Digital Detective

Abstract: Students are to decrypt a secret digital message. The message is written in 8-bit binary code, in which each 8-bit binary number represents an alphanumeric character. The translation from binary to character is based on the ASCII character set used by modern computers to translate computer numbers to equivalent text. The decryption process could be reversed to provide an encryption of text to binary code. Students might also write a detective story that incorporates their secret message.

Prerequisites: Students need to be introduced to the storage of text on a computer as an 8-bit binary number. They need to understand the process of converting a digital number to a binary number.

Resources Needed: Access to an ASCII character set table, an algorithm or calculator to convert a decimal to a binary number (see page 3). The following links may be a useful starting point

- www.asciitable.com
- www.usbyte.com/common/Binary%20System.htm

Activity

1. Students should familiarise themselves with the ASCII character set and all its representations – decimal, hexadecimal and octal formats.
2. Students identify the steps needed to translate a single letter of the alphabet into a decimal and binary number using the conversion algorithm or computer/calculator.
3. Students then investigate the reverse process by starting with a binary representation and converting it to the character format.
4. Students draw a flowchart to outline the conversion process from start to finish (alphanumeric character to binary), then outline the steps of the reverse process (binary to alphanumeric character).
5. Students compose a short story with a secret message for their friends to decrypt. This may include the decryption of a secret binary message.

Learning Outcomes: The activity provides a range of themes that might appeal to different learning styles and allows for the individual construction of knowledge about the development of the modern computer.

Other benefits for students: Students might work in teams to author and produce the fictional detective story in the format of their choice (text, cartoon strip, video).

Digital Detective - Student Worksheet

Q1 Using the ASCII character set table provided by your teacher, familiarise yourself with all its representations – decimal, hexadecimal and octal formats.

From a single letter of the alphabet, work out the steps needed to translate it into its binary equivalent. Find the decimal number that represents the character then calculate the equivalent binary format.

Alphabet _____ Decimal _____ Binary _____

Q2 Investigate how a computer might undertake the reverse process by starting with a binary representation and converting it to an alphanumeric character.

Q3 Draw a flowchart to outline the conversion process steps from an alphanumeric character to a binary number.

Q4 Draw a flowchart to outline the reverse process steps from a binary number to an alphanumeric character.

Q5 'Why wouldn't the skeleton go bungy-jumping?'
Decrypt the code to find answer.

01001001 01110100 00100000 01100100 01101001 01100100 01101110 00100111
01110100 00100000 01101000 01100001 01110110 01100101 00100000 01110100
01101000 01100101 00100000 01100111 01110101 01110100 01110011 00101110

O6 On the reverse of this page, write a short detective story about the CSIRAC computer. In your creative story, include a secret message for your friends to decrypt.

Further information on Binary – Alphanumeric Conversion

The binary system plays a crucial role in computer science and technology. Two digits 0 and 1 suffice to represent any number in the binary system. The ASCII character set is used by modern computers to translate alphanumeric text to decimal numbers (0 to 255) and these are stored on the computer in the 8-bit binary number equivalent.

The table below lists the first 16 decimal numbers and their binary equivalents.

Decimal	Binary	Decimal	Binary
1	00000001	9	00001001
2	00000010	10	00001010
3	00000011	11	00001011
4	00000100	12	00001100
5	00000101	13	00001101
6	00000110	14	00001110
7	00000111	15	00001111
8	00001000	16	00010000

Binary to Decimal

Any binary number can be converted into the decimal system by summing the appropriate multiples of the different powers of two. For example, to find the decimal equivalent of 10101101, we take each number starting from the left:

10101101

$= (\mathbf{1} \times 2^7) + (\mathbf{0} \times 2^6) + (\mathbf{1} \times 2^5) + (\mathbf{0} \times 2^4) + (\mathbf{1} \times 2^3) + (\mathbf{1} \times 2^2) + (\mathbf{0} \times 2^1) + (\mathbf{1} \times 2^0)$

$= 128 + 0 + 32 + 0 + 8 + 4 + 0 + 1$

$= 173$

Decimal to Binary

For the conversion of decimal numbers to binary numbers, the same principle can be used, but the other way around. First find the highest power of two that does not exceed the given number, and place a 1 in the corresponding place value in the binary number. For example for the decimal number 67:

The highest power of 2 that does not exceed 67 is $2^6 = 64$
In the remainder 3 (= 67 – 64), the highest power of 2 is $2^1 = 2$
In the remainder 1 (= 3 – 2), the highest power of 2 is $2^0 = 1$

67

$= 0 + 64 + 0 + 0 + 0 + 0 + 2 + 1$

$= (\mathbf{0} \times 2^7) + (\mathbf{1} \times 2^6) + (\mathbf{0} \times 2^5) + (\mathbf{0} \times 2^4) + (\mathbf{0} \times 2^3) + (\mathbf{0} \times 2^2) + (\mathbf{1} \times 2^1) + (\mathbf{1} \times 2^0)$

$= 01000011$