The Turing machine

In this lesson students will learn about English mathematician Alan Turing, his life, and his contribution to modern day computing. They will learn how Turing's system of computing works, and how this is still used in every electronic device to this day. They will also learn about Alan Turing's status as a World War II hero, who was later convicted for being homosexual. They ask themselves what it means to be considered a 'hero'. Duration: 1 hour.

STRUCTURE
- Introduction: Alan Turing and his Turing machine. (15 min.)
- Next step: The language of computers. (10 min.)
- In practice: Talking like a computer. (20 min.)
- Evaluation: From hero to zero and back. (15 min.)

PREPARATION
You can prepare by:
- Reading this teacher's guide and the students worksheet.
- Opening the presentation.
- Watching the video's.
- Watching the movie 'The imitation game'.

👥 CITIZENSHIP
This lesson focuses on the pillar 'participation', with the focus on developing the stances 'Promoting an atmosphere of non-discrimination in social relationships' and 'Contributing to the common good' (learning goals 5 and 6 curriculum framework SLO citizenship education and human rights education). In this lesson, students learn how Alan Turing served his country with his mathematical brilliance during World War II. They also learn how shortly after the war, Turing was not recognized for his contribution because of his homosexuality.

The component Citizenship in the Digi-doener is based on the citizenship portal from SLO. SLO distinguishes three domains of citizenship education: democracy, participation and identity. From this perspective we are working on citizenship in the Digi-doeners, more information can be found here.

⚖️ ETHICS
Alan Turing was considered a hero for helping decrypt secret messages during the second world war. After the war, he was arrested and convicted for being homosexual, and lost his hero status. Nowadays people see him as a hero again for being the father of modern computers. What does it mean for someone to be considered a hero? Can this change over time?

LEARNING TARGETS

| Domein curriculum 2021	Leerdoelen digitale vaardigheden	Kerndoelen	21st century skills
1 De werking en het (creatieve) gebruik van digitale technologie DG3.1 Interactie en creatie met digitale technologie.	**1 ICT-basisvaardigheden** De leerling weet hoe een 'klassieke' computer verschilt van een kwantumcomputer.	**1 Engels** De leerling leert strategieën te gebruiken bij het verwerven van informatie uit gesproken en geschreven Engelstalige teksten.	**1 Communiceren**
2 Digitale communicatie & samenwerking DG4.2 Digitale communicatie.	**2 ICT-basisvaardigheden** De leerling weet wat digitale afspraken/protocollen zijn die de basis vormen van een verbinding tussen verschillende apparaten in een netwerk.	**2 Engels** De leerling leert verder vertrouwd te raken met de klank van het Engels door veel te luisteren naar gesproken en gezongen teksten.	**2 Sociale & culturele vaardigheden**

INTRODUCTION

Opening slide

Slide 1, Group discussion

Ask the group: What do you think of when you hear the word 'computer'? (Possible answer: Desktop computer, laptop.) Would you say that a smartphone or tablet is a computer as well? (Answer: Yes, they are.) In today's lesson you will learn that all digital devices are computers and work in the exact same way.
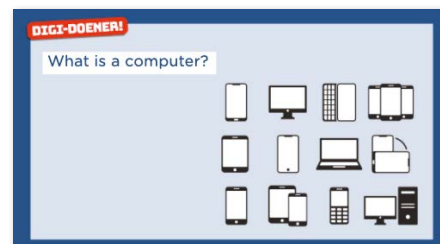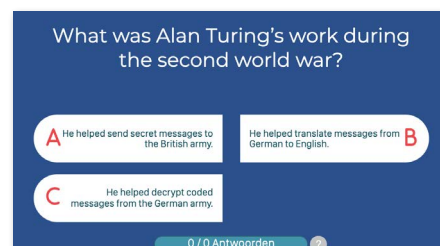

Slide 2, Group discussion

Watch the video together with the students. Explain: Nowadays we use computers, phones and other electronic devices for almost everything. But just a hundred years ago, none of these even existed! We'll explore the life and work of one man who was important for the development of the digital world. The British mathematician Alan Turing.

Slide 3, Individual

Ask the students: What was Alan Turing's work during the second world war? Correct answer: He helped decrypt coded messages from the German army.


Slide 4, Individual

Ask the students: What is rumoured about Alan Turing's friendship with his classmate Christopher Morcom? Correct answer: Alan was secretly in love with Christopher.

NEXT STEP
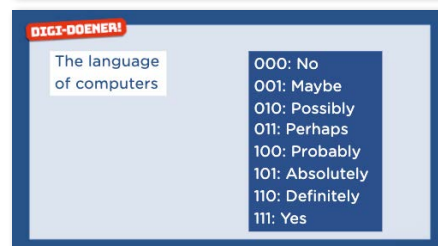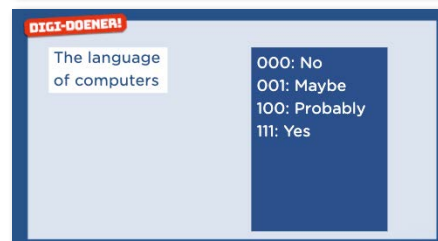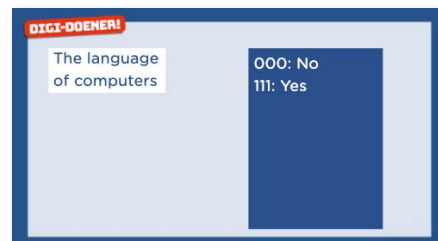

Slide 5, Group discussion

Ask the students: When he was young, Turing was fascinated by how the human mind works. He wanted to create a machine that could do the same things, but how could that work? What would that system need to do? Answer: Turing invented a system that could read, write and make calculations, just like his own mind. He realized that this is all he needed to simulate a simple 'mind'. This is now known as the 'Turing machine'.
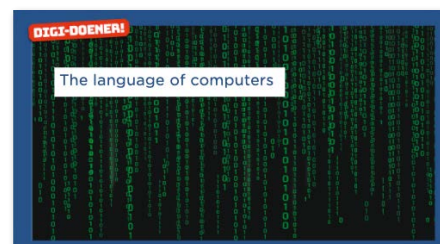
Turing's system didn't speak English though. It only spoke in 0's and 1's, so called 'bits'. Each bit can be either a 0, or a 1. The data in a computer is just an almost endless string of 0's and 1's. If each bit can only be a 0 or a 1, you only have two options! The computer would only be able to remember 'yes' and 'no', or 'on' and 'off'. Ask the students: How would you use bits to store complex data, like a word for example? (The is given on the next slide.)
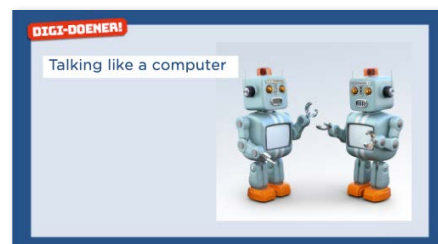
Slide 6, Group discussion

Explain: The solution Turing came up with, is to combine multiple bits, to create more options! (*Slide 2 tonen*) If each word is two bits long, the computer can already remember up to four. (*Slide 3 tonen*) The more bits you add, the more words you can store! Of course, a computer can store much more than just words. Anything on a computer, images, videos, sounds, is stored like this.

DIGI-DOENER!

The language of computers

000: No
111: Yes

DIGI-DOENER!

The language of computers

000: No
001: Maybe
100: Probably
111: Yes

DIGI-DOENER!

The language of computers

000: No
001: Maybe
010: Possibly
011: Perhaps
100: Probably
101: Absolutely
110: Definitely
111: Yes

IN PRACTICE

Slide 7, Group work

Explain: To exercise how this bit language of computers works, you're going to communicate like computers. First you will make a list of common English words, and assign a 'bit' word to them. Then one of you will communicate a sentence in bit language, and the other will translate it to English. You will work in couples, and you can find assignment 1 and 2 on the worksheet.

DIGI-DOENER!

Talking like a computer
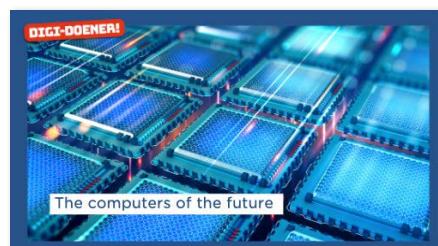
Slide 8, Group discussion

Explain: You have just coded and decoded a message from English to bits and back. The first time that Turing applied his idea of a 'Turing Machine', was to decrypt secret messages sent by the Germans during the second world war. The code was called the Enigma code, and Turing and others designed a computer that could automatically decrypt its messages. We'll now watch the trailer of a movie that was made about this time of Turing's life.

TRAILERS — The Imitation Gam...

TRAILER HD
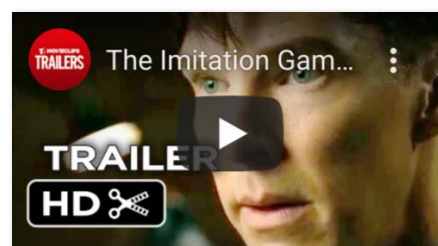
Slide 9, Group discussion

<u>Explain</u>: You have all just learned to talk like a computer. Most computers still use the basic system that Alan Turing invented. Some computer scientists are trying to invent a new kind of computer, the quantum computer. These quantum computers are special: instead of using regular bits that can either be 0 or 1, they use quantum bits, or Qbits. Qbits can be 0 and 1 at the same time! This may sound weird, and quantum computers are a bit weird, but it really works. If you want to know more, you can ask your physics teacher to tell you about quantum physics.

If you want to dive deeper into the subject of Qbits and quantum computing, you can show this video (in Dutch) from 2:47 till 4:54.

Slide 10, Group discussion

<u>Explain</u>: If a quantum bit can be both 0 and 1 at the same time, then it can store more than just the 'yes' or 'no' that a regular bit can store. You can store both 'yes' and 'no' in one bit at the same time! Or as you can see in example, you only need two quantum bits to store a sentence that would need eight regular bits. Can you think what the benefit of this would be? (<u>Answer</u>: You need a lot less storage space to store the same amount of data.)

EVALUATION

Slide 11, Group discussion

⚖️ 👫 Play the video, then discuss the following. <u>Explain</u>: Alan Turing was considered a hero for his work on the Enigma machine. After the war, he was convicted for being homosexual, and lost his hero status. Nowadays people see him as a hero again for being the father of modern computers. What does it mean for someone to be considered a hero? Do you think this can change over time? How relevant should personal details, like being gay for example, be to someone's hero status?

Write a short essay about the question 'What does it mean for someone to be considered a hero?' in 200 words.