## Overview

Binary code is the language that all computer use to understand data and instructions. Binary code uses only 1's and 0's to represent data. When data (like a photo or a sound clip) is processed by a computer, it is first stored as binary code. When a human writes instructions for a computer to carry out (e.g., a computer program), the program is first translated into binary code that the computer understands.

Understanding what binary code is and what it represents provides a foundation for learning about more complex computer science concepts such as encryption and computer networking. In this lesson, we cover the basics of binary code using language translation as an analogous basis for understanding the need for binary code and the process of translating data into binary code.

# Binary Basics

## Standards

Standards are based on fifth-grade learning standards unless otherwise specified.

| Computer Science |
| --- |
| CSTA 2-DA-07<br>CSTA 1B-IC-18 |
| CSTA Standards: https://www.csteachers.org/page/standards<br>AZ Computer Science:<br>https://www.azed.gov/sites/default/files/2018/10/Arizona%20Computer%20Science%20Standards_3_5_Final%2006.24.2019.pdf?id=5bc90a611dcb2510102f55b8 |

| Social Justice |
| --- |
| ID.3-5.1 |
| Learning for Justice:<br>https://www.learningforjustice.org/sites/default/files/2021-11/LFJ-2111-Social-Justice-Standards-Anti-bias-framework-November-2021-11172021.pdf |

| English Language Arts |
| --- |
| AZ 5.RI.4<br>AZ 5.RI.10 |
| AZ English Language Arts:<br>https://www.azed.gov/sites/default/files/2016/12/5th%20Grade%20ELA%202016%20Final.pdf?id=585aa90eaadebe12481b8443 |

| Math |
| --- |
| NA |
| AZ Math:<br>https://www.azed.gov/sites/default/files/2016/12/Math%20Final%2005Fifth%20Grade%20Standards%204_2_2018.pdf?id=58546f66aadebe13008c1a31 |

| Social Science |
|---|
| NA |
| AZ History and Social Studies: https://www.azed.gov/sites/default/files/2018/10/3-5%20Grade%20Band%20Standards%20at%20a%20Glance%206.10.19.pdf?id=5bd772a61dcb250b94e916ef |

## Learning Outcomes

By the end of this lesson, students will be able to:

- ☐ Describe the abstract process of translating
- ☐ Associate the process of encoding data as binary to the process of translating language
- ☐ Identify the steps associated with data encoding
- ☐ List examples of data that can be encoded as binary
- ☐ Recognize examples of binary strings
- ☐ Associate binary ones as high voltage values and binary zeros as low voltage values that are stored in wires that go into the CPU
- ☐ Convert a single digit decimal value to binary
- ☐ Convert a triple digit binary value to decimal

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## Background

[Background for teachers about the goal of the lesson and links to adult-level information about the curriculum]

Background for the basic parts of a computer system, including the I/O sub system, CPU,
▶ Inside your computer - Bettina Bair

The language of binary code
▶ How exactly does binary code work? - José Américo N L F de Freitas

# Binary Basics

## Lesson Plan

Total time: **28 minutes**

| Time | Teacher is… | Students are… | Materials needed |
|------|-------------|---------------|------------------|
| 5 minutes | Engaging students with the topic using an exploratory talking circle or journal prompt.<br><br>Teacher asks:<br>☐ Do you or someone in your family speak a language other than English?<br>☐ Have you ever had to translate words from English to a different language? Or from a different language to English? What steps did you need to do to translate from one language to another? | Reflecting on the teacher's questionst, either as a group or independently as the teacher deems appropriate.<br><br>Students can volunteer to share their responses. | Space for exploratory talking circle or reflection journals<br><br>*Optional:* shared space where teacher takes notes on what students share |
| 5 minutes | Introducing students to the concept of binary code, which is a special language that all computers use<br><br>**Key Ideas**<br>☐ Binary is a special language that all computers use to represent data<br>☐ Data is information about the world around us that we can taste, hear, touch, smell, and see. It can be the | | |

# Binary Basics

| | | | |
|---|---|---|---|
| | sounds that make a song, the colors that make a picture, the pressures that make the feeling of a handshake.<br><br>***Ask students if they can provide any examples of data.*** | | |
| 2 minutes | ***Ask students if anyone can describe how data is translated into binary code that computers can understand*** | Answering the teacher's question by guessing how data is translated. | |
| 6 minutes | Showing students the video about how computers use binary code<br><br>**Key Ideas**<br>☐ Computer programs are human instructions that tell computers what to do that get translated into binary instructions that the computer understands | Watching the video and asking questions | Projector/classroom monitor<br><br>▶ How Computer… |
| 5 minutes | Demonstrate an example of translating a decimal number into a binary code:<br><br>(See Appendix A for some ideas) | Working with the teacher to walk through the binary translation examples | Projector/classroom monitor<br><br>Whiteboard |
| 5 minutes | Assessing student learning with Assessment Ideas | Completing assessments | Whatever you use to deliver assessments |

# Binary Basics

## Assessment Ideas

### Quiz Questions and Answers

Use these questions in whatever format you use in your class to check for understanding, including Kahoot, iClicker, or Google Classroom quizzes.

**Q**: What is binary code?
**A**: A code of 1's and 0's that represents data to a computer

**Q**: What are the numbers that are used in binary code?
**A**: 1's and 0's

**Q**: What is the name of the language that computers use to understand data?
**A**: Binary code

**Q**: How would you represent the decimal number 7 as binary code? (hint: it requires 3 values)
**A**: 111

**Q**: How would you represent the binary number 1010 as a decimal number?
**A**: 10

**Q**: What is the part of a computer that understands binary code?
**A**: CPU

### Reflection Questions

You can use these in whatever format you use in your class for reflection, including science journals, Near Pods, exit tickets, or in Exploratory Talking Circles. These are questions that are meant to get students to think critically and ask questions.

***What is a pattern you notice about all even numbers that are represented in binary code?***

***How do you think a picture might be represented as binary code?***

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*When you have had to translate something from one language to another, how did you do it? How is this similar to the way that data is translated into binary code?*

## Appendix A

**Translate decimal 1 to binary**

$1 = 2^0$ OR $2 = 2 \times 0$

$1 = 0\ 1$

**Translate decimal 2 to binary**

$2 = 2^1$ OR $2 = 2 \times 1$

$2 = 1\ 0$

**Translate decimal 3 to binary**

$3 = 2^1 + 1$

$1 = 2$ to the 0 power

$3 = 1\ 1$
$3 = 0\ 1 + 1\ 0 = 1\ 1$

**Translate decimal 4 to binary**

$4 = 2^2$
$4 = 1\ 0\ 0$