same image twice. The second time, we did a more frequent sampling by using smaller squares.

- What are the pros and cons of sampling an image more frequently?

Discuss: Allow students time to think, then have them share in pairs or groups of four. Call on a few students to share with the whole class.

Discussion Goal

Goal: We want students to start seeing that there are advantages and disadvantages as a result of decisions we make when we represent data digitally. Some key points to draw out from students:

- **Pros:** We get a much more smooth/clearer/accurate representation of the analog image. A little easier to decide whether to make a square black or white.
- **Cons:** More bits are needed. Took longer to enter in the widget. Still doesn't look exactly like the analog image. Still had many squares that contained both black and white, so decisions had to be made to choose one over the other.

Remarks

> Thank you for sharing. It looks like there are several advantages and disadvantages when it comes to sampling more frequently by using smaller squares. We get a better approximation of the analog image when we do more frequent sampling and it was a little easier to decide whether each square should be set to black or white. However, it took longer and we needed a lot more bits. We still got an image that didn't represent the image accurately enough, though.
>
> Fortunately, a computer does this process much more quickly than we can, and it can store thousands or even millions of bits to represent an analog image.
>
> By this point, we've used bits to represent numbers, text, and images. The same sequence of bits can represent different types of data depending on the context. It all comes down to 0s and 1s!

Journal: Have students add definitions to their journals for: analog data, digital data, and sampling.

Assessment: Check For Understanding

Check For Understanding Question(s) and solutions can be found in each lesson on Code Studio. These questions can be used for an exit ticket.

Question: Assume your friend just sent you 32 bits of pixel data (just the 0s and 1s for black and white pixels) that were encoded after sampling an image. Choose the two statements that are true.

Question: Which of the following would result in a better digital approximation of an analog black and white image?

Question: Your computer science teacher asks you to sample a black and white image that is 4"x6". How would you sample the image to provide a good digital approximation using the pixelation widget? What sample size would you use? How would your decision affect the digital representation?

Standards Alignment

CSTA K-12 Computer Science Standards (2017)

- **CS** - Computing Systems
- **DA** - Data & Analysis

CSP2021

- **DAT-1** - The way that the computer represents data is different from the way that the data are interpreted and displayed for the user

Lesson 8: Color Images

Overview

This is a second opportunity for students to interact with the Pixelation Widget, but this time they will work with color pixels. Students start off learning that each pixel uses red, green, and blue lights that can be turned on or off using bits. They will create more color variants using an increasing amount of bits per pixel, and apply their learning by approximating an analog color image using the widget.

Purpose

This lesson continues the story of how bits are used to represent digital images. Much like in the last lesson, students will use the Pixelation Widget to attempt to make digital approximations of analog images, this time in color. These images are produced using layers of abstraction, with each layer relying on the other to perform its process.

Students will begin to realize that analog color images have values that change smoothly and subtly, while digital images do not. The number of digital colors is also limited by the number of bits per pixel, whereas analog colors are unlimited.

Agenda

Warm Up (5 mins)
Activity (35 mins)
Wrap Up (5 mins)
    Assessment: Check For Understanding

View on Code Studio

Objectives

Students will be able to:

- Explain how bits can be used to represent the individual pixels of a color image
- Explain how digital data is used to approximate real-world analog data

Preparation

- [ ] Practice using the color pixelation widget
- [ ] Review slides from **CSP Unit 1 - Digital Information - Presentation**

Links

Heads Up! Please make a copy of any documents you plan to share with students.

For the Teachers

- **CSP Unit 1 - Digital Information** - Presentation

For the Students

- **How Computers Work - Data and Binary** - Video

Teaching Guide

Warm Up (5 mins)

Prompt: How many different shades of the color blue can you name? How many do you think there are in total?

Discuss: Have students share with a partner. Then, invite a few students to share what their partner said.

Remarks

> Great job! We came up with many different shades of blue. As we continue today, let's keep thinking about whether there is a limit to the number of shades of blue there are in the world, and whether a computer can display all of those shades.

Discussion Goal

Goal: Start with having students name shades, but quickly transition to how many they think exist altogether. The goal here is to have students begin to wonder if computers can represent all of the vast number of shades of colors in our world. This should be a quick discussion. You can move on as soon as this point is made.

Activity (35 mins)

Note: This lesson includes color images in a number of places. See the teaching tip on the right for some additional guidance that may be useful when supporting students who are color-blind.

Remarks

> Today, we're going to see how this relationship between analog and digital plays out in the world of color. You're going to get a chance to play with the pixelation widget again, but this time you'll be using it to make your own special color blends, or gradients. After each level, I want you to check your work with your partner.

Group: Students will work individually in Code Studio, checking each level with a partner before proceeding.

Teaching Tip

In Levels 3, 5, and 6: The directions are written in so that students who are color-blind do not need to be able to distinguish between colors to be able to complete the task. That being said, students who are color-blind may not be able to visually check their work in the same way as other students. You can suggest that students who are color-blind ask a partner to check their work at the end of each of these levels.

In Level 8: It is recommended that students who are color-blind do the black and white gradient image which is the option in the lower right hand corner of the pop-up in Level 8, which looks like this:

Levels 2-3: Students should type in a unique 3-bit code for each pixel, producing 8 different colors.

Level 4-5 Students make four different shades of blue, followed by four different shades of green, using 6 bits per pixel. The red row is already done for them.

Level 6: This time, students use 9 bits per pixel. They will make 8 different shades of green and 8 different shades of blue (the red row is done for them).

Do This: Regroup the class for levels 7-8 and direct everyone to the images on the slides. **Levels 7-8:** Level 7 contains samples of various color gradients. Students should choose a section from one of the images, try to take a sampling, and attempt to reproduce the sample gradient as best they can on Level 8.

Wrap Up (5 mins)

Remarks

> So as we saw in the last two lessons, the digital versions of images we produce differ from the original analog images. Analog images change smoothly and continuously. With digital images, we are limited by the number of bits we use. Even if we use a lot of bits, we can still only represent a finite number of colors, and gradual color changes can only happen discretely through a finite set of pixels.

Prompt: How is an image represented on a computer?

Journal: Students record the layers of abstraction in their journals. Click through the animation.

Remarks

> We can see that a digital image is made up of several layers that work together to represent the analog image. This is an example of abstraction because we don't always look at the details of what's going on in all of these layers, but they are working behind the scenes. Let's watch a video of how this works.

Display: How Computers Work Video

Assessment: Check For Understanding

Check For Understanding Question(s) and solutions can be found in each lesson on Code Studio. These questions can be used for an exit ticket.

Question: Which statement about analog and digital images is true?

Question: Describe how the process of sampling, RGB pixels, and binary sequences work together to display a digital color image.

Teaching Tip

Each section of levels begins with a reference level before moving on to a widget level. Make sure the students carefully read the reference levels.

Reference Tabs: Encourage students to keep the reference levels open in a second tab as they work with the widget. They can do this by hovering over the circle of the level at the top of the screen, then right click and choose “open in a new tab”.

Counting in Binary: Students who are struggling with the binary sequences should be encouraged to take out their Flippy-Do to help them count, especially on Challenge 3 and 4.

Sampling Support: Students may become frustrated if they feel they cannot match the analog images. Reassure them this is fine. Remind them about the discussion from the warm up and ask if it's possible that digital images ever look exactly like analog images. You may also ask the students if their representation would be improved if they use more bits per pixel.

Teaching Tip

In the video on Level 2, metadata (data that explains other data) is explained - these are the pixels we now see at the beginning of the work space which represent the height, width, and bits of pixel of the image. These can be changed using the sliders.

Discussion Goal

Goal: Students should understand how sampling, pixels, and binary work together to make a digital approximation of an analog image. They should also understand that while analog images are able to change color values smoothly and continuously, digital images rely on pixels to change from a fixed number of color values discretely using squares of equal size.

Standards Alignment

CSTA K-12 Computer Science Standards (2017)

- **CS** - Computing Systems
- **DA** - Data & Analysis

CSP2021

- **DAT-1** - The way that the computer represents data is different from the way that the data are interpreted and displayed for the user

Lesson 9: Lossless Compression

Overview

Students use the Text Compression Widget to experiment with compressing songs and poems and try to find their 'personal best' compression. A video introduces important vocabulary for the lesson and demonstrates the full features of the widget. Students pick a text they think will be 'easy' to compress and one they think will be 'difficult', paying attention to why some texts might be more compressible than others. As a wrap-up, students discuss what factors make some texts more compressible than others.

Purpose

As students have been creating images over the last few lessons, the number of bits it takes to represent that information has grown and grown. In this lesson, students are introduced to the concept of compression as a way to address the growing file sizes of all of our information. This lesson is anchored by the Text Compression widget, which is a very hands-on & active widget for students to experiment with. Most of the lesson should be spent in the widget, having students experiment with different strategies for compression and creating a memorable experience to help anchor the concept of compression. Students also watch a video that introduces **lossless** and **lossy compression** - today's lesson is an example of **lossless compression**, while tomorrow's lesson is dedicated to **lossy compression**. The widget is just one example of lossless compression and students aren't expected to master specific compression strategies - instead, they should understand that lossless compression uses less data and still lets them re-create the original information.

Agenda

View on Code Studio

Objectives

Students will be able to:

- Create lossless compressions of text files
- Analyze patterns in data to determine compression strategies

Preparation

- [ ] Familiarize yourself with the Text Compression Widget
- [ ] Open Unit 1 Slideshow to current lesson
- [ ] Plan for how you will display the initial Pitter Patter Message & it's Compressed Message during the warm-up

Links

Heads Up! Please make a copy of any documents you plan to share with students.

For the Teachers

- **CSP Unit 1 - Digital Information** - Presentation

For the Students

- **Text Compression widget (tutorial)** - Video (**download**)

Teaching Guide

Warm Up (5 mins)

Prompt: This list represents several common abbreviations used in text messages. What other abbreviations could you add to this list?

- lol
- ty
- c u soon

Prompt: Why might we use abbreviations when sending messages? What are the advantages?

Discussion Goal

Goal: There are many possible responses to this - to talk in code, to hide information, to be clever - but an important response to highlight is that abbreviations save time & space when communicating. If a student suggested an abbreviation that not everyone knew, this is a great moment to bring up that both the sender and the receiver need to understand what the abbreviation stands for in order for it to make sense. Both of these points foreshadow today's activity on compression.

Activity (35 mins)

Introduction to Compression (5 Minutes)

Remarks

> I want to send this message to a friend, but their phone can only accept 80 characters of text at a time. I notice this pattern has some repetition in it, so rather than sending the whole message, I send this instead:

Do This: Click to show next slide with message highlighted in red.

Prompt: How is this message the same as the first? What actually gets sent to my friend?

Remarks

> Using abbreviations and symbols is a form of **compression**, where we try to represent the same information with fewer characters. The original message had 93 characters, but the new message and key, also called a dictionary, have a total of 56 characters. We're essentially sending the same information, but with fewer characters. Our goal today will be to create our own text compressions using similar methods.

Discussion Goal

Goal: Students should notice that each symbol represents other snippets of text. By substituting each symbol for the text it represents, we can re-create the original message.

Students may need some guidance to see that the entire sent message is really two parts - the text with symbols and the key that shows what each symbol represents. Students should see that both need to be sent in order for the original message to be recreated - if only the text is sent, the receiver won't know how what each symbol represents to recreate the message.

Text Compression Widget (15 Minutes)

Do This: Have students log into Code Studio and open Level 2 of this lesson - the Text Compression Widget.

Remarks

> This widget will let you use symbols to compress the text in the center of the screen. You can type in the dictionary on the right-side. As you do, the text on the left-side will update with your symbols. You have 4 minutes to try and compress this text as best you can.

Circulate: Help students understand how this widget works so they can successfully compress text. Make note of students who have found successful strategies so they can be highlighted in the upcoming discussion.

Regroup: Gather the class back together. Emphasize the black box at the bottom of the widget, which has their current compression rating. Have students make a note of their current Compression Percentage at the bottom of the box

Prompt: What strategies are you using to compress your sample text? Which ones seem most successful?

Video: Show **Text Compression widget (tutorial) - Video** (feel free to skip from 2:30-5:00 if your students are comfortable with how the widget works, but don't miss 5:00+). After the video, be sure to emphasize two things:

- The widget we are using is an example of **lossless compression**
- The compression percentage at the bottom of the screen is calculated by comparing the number of **bytes** in the original message and the number of **bytes** in the compressed message.

Do This: Give students another 4 minutes to apply the strategies they've just seen to continue to raise their compression percentage.

Circulate: Check in with students on their strategies and their compression rates. Encourage students to continually try and reach a 'personal best' by looking at how their compression rates change when they add or remove items from the dictionary.

Remarks

> We're starting to reach the 'limit' for how much we can compress this particular message. But not every message can be compressed with a high rating. We're going to investigate what makes some messages more compressible than others.

Comparing Compressions (10 Minutes)

Remarks

> Click the Drop-Down Menu to explore other texts to compress. Be looking for texts you predict will be 'easy' to compress and texts you predict will be 'difficult'

Group: Have students work with their neighbor for this activity. Place students in groups of 2 with at most one group of 3.

Do This: Students work together to compress an 'easy' text and a 'difficult' text.

Circulate: Give students several minutes to complete their compressions. Emphasize that students should work in pairs using two different computers so both examples can be referenced during the wrap-up discussion.

Wrap Up (5 mins)

Synthesis

Prompt: What made some messages "easier" to compress than others? What made some messages more "difficult" to compress than others?

Discussion Goal

Goal: Students will have encountered a variety of strategies, but there are a few worth emphasizing for the full class:

- Look for repeated words, sentences, or even parts of words (like -ing or -th).
- The widget lets you copy-and-paste to embed symbols within symbols. This was demonstrated in the pitter-patter example where some symbols were 'unpacked' to include other symbols.
- The order of the dictionary matters and trying to rearrange the dictionary once it's made can lead to problems

It's okay if not all of these points are highlighted - the upcoming video will emphasize these same points for students.

Teaching Tip

Competitions: You could incorporate a peer-to-peer competition (in small groups or as a full class) to get the 'highest' rating, but that can be isolating for students and suggests there is a single 'best' way to do this. An alternate strategy is: when students start for the second time, have them compete against themselves to beat their rating during the first 4 minutes. In this way, success is measured by personal growth and has a higher chance of letting every student feel successful.

Starting Over: When solving computational problems, it can sometimes be helpful to restart completely from the beginning. This activity may be a good place to suggest this to students, especially those that feel particularly stuck or frustrated - sometimes restarting from the very beginning surfaces new ideas and strategies that we didn't see before.

Teaching Tip

"aaaa...aaa": Many groups will probably attempt the last option, all A's, as their 'easy' text - it's possible to get a compression rating into the mid-80's with this text. This is fine, since it still emphasizes one of the big takeaways from this activity: information with high repetition is easier to compress. However, it is also reasonable to ask groups to do a second 'easy' text once they're satisfied with this one

Priorities: It's not necessary for all groups to pick the same texts, nor is it important to find the very 'best' compressions. Instead, students should focus on the qualities that they think make some texts 'easier' or more 'difficult' than others. You can emphasize this with the questions you ask as you circulate to groups: "What made you pick this for your 'easy' text? What made you pick this for your 'difficult' text?"

Remarks

> There are many strategies we can use when creating **lossless compressions** and there isn't a single best way to do it. Instead, our compression rate usually depends on which strategy we choose and the patterns in the text we're compressing. Most importantly, even though the number of **bytes** is getting smaller, we're never actually losing information - we can always perfectly recreate the original message using our dictionary key.

Journal: Have students add the definition of **lossless compression** to their journal

Discussion Goal

Goal:

- 'Easier' texts usually had lots of repetition - repeated words or phrases or syllables. A useful strategy is to use this repetition to create the compression.
- 'Difficult' texts usually have less repetition, making it less likely to apply this particular method of compression. Some strategies may actually make compression worse, which can be counter-intuitive

Assessment: Check For Understanding

Check For Understanding Question(s) and solutions can be found in each lesson on Code Studio. These questions can be used for an exit ticket.

Question: What is the most important quality of lossless compression?

Question: An author is preparing to send their book to a publisher as an email attachment. The file on their computer is 1000 bytes. When they attach the file to their email, it shows as 750 bytes. The author gets very upset because they are concerned that part of their book has been deleted by the email address. If you could talk to this author, how would you explain what is happening to their book?

Standards Alignment

CSTA K-12 Computer Science Standards (2017)

- **DA** - Data & Analysis

CSP2021

- **DAT-1** - The way that the computer represents data is different from the way that the data are interpreted and displayed for the user

Lesson 10: Lossy Compression

Overview

Students are introduced to lossy compression via the Lossy Text Compression widget. They apply this concept and their prior knowledge of sampling to create their own lossy compressions of image files using the Lossy Image Widget. Students then discuss several practical scenarios where they need to decide whether to use a lossy or lossless compression algorithm. The lesson ends with a discussion of the situations where lossless compression is important and the situations where lossy compression is important.

Purpose

After exploring lossless compression in yesterday's lesson, students are introduced to lossy compression. A theme throughout the lesson is that lossy compression can greatly reduce the file size, but it can also greatly reduce the quality and it's important to find that balance between quality and file size. The real challenge here is finding where that line is - how much can we compress but still keep it recognizable? In the final discussion, students compare lossy compression with lossless compression to see that each has value depending on the situation - lossy is useful when file size needs to be minimized, but lossless is important when its vital to be able to reconstruct the original image.

Agenda

Warm Up (5 mins)
Activity (30 mins)
- **Lossy Image v1 (5 minutes)**
- **Lossy Image v2 (15 minutes)**
- **Compression Decisions (10 minutes)**

Wrap Up (10 mins)
- **Assessment: Check For Understanding**

View on Code Studio

Objectives

Students will be able to:

- Examine the effects of lossy compression on text & images
- Given a piece of media, decide whether to use lossy or lossless compression based on the needs of a situation

Preparation

- [ ] Explore each of the widgets for this lesson
- [ ] Decide how you will let students share their lossy compressions with each other or the whole class
- [ ] Have **CSP Unit 1 - Digital Information - Presentation** ready for the discussion towards the end of the lesson

Links

Heads Up! Please make a copy of any documents you plan to share with students.

For the Teachers

- **CSP Unit 1 - Digital Information** - Presentation

Teaching Guide

Warm Up (5 mins)

Remarks

> This widget claims you can keep the first letter of a word then remove all of the vowels and the result will still be readable. Let's test this out - what are some other sentences we should try with this widget?

Do This: Navigate to the widget using the link in the slide and try out a few phrases before returning to the slide.

Prompt: How is this widget similar to the widget we used yesterday? How is it different?

Discussion Goal

Goal: Students should identify that this widget is similar to yesterday's text compression widget because it also shortens text, but it is different in that some of the information is permanently lost when it is shortened. You can emphasize this point by supplying some carefully-chosen sample text and seeing that the results can be ambiguous:

- "there are three tiers of tires at the shop"

Students may debate whether or not this really fits the definition of compression we saw yesterday, which is a great bridge to the next part of the lesson.

Activity (30 mins)

Remarks

> Yesterday's widget was an example of **lossless compression** because we could always reverse the process to recreate the original. This widget is an example of **lossy compression** because some information gets lost, making this process not reversible. In today's lesson, we will investigate how lossy compression works with images.

Do This: Have students open Code Studio - they will use several widgets throughout today's lesson.

Teaching Tip

Video: Students should have seen these definitions in the video at the end of yesterday's class. However, it could be worthwhile to replay part of the video here as well to reinforce that vocabulary - specifically, just the section where Aloe Bloc discusses lossy & lossless compression.

Lossy Image v1 (5 minutes)

Level 2: Have students adjust the slider to see different lossy compressions.

Prompt: What do you notice about the quality of the image when you compress it? What do you notice about the compressed file size?

Teaching Tip

For the app to work, students need to click the "Run" button on the app before they can play with it. They may need to be reminded of this when starting.

Lossy Image v2 (15 minutes)

Level 3: Have students pick a new image. Encourage students to settle on a compression that they think still represents the original image while maintaining a high compression rate (low number of bytes).

Circulate: Check in with students as they find images to compress. Emphasize that the goal is for us to eventually be able to identify the image while still keeping the image compressed.

Share Out: Have class share out the compressions they have made with students nearby. Encourage students to try and guess the image.

Discussion Goal

Goal: Guide the conversation towards these two observations:

- The larger the sample size, the smaller the file size but the image looks worse
- The smaller the sample size, the better the image looks but the file size is larger

Ultimately, students should be aware that there are tradeoffs with compression - highly compressed images may not look as good as lower compressed images, but will have a smaller file size.

Remarks

> We've now seen that lossy compression can greatly reduce the file size of our images, but we lose some information along the way. Let's explore what this looks like with some common image compressions we use on the internet.

Compression Decisions (10 minutes)

Prompt: Let's imagine we are trying to use this image for a particular purpose, and we need to decide which level of compression we want to use. We will look at a series of scenarios and we will vote on how much compression is appropriate.

- **Scenario 1:** You are sending this as a text message to a friend but you've almost run out of data on your phone plan
- **Scenario 2:** You are a crime-scene photographer and this image is part of a crime-scene photo
- **Scenario 3:** This image is part of a satellite imaging assignment for the military, being used for intelligence gathering
- **Scenario 4:** You are a Social Media manager posting this to an Instagram story for an event happening right now
- **Scenario 5:** This image will be part of a collage where 100 copies will be stitched together to make a larger image
- **Scenario 6:** You are a professional photographer submitting to a design competition where your submission will be carefully judged for color & composition

Teaching Tip

This activity emphasizes that there is a balancing act between compressing an image while making sure it is still recognizable, and students are trying to find where this balance is for their particular image. Sharing results with the class is a way for students to see a wide variety of images and compressions before the next class discussion. There are many ways to structure this share-out, but here are a few options:

Gallery Walk: Have students circulate around the room. On a post-it note, they should write down what they think the original image is and leave the note on each computer they visit

Screen Sharing: If students have a way to share their screen with the rest of the class, students can volunteer to have their screen projected for the rest of the class.

Teaching Tip

Voting can be done by students holding up the number of fingers for the option they would select.

After voting, briefly discuss each scenario and come to a classroom consensus on the best option.

Note that there is not necessarily one "correct answer" to these scenarios the goal here is to weigh the pros and cons and make an informed decision.

Wrap Up (10 mins)

Prompt:

1. When is it a good idea to use lossless compression?
2. When should you use lossy compression?
3. What are the important factors in making that decision?

Remarks

> We've seen today that lossy compression can greatly reduce file size, but can also reduce the quality of the image. Finding that balance is important, especially when the size of your file is a concern. But, if you need to recreate an exact copy of the original, then lossless compression is a better choice.

Discussion Goal

Goal: This discussion should draw out two key points:

- Lossless compression is useful when the accuracy of the original item is most important
  - Examples: Bank records, text files, some images
- Lossy compression is useful when file size is a concern or when it needs to be sent in a reasonable amount of time.
  - Examples: Multimedia - especially streaming media (images, video, audio)

Journal: Have students take out their journals and add the definition for lossy compression.

Assessment: Check For Understanding

Check For Understanding Question(s) and solutions can be found in each lesson on Code Studio. These questions can be used for an exit ticket.

Question: Choose all that match this question: Which of the following describe lossy compression?

Question: You’ve been given a new cell phone with a 2 gigabyte data plan. You plan to use your phone for text messages, images, video, and music. Which of these categories are best compressed using lossless compression? Which of these categories are best compressed using lossy compression? Why?

Standards Alignment

CSTA K-12 Computer Science Standards (2017)

- **DA** - Data & Analysis

CSP2021

- **DAT-1** - The way that the computer represents data is different from the way that the data are interpreted and displayed for the user

Lesson 11: Intellectual Property

Overview

Students are asked to reflect on who owns their creative works from this class, such as their pixel images, before reading an article describing how ownership can become complicated as analog works become digital artifacts. After reading the article, students watch several videos explaining copyright and introducing them to the Creative Commons. Students then re-read the article answering three questions about the benefits, harms, and impacts of current copyright policy. Students use their new understanding of copyright to form an opinion about current copyright policies and create a small poster justifying their opinion with a quote from the article.

Purpose

Students have been examining how digital information is created and stored, but they have not closely examined the question of who owns their digital data and what rules govern how that information can be shared. This lesson introduces the concept of copyright by presenting students with an article that challenges their current understanding of digital ownership and makes them wrestle with some of the complexities of owning and sharing digital information. It's important for students to talk through their ideas and hear the perspectives of their peers as they try to unpack how copyright law can impact society. Ultimately, students begin to form their own opinions about copyright focusing on how these policies impact the world around us and observing who benefits and who is harmed in particular copyright situations.

This lesson is also a scaffold to the larger project that begins after this lesson which includes several tasks that are also a part of this lesson such as, annotating an article, answering questions, and forming an opinion using the article as evidence. Students may need support with these processes during this lesson so they are able to complete the following lesson independently. It is especially important that students use marking the text strategies to help them comprehend and synthesize the information from their article, because they will need to do this in the next lesson as well.

Agenda

Warm Up (5 mins)
Activity (30 mins)

- **Activity Part 1: Read the Article (10 minutes)**
- **Activity Part 2: Copyright Overview (10 minutes)**
- **Activity Part 3: Article Re-read (10 minutes)**

View on Code Studio

Objectives

Students will be able to:

- Explain how copyright and Creative Commons Licenses can be applied to digital works of creativity
- Argue if current copyright laws are helping or harming society using evidence from an article

Preparation

- [ ] Print out **Article - Fortnite Stealing Dance Moves - Article** with highlighters ready to mark the text. If you are unable to print copies, see the Teaching Tip below.

Links

Heads Up! Please make a copy of any documents you plan to share with students.

For the Teachers

- **CSP Unit 1 - Digital Information** - Presentation

For the Students

- **Article - Fortnite Stealing Dance Moves** - Article

Wrap Up (10 mins)

Assessment: Check For Understanding

Teaching Guide

Warm Up (5 mins)

Prompt: Imagine you were using some of our pixelation tools to create an image and you posted it online for your friends to see - but, a week later you find out someone took that image and put it on a T-shirt that they're selling for $10 each. How would you feel in this situation?

Discussion Goal

Goal: This discussion doesn't need to come to a definite conclusion - it should generate more questions than answers. You can complicate this discussion by asking:

- What if the owner gives you credit for the drawing on the T-shirt - does that make it more or less okay?
- If we use the pixelation widget, then our image is just a binary number that's been transformed into an image - can we really 'own' a number?
- What if, instead of this happening a week later, it happened 20 years later. Does that change anything?

Remarks

> When you create materials on the computer, you own them - they are your "Intellectual Property". Using materials created by someone else and trying to pass them off as your own is plagiarism when you don't have the creator's permissions. There may even be legal consequences for using these materials!
>
> However, we can see from our discussion that it can be complicated when we talk about ownership of digital information. Today we are going to explore these issues.

Activity (30 mins)

Activity Part 1: Read the Article (10 minutes)

Distribute: Article - Fortnite Stealing Dance Moves - Article.

Do This: Students read the article. After they are finished reading they should mark up the text with the following:

- **Highlight / Underline:** Any information in this article that you want to know more about
- **At The End:** Write a 10-word summary of the article

Prompt: This article brings up issues around copyright. Based on what you've read and your own experiences, what questions do you have about copyright?

Display: Today's central question: Are our current copyright policies helping society or hurting society?

Teaching Tip

You may find that a topic about digital copyright is in the news when you are teaching this lesson. It may be appropriate and relevant to use those news events in addition to, or instead of, the article in this lesson plan. Any article you use should:

- Discuss the complexities of owning and sharing digital information
- Explore who benefits or is harmed by policies around copyright

If you find current news stories that also cover these points, you may want to consider using those articles here. This is also a good opportunity to visit the **forum** to share with other teachers the articles you found.

Activity Part 2: Copyright Overview (10 minutes)

Remarks

> Before we can really discuss this question, we need some additional background information. We are going to watch three videos. Our goal is to better understand the rules of copyright, and to better understand when we can reuse or remix something.

- Video #1: **Copyright Overview** (2 minutes)
- Video #2: **Copyright in Practice** (4 minutes)
- Video #3: **Creative Commons Copyright** (3 minutes)

Activity Part 3: Article Re-read (10 minutes)

Remarks

> Now that we better understand the rules & controls of copyright, we're going to re-read this article to see if we can determine if current copyright policies are helping or hurting society

Display the central question again: Are our current copyright policies helping society or hurting society?

Do This: Have students re-read the article in order to answer these questions:

- What was digitized?
- What was the goal or purpose of digitizing this thing?
- Is someone benefiting from this situation? If so, who?
- Is someone being harmed in this situation? If so, who?
- Are these impacts intended or unintended? How do you know?

Students should continue to annotate the article by adding the following symbols:

- Add a + next to sentences that show benefit
- Add a - next to sentences that show harm
- Add a face next to sentences that show impact

Prompt: Share some of the sentences you annotated. Did everyone identify the same areas?

Wrap Up (10 mins)

Remarks

> You need to take a stand on today’s question, using this article to help support your position. We will do this by creating a position poster so we can see how everyone feels about Copyright based on this article.

Do This:

- Distribute paper to each student. Have students fold the paper in half.
- In the top section, complete this sentence stem: “I think copyright can [help / hurt] society because __”
- In the bottom section, provide a quote from the text that helps justify the sentence you wrote in the top

Circulate: Check in with students and encourage them to use one of their highlighted sentences as evidence for their opinion. As students finish, they

Teaching Tip

To Print or Not To Print? This lesson is written assuming that you have printed out the article and have it physically available for students to write on, even though it is also possible to have students interact with this text digitally. If students read the article digitally, it is most important that they still follow the active reading strategies outlined in this lesson - highlighting the text, writing in the margins, and summarizing. This may require some additional time & instruction to teach students your preferred tools of digital annotation, and may require some additional adjustments to some of the later annotation strategies in this lesson.

Discussion Goal

Goal: This discussion continues to generate questions and spark student curiosity based on the article. Ultimately we will present students with a focused question to continue the lesson, but this lets students voice their ideas and concerns with the class. It can be helpful to keep these questions & concerns in mind as the lesson continues and return to them when you can.

Teaching Tip

The videos in this section are sourced from the **Copyright & Creativity for Ethical Digital Citizens Curriculum**. Credit to the Internet Education Foundation and iKeepSafe for these videos.

Teaching Tip

Activity Repetition: This aspect of the lesson - reading an article and looking at these questions - is repeated in tomorrow’s lesson as well. Students are presented with a different set of articles to examine and must also identify benefits, harms, and impacts. Having them complete this same task today acts as a scaffold to prepare students to read an article with purpose. As you circulate and work with students, offer reading tips and strategies that will help them complete this similar task independently tomorrow.

Teaching Tip

Creating the Artifact: This is another aspect of the lesson that will be repeated in tomorrow’s project - students will create an artifact that will be displayed for their peers to see, and this artifact must also include references to the text they read. Displaying the artifacts from today’s lesson acts as a model for what students will be expected to do independently in tomorrow’s lesson.

hang them in a public space edge-to-edge like a quilt to form a larger tapestry of opinions about copyright with evidence. This class artifact can hang in the classroom as a reference for the next few lessons.

Remarks

> Today we learned about Creative Commons, a license that allows you to freely use materials created by others. There are a few other licenses that you may have heard about that also allow access:
>
> - Open Source: programs that are made freely available and may be redistributed and modified.
> - Open Access: online research output free of restrictions to access and use
>
> You do have options when you want to ethically use others materials! Because of these licenses, we have access to a wide variety of digital materials.
>
> To close, when you use these materials, alwayas make sure to cite where you go these sources. Citations come in many forms - it could be a link, or a description of where you got the source. There are formal versions of citations recommended by various organizations, but genearlly the most important thing to remember when citing a source is to provide as much information as possible about the materials you are using.

Assessment: Check For Understanding

Check For Understanding Question(s) and solutions can be found in each lesson on Code Studio. These questions can be used for an exit ticket.

Question: How is a Creative Commons license different from a regular copyright?

Question: Now that we understand Copyright, what would need to change in order for the scenario from the warm-up to be okay? As a reminder, here was the scenario from the warm-up:

Imagine you were using some of our pixelation tools to create an image and you posted it online for your friends to see - but, a week later you find out someone took that image and put it on a T-shirt that they're selling for $10 each.

Standards Alignment

CSTA K-12 Computer Science Standards (2017)

- ▶ **IC** - Impacts of Computing

CSP2021

- ▶ **IOC-1** - While computing innovations are typically designed to achieve a specific purpose, they may have unintended consequences

Lesson 12: Project - Digital Information Dilemmas Part 1

Overview

In this lesson students begin tackling the question of whether digitizing information has made the world a better or worse place. To begin the lesson, students place stickies on a spectrum of "worse" to "better" to state their opinion prior to doing the activity. Students then choose an article they are interested in reading using a process the class completely collectively in the previous lesson. Students will discuss their preliminary reading and opinions after today's lesson and will have a chance to start making an artifact to present their findings.

Purpose

At this point in the unit students understand a great deal about how information is digitized and they are ready to start considering the impacts of digitization on society at large.

This lesson is very similar to the project that students will complete at the end of Unit 2 in which students evaluate the benefits and harms of connecting humanity through vast networks.

Agenda

Warm Up (5 mins)
Activity (35 mins)
Wrap Up (5 mins)
Assessment: Check For Understanding

View on Code Studio

Objectives

Students will be able to:

- Analyze an article about information digitization to determine the information being digitized and the initial goal or purpose.
- Weigh social benefits or harms from a specific instance of information digitization

Preparation

- [ ] Print copies of articles for students

Links

Heads Up! Please make a copy of any documents you plan to share with students.

For the Teachers

- **CSP Unit 1 - Digital Information** - Presentation

For the Students

- **The Ethics of Computer-Generated Actors** - Article
- **DNA Testing Kits & The Security Risks in Digitized DNA** - Article
- **Athletes Don't Own Their Tattoos** - Article

Teaching Guide

Warm Up (5 mins)

Remarks

> This unit we have considered how our analog world can be represented digitally. Today we will consider the impact of digitizing our world. Does it make it better or worse?

Prompt: Is our world better or worse because of digital representation? Place a sticky note (or draw an X) on the board at the place on the line that feels right to you right now.

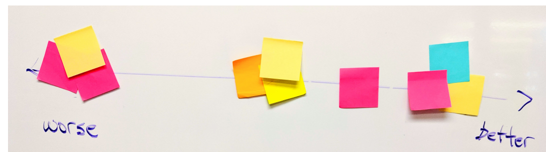
Remarks

> We're going to think more about this question together. You'll have a chance once we've done some more digging to update your answer if you like.

Discussion Goal

Goal: This activity is supposed to be open-ended and something that students come back to at the end of this lesson and the following one. Don't enforce too many rules and don't spend too much time. Just ask them to make a decision and let them know they'll have a chance to make a change to their choice at the end of the next two lessons.

When students have filled in the spectrum it will look something like the drawing below.



Activity (35 mins)

Remarks

> Yesterday, you stated an opinion on a copyright issue based on reading an article. Today, you will get to choose an article to read and respond to, focusing on the digital dilemma: Is our world better or worse?

Distribute: Students pick one of the articles below.

- **The Ethics of Computer-Generated Actors - Article**
- **DNA Testing Kits & The Security Risks in Digitized DNA - Article**
- **Athletes Don't Own Their Tattoos - Article**

Display: Instructions on lesson slides.

- **Highlight/Underline:** Any information in this article that you want to more about.
- **At The End:** Write a 10 word summary of the article.

Teaching Tip

Role of the Assessment: In this lesson, students begin a two day project where they will demonstrate their understanding of key issues surrounding digital information. This project is designed to be used in tandem with the Unit 1 Assessment to evaluate student progress in Unit 1 content. You may find after this assessment that students are confused about how some things are represented digitally. This is a good opportunity to go back and review key takeaways from previous lessons before continuing on to the Unit 1 Assessment.

Group: Create groups of students who read the same article. You may need to have more than one group for a single article.

Prompt: Share your 10 word summary with the group and discuss the main content in the articles. Together look up any unfamiliar words or concepts.

Discussion Goal

Goal: At the end of this time, students should feel comfortable with the content of their articles. Opinions will be shared later.

Remarks

> Now, that you have a better understanding of the content of your article, you're going to re-read the article to determine if our world is in a better or worse place.

Display: Is our world in a better or worse place because of digital representation?

Do This:

Have students re-read their article in order to answer these questions. Students leave comments in the margins and text of the article.

- What was digitized?
- What was the goal or purpose of digitizing this thing?
- Is someone benefiting from this situation? If so, who?
- Is someone being harmed in this situation? If so, who?
- Are these impacts intended or unintended? How do you know?

Students should continue to annotate their article by adding the following symbols:

- Add a + next to the sentences that show benefit.
- Add a - next to sentences that show harm.
- Add a face next to sentences that show impact.

Prompt: Check back in with your group. Share some of the sentences you annotated. Did everyone identify the same areas?

Remarks

> You need to take a stand on today's question, using the article to help support your position. We will do this by creating a poster.

Do This: Direct students to create posters by following instructions on the lesson slides. Students will divide a sheet of paper into four quadrants and write information in each of the quadrants. For this lesson, students will complete the top two quadrants. In the next lesson, they will finish the bottom two.

Do This: Complete the top two quadrants.

- **Quadrant 1:** What is being digitized? How is the information represented digitally?
  - For example: Is it an image or text? Do you think it's been compressed? Which form of compression (lossy/lossless)?
- **Quadrant 2:** What is the goal or purpose of digitizing this thing?

Teaching Tip

Student answers will vary. Students could answer in complete sentences, draw pictures, or use other creative ways to represent information.

Wrap Up (5 mins)

Remarks

> Tomorrow we will finish our position posters.

Prompt: Do you think there is always both a benefit and a harm to digitizing analog content? Why or why not?

Discussion Goal

Goal: Answers will vary. The goal here is for students to start thinking about the tradeoffs when it comes to digitizing the world.

Assessment: Check For Understanding

Check For Understanding Question(s) and solutions can be found in each lesson on Code Studio. These questions can be used for an exit ticket.

Question: Many museums have digital catalogs of their collections. What are the potential benefits and harms of creating these digital catalogs?

Standards Alignment

CSTA K-12 Computer Science Standards (2017)

▸ **IC** - Impacts of Computing

Lesson 13: Project - Digital Information Dilemmas Part 2

Overview

In this lesson students finish designing an artifact that represents their analysis of an article on the impacts of digitizing information. Students will complete the final two quadrants of their poster in which they identify the benefits and harms highlighted in the article and then make an overall claim about whether the world has been made better or worse through the digitization of information. At the conclusion of the class students update the position of their stickies on the "better" to "worse" spectrum they designed yesterday and then discuss whether and why they changed their opinion.

Purpose

This lesson is a continuation of the major unit project. Students continue to consider broad societal questions about the impacts of computing and the ways it is changing their world.

Agenda

Warm Up (5 mins)
Activity (35 mins)

- **Position Posters (15 mins)**
- **Jigsaw (10 mins)**
- **Digital Dilemma Debate (10 mins)**

Wrap Up (5 mins)

- **Assessment: Submit**

View on Code Studio

Objectives

Students will be able to:

- Argue whether the digitization of information has broadly speaking improved or damaged society
- Examine articles to identify the social benefits and harms caused by information digitization

Preparation

- [ ] Make sure students have access to the posters they began designing in the previous lesson

Links

Heads Up! Please make a copy of any documents you plan to share with students.

For the Teachers

- **CSP Unit 1 - Digital Information** - Presentation

For the Students

- **CSP Unit 1 Project Rubric** - Rubric
  Make a Copy ▾

Teaching Guide

Warm Up (5 mins)

Remarks

> Yesterday you began making a position poster based on an article you read. Today we are going to finish that up before debating our positions!

Teaching Tip

Get to the Activity: The warm-up is short today. Continue on to the activity as soon as possible to give students the maximum amount of time to complete their posters.

Activity (35 mins)

Position Posters (15 mins)

Do This: Use the lesson slides to guide students through completing their position posters.

Do This: Complete quadrants 3 & 4.

- **Quadrant 3:** What are the benefits and harms of digitizing this content?
- **Quadrant 4:** Is our world better or worse because of digital representation? Explain why, giving examples from the article.

Teaching Tip

Encourage students to find creating ways to represent the information in each quadrant.

Jigsaw (10 mins)

Group: Place students in groups with one representative for each article.

Discuss: Students share their position papers and discuss the articles they read with their groups.

Digital Dilemma Debate (10 mins)

Remarks

> In the last class, we started the lesson by placing a sticky note on a spectrum. Based on your jigsaw discussions, put a sticky note back on the board. Has your position changed since yesterday?
>
> Where do you stand?

Do This: Students move their sticky notes along the spectrum of worse to better.

Remarks

> Now, where does our class stand? Where do the majority of our sticky notes fall on the spectrum? Let's consider our group position.

Debate: Is our world better or worse because of digital representation?

Do This: Conclude the debate by grouping all sticky notes into a single location on the spectrum to represent the majority position of the class.

Discussion Goal

At this point, open the floor for general discussion. Students should state their case for the group position, referencing the articles and sharing from their own experiences.

Wrap Up (5 mins)

Remarks

> There are trade-offs in representing information digitally. Usually someone is benefitting while others are harmed.

Prompt: Why should we care about information being represented digitally? How does this impact you personally?

Discussion Goal

Allow students time to think and share about the personal implications of digital representation.

Assessment: Submit

Students turn in both the pieces of their project for assessment:

- Annotated article
- Position Projects

Standards Alignment

CSTA K-12 Computer Science Standards (2017)

- **IC** - Impacts of Computing

Lesson 14: Assessment Day

Overview

Students complete a multiple choice assessment which covers the unit topics.

Agenda

- **Assessment (25 mins)**
  - Topic Coverage
- **Assessment Review (20 mins)**

View on Code Studio

Preparation

- [ ] Preview the assessment questions

Teaching Guide

Assessment (25 mins)

Do This: Administer the Unit 1 Assessment, found on Code Studio. Make sure to unlock the assessment following instructions **here**.

Assessment Review (20 mins)

Review the answers to the assessment with the class. Discuss any questions that come up and take note of topics where students may need extra review.

Teaching Tip

Topic Coverage

The College Board has provided a bank of questions to help formatively assess student understanding of the content in the framework. These questions are mapped to topics with each topic having a handful of questions available.

The College Board has a few strict guidelines about how topic questions can be used. In particular, students may not receive a grade based on performance on topic questions nor can they be used for teacher evaluation. Beyond these requirements, however, they are primarily intended to formatively assess student progress and learning as they prepare for the end of course exam.

Within our own course we recommend that you use them in a variety of ways:

- Throughout the unit assign topic questions to students related to the topics students are learning about that day or that week
- Prior to the unit assessment assign topic questions to help students practice and prepare for the summative assessment
- After the unit assessment use these topic questions to help students track their progress towards preparation for the AP assessment

Unit 1: Digital Information	**Topic 2.1** Binary Numbers
	Topic 2.2 Data Compression
	Topic 5.5 Legal and Ethical Concerns • **Note**: A few of the EKs in this topic are not covered until Unit 2 and 10 of the course. Since the majority of the EKs relate to Intellectual Property, we recommend you evaluate student learning of this topic in Unit 1 and return to this topic later in the course.

Click for more info: **Code.org CSP Topic Coverage**