

Lesson 2: Patterns and Representation

Overview

Question of the Day: How can we create a system for representing information?

In this lesson students create their own system for representing information. They begin by brainstorming all the different systems they already use to represent yes-no responses. They then work in small groups to create a system that can represent any letter in the alphabet using only a single stack of cards. The cards used have one of 6 different possible drawings (6 animals, 6 colors, etc.) and so to represent the entire alphabet students will need to use patterns of multiple cards to represent each letter. Students create messages with their systems and exchange with other groups to ensure the system worked as intended. In the wrap-up discussion the class reviews any pros and cons of the different systems. They discuss commonalities between working systems and recognize that there are many possible solutions to this problem and what's important is that everyone uses the same arbitrary system to communicate.

Purpose

In this lesson students get to explore for themselves the qualities of a good system for representing information. They should find through creating and testing their systems that

1. there are typically many possible systems for representing information
2. people must agree on a common set of rules for a system to work

The features of the systems students create in this lesson serve as a reference point in coming lessons when students explore the representation systems actually used in computers.

In the next lesson students will be introduced to the concept of binary and how computers use on-off signals or "0's and 1's" to represent information. Even though this concept is hinted at in the introductory yes-no activity, it shouldn't be introduced until the next lesson.

Assessment Opportunities

1. **Describe the necessary features of a system for representing information**

Objectives

Students will be able to:

- Create and use a system for representing information
- Describe the necessary features of a system for representing information

Preparation

- Print one copy of the activity guide for each group of 2-3
- Print and cut up one copy of the manipulative resource for each group of 2-3

Links

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

For the teachers

- **CSD Unit 5 - Data & Society** - Slides

For the students

- **Animal Shapes**
- **Representing Information** - Activity Guide

Vocabulary

- **Decode** - to change how information is represented so that it can be read by a person
- **Encode** - to change how information is represented so that it can be read by a computer

Wrap up: students should identify key features that their systems needed to be effective.

2. Create and use a system for representing information

Activity Guide: There should be a unique code for each letter on the activity guide, with a system for determining when one letter stops and the other begins. During the activity, you may also want to circulate to see the codes in use.

Standards

Full Course Alignment

CSTA K-12 Computer Science Standards (2017)

► **DA** - Data & Analysis

Agenda

Warm Up (5 minutes)

Journal

Activity (35 minutes)

Wrap Up (5 minutes)

Journal

Teaching Guide

Warm Up (5 minutes)

Journal

Prompt: Imagine your friend asked if you could hang out later. This is a yes-no question and so one way you could respond is by saying "Yes" or "No". This is one possible pair of responses you could use so your friend understood, but there are many more possible pairs.

List as many different ways that you could write, say, or represent the answer to a "Yes-No" question.

Discuss: Students should brainstorm silently, then share with their tables, then finally share as a class. Write down ideas in a table at the front of the room as ideas are shared.

Discussion Goal

Goal: Students should see that the same information can be represented in lots of different ways. They might come up with saying "Yes" or "No" in many different languages, thumbs up vs. thumbs down, plus or minus, up arrow vs. down arrow, shaking head up and down vs side to side etc. Prompt students with examples if they don't understand that they need pairs of responses.

Your board might look like this after writing responses.

Yes	No
Say "yes"	Say "No"
Thumbs up	Thumbs down
Nod	Shake Head
Si	No

Prompt: Each row in our table is a different "system" but they all represent the same information. Why do you think we have so many different systems to represent the same information?

Discussion Goal

Goal: This conversation sets you up to make another important point, that different systems are created for different contexts. Today you're going to ask students to make a system for what will seem like a very arbitrary context, a deck of animal cards. Lean on the fact that they'll have brainstormed lots of "weird arbitrary systems" in this warm-up. That's because there's different contexts in which they're used. In the subsequent lesson you can call out how designing systems for wires with electricity in them is just as weird and arbitrary.

Ask students to discuss with a partner before asking a few students to share with the class. There is no one right or wrong answer to this prompt.

Remarks

What we're seeing here is that there are many "systems" that we could choose to use to represent the same information. The information of a "Yes" could be a head nod or a thumbs up, and a "No" might be a minus sign or a down arrow. As humans we've created lots of systems because they are better or worse depending on the situation. In a loud room a thumbs up works better than shouting. People speak many different languages. We've made lots of systems because we want to communicate information in lots of different situations.

Computers need systems to represent information too, and today we're going to start exploring what kinds of systems a computer would need to represent information. Today we're going to focus more on what makes good systems, and tomorrow we'll start zooming in on the specific systems computers use.


Question of the Day: How can we create a system for representing information?

Activity (35 minutes)

Group: Place students in groups of two or three.

Distribute: Give each group a copy of the activity guide and a set of animal shapes. If possible, try to have them cut beforehand to save time - otherwise, have the group cut their own set.

Activity Guide - Representing Information

 **Display:** Review the rules of the activity with the class. Students are asked to create rules that let you represent any word you want using a single row of cards. Another person should be able to use the rules you write on the activity guide to read the words represented by your row of cards without talking to you.

Brainstorm: Give students a few minutes to brainstorm their rules. Encourage them to test their ideas with their group members since they know exactly how the test will run. Ask them to choose a couple short words and test them with their group members before sharing with another group.

Content Corner

Understanding the Activity: The fact that there are only six types of cards means students will need to make patterns of multiple cards to represent each letter. The fact that the cards are all placed in a row means that they will need to indicate when one pattern stops and the next begins. Computer scientists run up against these same challenges when designing their own representation systems.

The simplest solutions to the activity will be to assign each letter a unique pattern of two shapes (e.g. A = "Pig Pig", B = "Pig Elephant" and so on). Nevertheless there are still an enormous number of systems possible systems with these qualities and likely no two systems in your class will be the same. There is no one "best" system and so what matters is that each group collectively decides to use the same one. Again this is true of representation systems students will see in coming lessons.

Circulate: Monitor group progress, listening for groups working together and listening to each other's ideas. Offer tips or starter-patterns if a group appears particularly stuck in coming up with their initial set of rules.

💡 Teaching Tip

Encourage Students to Problem Solve: There are many possible solutions to this activity and it is intentionally very open-ended. Remind students that problem solving doesn't always mean getting something to work the first time, and that they'll need to iteratively test their solutions before being sure they're correct.

Common Misconception: Students may come up with patterns of different lengths. For example "A = 1 Elephant, B = 2 Elephants, C = 3 Elephants ...". They'll find that then they won't know if a word has 2 A's in a row or a single B. Let students find this for themselves by testing their system (an important part of the problem solving process).

Test Rules: Once students have finished developing their rules, have them pick a new short word to represent and carefully make a single row of cards to represent their word. Groups should trade with each other by either rotating around the room to visit other groups, or passing their rules and cards around the room. Groups should then carefully decode the word using the rules from the other group.

When they are finished, groups should check with the original rule creators to see if they successfully decoded the word.

Circulate: Monitor groups as they exchange cards & rules, making sure no cards get jumbled in the process. Encourage groups to follow the rules exactly as written, even if they are different from the rules their group came up with.

Feedback & Revision: Based on the test, have groups decide if the rules make sense or if they need to be improved in some way. Ask groups to provide constructive feedback using the phrases "I Like..." and "I Wish...". Provide some time for each group to revise their rules if necessary.

Test Rules Again: Have groups prepare a row of cards to represent a new word before repeating the test. They should switch rules with a different group this time.

Review and Revise Rules: Give students one more opportunity to provide feedback and make final edits to their rules.

💡 Teaching Tip

How Many Tests: This activity gives students a chance to experience for themselves the challenges of creating a system to represent information. After two tests students should have enough experience to participate in the wrap-up discussions and see the important points of the activity, even if they feel their system is still incomplete.

Wrap Up (5 minutes)

Journal

Prompt:

- What was the same and what was different about the different sets of rules you saw?
- Are there some things that every group needed to account for to complete the challenge?

✔ Assessment Opportunity ▲

Students should recognize that even very different sets of systems for representing this information could work, but that each system must share key features to work. For example:

- Each letter needs a separate pattern
- We need to know when one pattern stops and the next starts.

🎤 *Remarks*

Today you created your own systems to represent information. We saw that there are many different systems we could use to represent the same information. What's important is that there are clear rules for how to use the systems, and that everyone knows the rules.

Computer scientists care about systems for representing information because a computer doesn't "understand" the world the way humans do. It needs to be given information using a system that takes into account the fact that it's just a box of wires.

When we change the way that we represent information so that it's easier for a computer to use, we encode that information. When we change it back so that it's easier for a human to understand, we decode that information.

Vocabulary: Introduce the following terms

- **Encode:** change how information is represented so that it can be read by a computer
- **Decode:** change how information is represented so that it can be read by a person

🎤 *Remarks*

In the rest of this chapter, we're going to look at ways that we can encode information so that it can be used by a computer.