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BINARY FOR THE YOUNGER SET

A Lesson Plan for TryEngineering - www.tryengineering.org

Lesson Focus

This lesson is intended to provide very young students with a basic understanding of how the system of binary numbers works. The format of this lesson makes it easy for younger students to understand, as the format includes easy to digest colored slides. To conform to the young ages of these students, it is written in a very lighthearted form.

Lesson Synopsis

The lesson begins by asking how a Stone Age man managed to go home to his cave and tell his family he had caught 11 fish when he only has 10 fingers? It then draws the students attention to the curious fact that whereas, when we write a word on paper or on a blackboard, we begin at the left and gradually work over to the right. But when we write numbers we start over on the right, and work over to the left. And so it is the same with binary numbers. We then explain how simple binary numbers really are. It notes the convenient similarity between the binary system, which uses only two digits, a **0** or a **1** for everything it does, and electronic computers, which essentially asks itself two questions, **No** or **YES.** In essence, the binary system and computers seem to have been made for each other. There is also a side reference to the Morse Code, which also employs two symbols – a **Dot** and a **Dash**.

This lesson has been assembled with the youngest students in mind. In late 2015, it was tested on two classes of Grade 4's who found it not only easy, but also fun. In fact they were still at it when the bell rang. With this age bracket in mind, the text is light hearted and humorous. The lesson gives the binary version of all 26 letters in the alphabet, so that students can send coded messages to each other.

The lesson ends with a section in which the students are invited to discuss with the teacher, various ways in which they think these demonstrations could be improved.

Age Levels

9 – 12

Objectives

Students will:

- Gain a useful initial acquaintance with the basis of binary numbers, and by inference how computers work.
- Learn about the importance of discipline and team work.

Anticipated Learner Outcomes

Students will demonstrate/explain how:

- the Binary System works and its similarity to today's electronic computers.

Lesson Activities

- The cost of the materials required for this lesson are virtually zero – ten sheets of paper only.

Resources/Materials

- Teacher Resource Documents (PPT Slides).
- Student Resource Sheets (PPT Slides)

Alignment to Curriculum Frameworks

- See attached curriculum alignment sheet.

Internet Connections

- TryEngineering (www.tryengineering.org)
- ITEA Standards for Technological Literacy: Content for the Study of Technology (www.iteaconnect.org/TAA)
- NSTA National Science Education Standards (www.nsta.org/publications/nses.aspx)

Recommended Reading

- n/a

Optional Writing Activity

- Having discussed the obvious limitations of this very simple demonstration, students should be asked to set out ways in which they think it could be improved.

For Teachers:
Teacher Resources

Materials and Costs

For all intents and purposes, the material costs for the demonstrations in this lesson are zero; ten sheets of paper only, as set out in the hands-on section set out at the end of this lesson.

Safety Note

There are no conceivable safety hazards associated with this lesson.

◆ **Time Needed**

- It is suggested that, for the younger students, aged between 8 and 10, three sessions of 45 minutes each should be sufficient. For older students, two such sessions should be enough.

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Student Worksheet/Handout:

◆ **Reflection**

Student/Teacher discussion and exercises using the following colored handouts as an aid.

INSERT 41 SLIDES HERE

PUT LAST SLIDE HERE

AN INTERESTING AFTERTHOUGHT

Most of you will have heard of Morse Code. This is the code which was used in the mid 1850's for sending telegraph messages over telegraph lines. It is actually still in use today for some radio applications. The telegraph itself was invented by others, but the code which made the telegraph usable was developed by William Samuel Morse (1791 – 1878) of the USA in the period 1832-1843. The sender had a button to press, which sent an electric current down the line to the receiving end, where there was just a simple buzzer, just like a front door buzzer. Although people in those days didn't know it, Morse code was, in effect, an early predecessor of the binary code. It only has two characters – a "dot" and a "dash". The dot was simply the noise the listener heard when the operator gave his button (called a sending key) a quick tap. A dash was what the listener heard when the operator held his key down for a slightly longer time. Experienced operators could send and write down messages surprisingly quickly – often as many as 10 words a minute, depending on the length of the word. One of the most famous instances of the use of the Morse code was when the liner Titanic sank after hitting an ice berg in 1911. The signal sent out was S O S, which by agreement meant "Save Our Souls". It was used because the Morse symbols were very simple and easily repeated:-

S is - dot, dot, dot.
O is - dash, dash, dash,
S is - dot, dot, dot.

Or, **... --- ... .**

These symbols are still used today. Sometimes, when people want help quickly by e-mail, the put S.O.S. as the subject of the message.

For Teachers:
Alignment to Curriculum Frameworks

Note: Lesson plans in this series are aligned to one or more of the following sets of standards:

- U.S. Science Education Standards (http://www.nap.edu/catalog.php?record_id=4962)
- U.S. Next Generation Science Standards (http://www.nextgenscience.org/)
- International Technology Education Association's Standards for Technological Literacy (http://www.iteea.org/TAA/PDFs/xstnd.pdf)
- U.S. National Council of Teachers of Mathematics' Principles and Standards for School Mathematics (http://www.nctm.org/standards/content.aspx?id=16909)
- U.S. Common Core State Standards for Mathematics (http://www.corestandards.org/Math)
- Computer Science Teachers Association K-12 Computer Science Standards (http://csta.acm.org/Curriculum/sub/K12Standards.html)

◆National Science Education Standards Grades K-4 (ages 4 - 9)

CONTENT STANDARD A: Science as Inquiry

As a result of activities, all students should develop

- ✦ Abilities necessary to do scientific inquiry
- ✦ Understanding about scientific inquiry

CONTENT STANDARD B: Physical Science

As a result of the activities, all students should develop an understanding of

- ✦ Binary Number System

CONTENT STANDARD E: Science and Technology

As a result of activities, all students should develop

- ✦ Understanding about science and technology

◆National Science Education Standards Grades 5-8 (ages 10 - 14)

CONTENT STANDARD B: Physical Science

As a result of their activities, all students should develop an understanding of

- ✦ The binary system for expressing information and how it relates to Information Technology today

CONTENT STANDARD F: Science in Personal and Social Perspectives

As a result of activities, all students should develop understanding of

- ✦ Science and technology in society

CONTENT STANDARD G: History and Nature of Science

As a result of activities, all students should develop understanding of

- ✦ History of science

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For Teachers:
Alignment to Curriculum Frameworks

◆Next Generation Science Standards Grades 3-5 (Ages 8-11)

◆Standards for Technological Literacy - All Ages

Technology and Society

- Standard 7: Students will develop an understanding of the influence of technology on history.

Design

- Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

The Designed World

- Standard 16: Students will develop an understanding of and be able to select and use energy and power technologies.