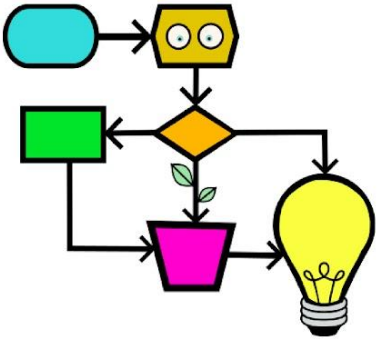
CTprimED

Extra: Basic concepts



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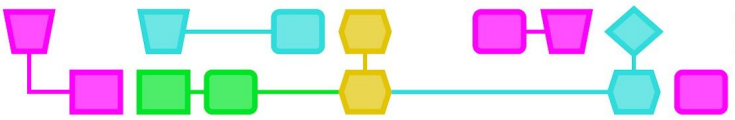


Summary:
This activity introduces the concept of algorithms and binary code. You use a deck of cards to both understand how pixels work and to write hidden messages in binary code.

Target group: students from 7 years and older with basic literacy and numeracy skills

Duration: One session, 60 - 90 minutes maximum

Learning goals:
- Learn and operate the binary numbering system
- Understand the representation of decimal numbers in the binary numbering system (binary code)
- Understand, interpret, and design algorithms
- Understand the representation of images through pixels
- Create images with pixels using the binary code

Online/offline: offline

Computational Thinking:
- General skills: teamwork, creativity, logical thinking, algorithm thinking
- CT foundations: Algorithm
- CT concepts: binary code, arithmetic & logical operations, information representation in computers

Materials:
For each student (if individually) or groups of students (if in groups):
- 10 plastic or cardboard cups
- one deck of poker cards per 4 students/groups
- paper
- pencils
- erasers

Preparation
- Select the cards with the numbers 1, 2, 4 and 8 from all the different suits (clubs, diamonds, hearts, and spades) in the deck of cards and create four sets. Only these cards will be used in the activity. Each student/group uses one of these sets.
- Print the pixel and hidden message activity sheets for each student.

Learning about important concepts through play

Introduction (5 min):
Explain to the students that they are going to carry out a set of challenges that introduce them to important concepts about binary code, image representation and algorithms.

Description of the lesson (45-60 min):

CHALLENGE 1 – PROGRAMMING WITH CUPS

An algorithm is an ordered and finite set of instructions to help come up with a solution to a problem. The students must use plastic or cardboard cups to replicate this structure. Explain to the students that they will work in small groups of two, where one student will act as the programmer, who gives the instructions to another student who acts as the computer and will be the person who moves the cups following the instructions of the programmer. Initially, the board is empty with the cups piled on one side.

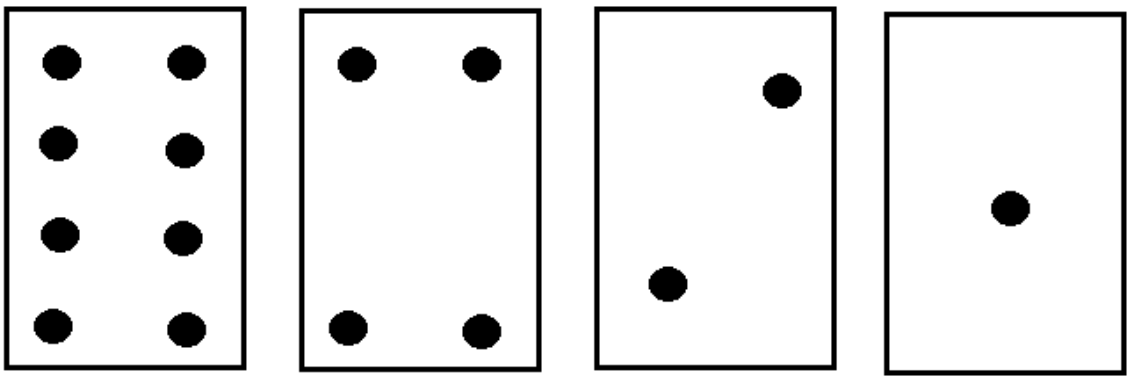
These are the instructions that the programmer can use:

- Raise the cup
- Lower the cup
- Move 1/2 cup width forward
- Move 1/2 cup width backwards
- Turn the cup 90° to the right
- Turn the cup 90° to the left

In this task, students will learn how important it is to be precise when writing instructions and will become aware of the complexity of conforming to the code provided to design instructions in an algorithm.

CHALLENGE 2 – COUNTING IN BINARY

Preparation: Create or print the following cards. The students will use them to count in binary.



Hand out the sets of cards to the groups of students. Ask them to place all the cards in the sequence pictured above out in front of them. Explain to them that when a card is face down it represents a 0. If it is face up, then it represents a 1.

Tell the students that they are going to count in binary. To find out the decimal value, they need to add the dots on the cards that are face up.

First, ask the students to write the number in binary on a piece of paper.
Start with 0010. Follow together the rules of binary code. 0010 means: cards 8-down, 4-down, 2-up, 0-down. So, the decimal value here = 2.
Conclude by telling them what 0010 (in binary) 2 in decimal means.

Now, try with 0110 - 8-down, 4-up, 2-up, 1-down.
Ask the students to add up the cards that are now facing upwards (4 + 2 = 6). What is the decimal equivalent of 0110? The decimal equivalent is 6.
Conclude: 0110 (binary) = 6 (decimal)

Keep on practicing with the students until they understand how to count in binary. The next step is to ask the students to write the binary numbers from 0 to 15.

Binary code is a language based on the numbers 1 and 0, the combination of which gives rise to a series of commands. This system is used by computers to communicate and process all the information they store. Binary code has many uses, such as programming, data transfer, digital and electronic communication.

CHALLENGE 3 – CODING/DECODING A MESSAGE

Once the students have learned to count in binary code, they can then decode the hidden message.

Tell the students they need to find a hidden message. Hand-out and then explain worksheet 1. First, they need to write the equivalent decimal number next to the binary number. Next, they use the table below to both see what letter it corresponds to and to read the hidden message.

Binary System					Decimal System	Letter
16	**8**	**4**	**2**	**1**		
0	0	0	1	1		
1	0	0	1	0		
0	0	1	0	1		
0	0	1	1	0		
0	0	1	1	1		
1	0	0	1	0		
1	0	1	0	1		
0	0	1	1	1		
1	1	0	0	0		
1	0	0	0	0		

Decoding table:

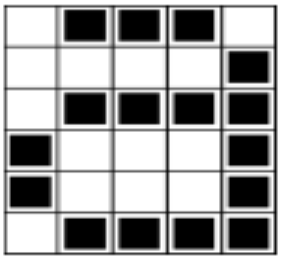
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
a	b	c	ch	d	e	f	g	h	i	j	k	l	ll	m
16	17	18	19	20	21	22	23	24	25	26	27	28	29	
n	ñ	o	p	q	r	s	t	u	v	w	x	y	z	

Extra activity: Ask the students to write a hidden message to another student. This involves them having to do the opposite:

1. write the message using text.
2. write the decimal number next to each letter.
3. convert it into the corresponding binary number.

CHALLENGE 4 – REPRESENTING IMAGES

Binary code is also used in the representation of images. Ask the students if they know what a pixel is? Explain that a pixel is the smallest unit of colour in a digital image. For example, a 12-megapixel camera has images consisting of 12 million pixels.



1, 3, 1
4, 1
1, 4
0, 1, 3, 1
0, 1, 3, 1
1, 4

Explain to the students that 0 and 1 in binary are like electrical pulses, and that something similar happens with pixels. Show them the example on the left and explain to them how they can find out how many 0 (off) and 1 (on) there are in the image.

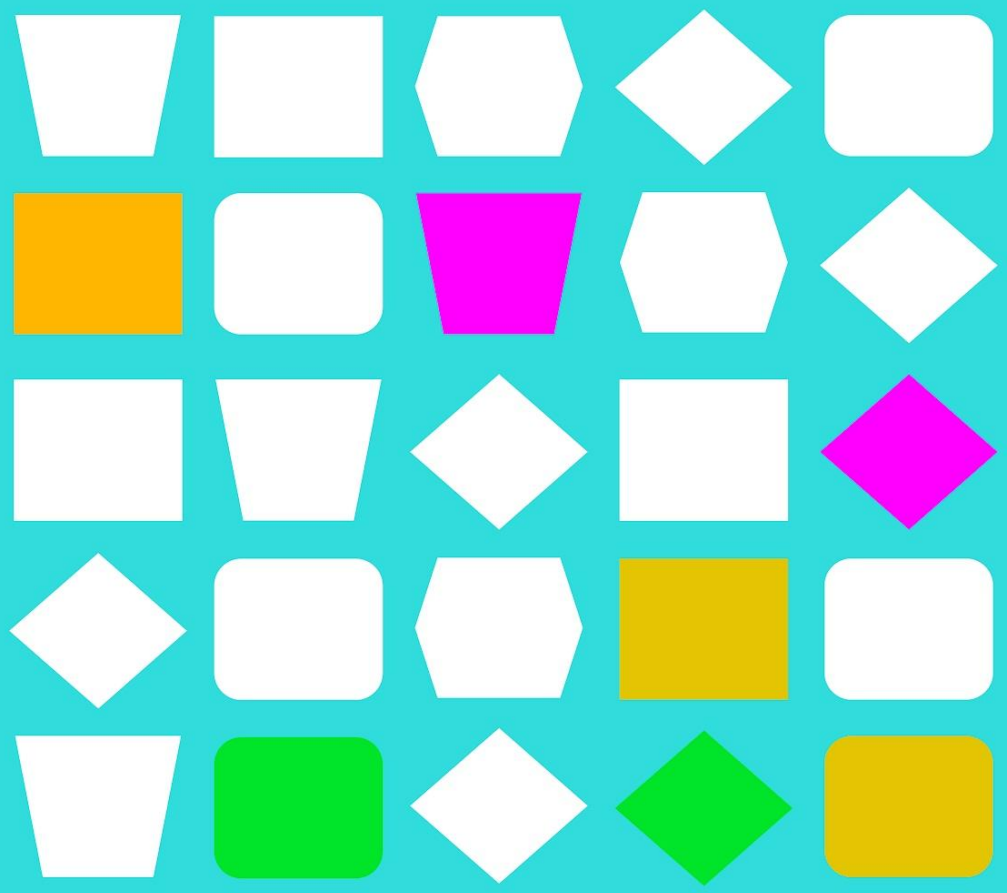
The pattern 1, 3, 1 tells us that in the first row there is 1 white, then 3 black and then 1 white. If a row starts with 0, as is the case with row 4, then this means that it starts directly with black.

Hand out appendix 2 to the students. Tell them to follow this same pattern to draw the hidden image of this template:

	6,2
	5,1,2,1
	5,1,2,1
	5,1,2,1
	5,1,2,1
	5,1,2,3
	5,1,2,1,2,2
	1,2,2,1,2,1,2,1,1,2
	0,1,2,1,1,1,7,1,1,1
	0,1,3,2,9,1
	1,1,13,1
	2,1,12,1
	2,1,12,1
	3,1,4,1,1,1,1,1,2,1
	4,1,3,1,1,1,1,1,2,1
	5,1,2,1,1,1,1,1,1,1
	5,1,8,1
	6,1,1,4,1,1
	6,1,6,1
	6,7

Extra activity: Ask the students to design a drawing with this pattern for another student by using the blank worksheet from appendix 2.

Conclusion (10 min):
Review with the students the knowledge they have learned through taking part in these activities. Remind them of the importance of binary code when transmitting and representing information as well as how important it is to be very concrete and exact when making programs or algorithms.



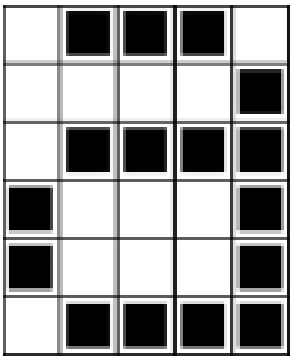
Appendices

Appendix 1: worksheet – challenge 3

Binary System					Decimal System	Letter
16	**8**	**4**	**2**	**1**		
0	0	0	1	1		
1	0	0	1	0		
0	0	1	0	1		
0	0	1	1	0		
0	0	1	1	1		
1	0	0	1	0		
1	0	1	0	1		
0	0	1	1	1		
1	1	0	0	0		
1	0	0	0	0		

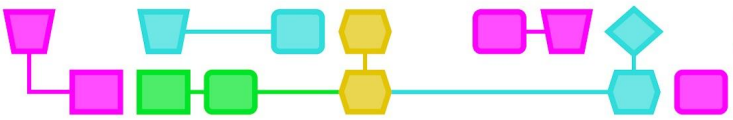
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
a	b	c	ch	d	e	f	g	h	i	j	k	l	ll	m
16	17	18	19	20	21	22	23	24	25	26	27	28	29	
n	ñ	o	p	q	r	s	t	u	v	w	x	y	z	

Appendix 2: Worksheet – challenge 4



1, 3, 1
4, 1
1, 4
0, 1, 3, 1
0, 1, 3, 1
1, 4

																6,2
																5,1,2,1
																5,1,2,1
																5,1,2,1
																5,1,2,1
																5,1,2,3
																5,1,2,1,2,2
																1,2,2,1,2,1,2,1,1,2
																0,1,2,1,1,1,7,1,1,1
																0,1,3,2,9,1
																1,1,13,1
																2,1,12,1
																2,1,12,1
																3,1,4,1,1,1,1,1,2,1
																4,1,3,1,1,1,1,1,2,1
																5,1,2,1,1,1,1,1,1,1
																5,1,8,1
																6,1,1,4,1,1
																6,1,6,1
																6,7



Appendix 3: solutions

CHALLENGE 3

Binary System					Decimal System	Letter
16	**8**	**4**	**2**	**1**		
0	0	0	1	1	3	C
1	0	0	1	0	18	O
0	0	1	0	1	5	D
0	0	1	1	0	6	E
0	0	1	1	1	7	F
1	0	0	1	0	18	O
1	0	1	0	1	21	R
0	0	1	1	1	7	F
1	1	0	0	0	24	U
1	0	0	0	0	16	N

CODE FOR FUN

CHALLENGE 4

	6,2
	5,1,2,1
	5,1,2,1
	5,1,2,1
	5,1,2,1
	5,1,2,3
	5,1,2,1,2,2
	1,2,2,1,2,1,2,1,1,2
	0,1,2,1,1,1,7,1,1,1
	0,1,3,2,9,1
	1,1,13,1
	2,1,12,1
	2,1,12,1
	3,1,4,1,1,1,1,1,2,1
	4,1,3,1,1,1,1,1,2,1
	5,1,2,1,1,1,1,1,1,1
	5,1,8,1
	6,1,1,4,1,1
	6,1,6,1
	6,7

Colophon

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