**AP CSP CodeX**

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| **LESSON: Binary Numbers** | | **Time: 45 minutes** |
| **Project Goal:** Students will learn and use binary numbers.  **Learning Targets**   * I can name the place values of a binary number. * I can convert a decimal number to binary. * I can convert a binary number to decimal. | **Key Concepts**   * Data that a computer uses can be represented using binary numbers. * Binary numbers can be converted to decimal, and decimal numbers can be converted to binary. | |
| **Assessment Opportunities**   * Binary Numbers Activity Guide | **Success Criteria**   * Convert decimal numbers to binary * Convert binary numbers to decimal | |
| **AP CSP Framework**  **DAT-1.A** Explain how data can be represented using bits.  **DAT-1.C** Calculate the binary equivalent of a positive integer and vice versa. Compare and order binary numbers. | **Materials**   * Binary Numbers slides * Binary Numbers Activity Guide / Answers * [Video that introduces binary numbers](https://www.youtube.com/watch?v=bva4N7hNrNs) * Activity 2 Manipulative (print in advance) * Pennies or small markers * Flippy-do (print in advance) & scissors for cutting on the dotted lines * [Binary Game (on AppLab)](https://studio.code.org/projects/applab/iukLbcDnzqgoxuu810unLw) * AP CSP CodeX Vocabulary List * Unit 1 Review Links and Test Questions | |
| **Teacher Notes**   * This is an unplugged lesson. The CodeX and CodeSpace are not needed. * This lesson gives students more information about binary numbers and lots of time to practice. There are many ways to teach binary numbers. This lesson gives one way, but you can modify the slides if you have a different way of teaching binary. * The lesson uses a video to introduce binary numbers. Prepare the video in advance to ensure you can play it in your classroom. Or use a different video to introduce binary numbers. * The PDF for Activity 2 goes with the video. If you use a different method for teaching binary, you don’t have to use this manipulative. Students will need small coins or game chips, or even small pieces of paper, to use with the manipulative. * I highly recommend using the flippy-do for Activity 3. It is a helpful unplugged device. * If students want more practice converting to binary, or want to test their skills, have them go to the website posted at the end of the activity guide. It is a [binary conversion game](https://studio.code.org/projects/applab/iukLbcDnzqgoxuu810unLw). * Another suggestion for assessment is for students to keep a daily journal, or use a reflection form for students to process information they learned and reflect on questions they may still have. * You can also add vocabulary to a word wall and keep a document or chart of the Python code learned during each mission. * The teaching guide (below) gives the narration for one way to present the lesson. | | |

**Teaching Guide**

**Warm-up (5 minutes)**

Start with the warm-up activity in the activity guide. Decide if you want it to be digital or printed. The warm-up can be a group or whole class activity where 7 is represented in as many ways as they can think of. Students can even use individual white boards and display their answers.

**Binary Numbers - Part 1 (7 minutes)**

💡 **Teaching tip – warm-up**

* Slide 1 – video. The suggested video is from the book series “Secret Coders” and has a good way of introducing binary numbers to students with no experience, using boxes. The video is about 6 minutes.

**Binary Numbers - Part 1 & 2 and Class Discussion (20 minutes)**

💻 Students will work in pairs or individually using the manipulatives. I recommend pairs or groups of three for this activity. Each pair or group of three needs a manipulative paper and some pennies or small tokens.

💡 **Teaching tip:**

Part 1: Slides 4-5

* Students use the manipulative with boxes to convert a number to binary.

💡 **Teaching tip:**

Part 2: Slide 6

* Students again use the manipulative with boxes. This time to convert binary to decimal.

💡 **Teaching tip:**

Class Discussion: Slides 7-8

* The manipulative with boxes only goes up to decimal 15. The class discussion leads to discovering how to represent larger numbers in binary.

**Binary Numbers - Part 3 (10 minutes)**

💻 Students continue to work in pairs, groups of three or individually. Use the second manipulative – the flippy do. You can either prepare the flippy-do in advance by printing and cutting on the dotted lines, or have scissors available for students to do the cutting. You can have one flippy-do per group, or have one for each student.

💡 **Teaching tip:**

Part 1: Slides 9-13

* The first slides go over how to set up the flippy-do.
* Slide 13 shows an example of using the flippy do.
* Students complete Activity 3 on the activity guide.

**Wrap-up and Challenge (10 minutes)**

💡 **Teaching tip:**

As a wrap-up students are given binary numbers and decimal numbers and they match the pairs. They can use their flippy-dos. Or, if you want to prepare them for the AP Exam when they will not have the flippy-do, they can create a simple binary chart like the one on slide 9 and use it for conversion.

💻 After the activities, if students have time, they can practice their conversion skills by playing a [binary game](https://studio.code.org/projects/applab/iukLbcDnzqgoxuu810unLw) created by Code.org using their AppLab. It is free and fun.

✅ Students turn in the activity guide as an assessment. You can also create an exit ticket with a couple conversion problems to gauge their mastery.

**Assessment Opportunities**

Students answer two questions in their activity guide. You can also have a class discussion on the questions, or have students share their answers.

Formative Assessment:

* Daily reflection journal
* Class discussion on what they learned about functions and RGB colors
* Activity Guide completion
* Exit ticket