BINARY NUMBER
LESSON PLAN: Class 04 / P / 10

(Rough sketch – design phase)

Overall goal of the lesson: Children will learn about Binary Numbers.

Prior knowledge required: Knowledge of basic mathematics: addition, multiplication.

MODULE 1:
Module time: 35 minutes
Goal: To give a brief introduction to the binary numeral system and explain why and where it is used.
Description: Children will learn about binary numbers with the help of an activity.
Material required:
Physical:

1. One copy of the worksheet (Binary Numbers) per child.
2. Writing material to solve the worksheet: pencil and eraser.

Electronic:
PPT Presentation for Binary Numbers.
Procedure Summary:
Distribute the worksheets (Binary Numbers) to the children.
Procedure Details:

1. Start the class by asking the children how old they are. *Typically, Class 4 students are 9 or 10 years old*. Ask them if they know how to count! Ask the children if they can count up to the number 9. Raise your palms up to the class and count with your fingers.
2. So what will happen if you wanted to count till twenty using this method? You could still do it using your hands and fingers. Ask the children to count with their fingers again.
3. Now try counting till fifty-seven. Tiresome isn't it? Imagine if you wanted to count to one hundred or five hundred. It would near impossible and chances of mistakes would also be high! And what if we wanted to have a written representation of the things we are counting.
4. For example, nine years can be represented with symbols as |||||||||. Ask the children if we can represent twenty using the same method. Ask them to represent twenty without using actual numbers or letters on the worksheet. *Allow about 2 or 3 minutes for this exercise*.
5. We can represent twenty as symbols, but we would quickly be in trouble if we wanted to count higher. This method is bulky and takes up too much space and too much time! Plus, we still have the problem of making mistakes while counting.
6. To solve this problem, mankind invented the Number System. The most commonly used number system or the most familiar number system is the Base 10 or the Decimal Number System. Why ten? Probably because we have 10 fingers and it is natural to think in terms of ten or to put things in bundles of tens. So now, if are using our fingers to count till twenty, we are basically counting all our fingers twice. That means we have two bundles of ten fingers making up the count of twenty!
7. In the Base 10 or Decimal Number System there are ten symbols to represent numbers: 0 1 2 3 4 5 6 7 8 9. We are all familiar with these symbols. We use them every day in our lives ... and yes, also in our Math class!
8. Ask the children if they know how many days in one year. Answer is 365 (assuming non-leap year).
9. Ask the children if they can write the number of days in a year on the blackboard. Ask one of the children to come up and write it on the board.
10. Ask the children why three hundred and sixty-five is represented by the digits 3 6 and 5, in that order. Answer is: the digit 3 is in the hundreds place, the digit 6 is in the tens place and the digit 5 is in the unit's place, giving us a total of three hundred and sixty-five i.e.: 10x10x3 + 10x6 + 1x5 = 365.

    This literally means we have five bundles of one, plus six bundles of ten, plus three bundles of hundred, giving us a total of three hundred and sixty-five. Every digit is assigned a PLACE Value! The units

or ones' place has a place value of 1. The tens place has a place value of 10. The hundreds place has a place value of 10x10 = 100.

11. Let's go over what we know so far.
    a. We know that we have ten fingers.
    b. We know that we can count using our fingers. We know we can count in bundles of ten.
    c. We know that this is the basis of the Base 10 or the Decimal Number System.
    d. We know that in the Decimal Number System, the rightmost digit is assigned ones' place and as we move leftward, the digits are assigned place values in bundles of 10.
12. Ask the children whether the Decimal Number System the only numbering system in the world? Answer is No. There are many more… for example: Unary (like the line symbols we used earlier), Binary (which we are going to talk about in greater detail), Octal, Hexadecimal etc.
13. What is Binary? Binary literally means composed of or involving two things! We see "bi" in words like bicycle (two wheels), biannual (twice a year), bifurcate (split into two), bifocal (two lenses). BI = TWO.
14. We see Binary in our everyday lives! For example, a light bulb is Binary because it has two positions: it is either OFF or it is ON. Let's turn to our work sheet and write down other examples of Binary we see in our everyday lives*. Allow about 5-6 minutes for the students to write their answers. Some examples are: Tap (Turn on for water. Turn off to stop), Door/Window (It's either open or closed), Candle (lit/unlit), Gas Stove (on/off), Vehicle Horn (Press to sound. Release to Stop), Bell (ringing/not ringing), Engine (running/stopped). TV (on/off) … Mom shouting (yes/no)*.
15. So then, how is Binary represented as numbers? In the decimal number system, digits are represented as symbols 0 through 9 (0 1 2 3 4 5 6 7 8 9). **Bi**nary Digi**t**s, also known as Bit, are represented by two symbols 0 (OFF) and 1 (ON). Repeat after me: 0 = OFF and 1 = ON.
16. How can 0 and 1 make up a numbering system? As we learned earlier, the Decimal Number System is based on bundles of ten … similarly the Binary Number System is based on bundles of two. Remember, BI = TWO. So if we compare the two numbering systems for place values, this is what it looks like

	Decimal (Bundles of Ten)	Binary (Bundles of Two)
Units Place	1	1
First Bundle	1x10 = 10	1x2 = 2
Second Bundle	10x10 = 100	2x2 = 4

17. We can make Binary Numbers using a combination of the OFF = 0 and ON = 1 bits. For example

Second Bundle = 2x2 i.e. Value = 4	First Bundle = 1x2 i.e. Value = 2	Units Place. Value = 1	VALUE (Add values of ON bits)
OFF	OFF	ON	0 + 0 + 1 = 1

18.

Second Bundle = 2x2 i.e. Value = 4	First Bundle = 1x2 i.e. Value = 2	Units Place. Value = 1	VALUE (Add values of ON bits)
OFF	ON	OFF	0 + 2 + 0 = 2

19.

Second Bundle = 2x2 i.e. Value = 4	First Bundle = 1x2 i.e. Value = 2	Units Place. Value = 1	VALUE (Add values of ON bits)
OFF	ON	ON	0 + 2 + 1 = 3

20. OFF/ ON? How does this get represented as numbers? Remember we said OFF = 0 and ON = 1. Using these symbols, if we wanted to write the number 2 in Binary, we will write it as: 010

21. The number 3 is written as 011.

22. You are probably thinking what possible use could this be? Why would I want to know about a numbering system made up of just 0 and 1? Because … This numbering system is used extensively in the digital world. The Binary Number System is used internally in almost all modern computing systems. Every computer,

phone, tablet, gadget … Google, Facebook, twitter, Instagram, WhatsApp and what have you … all use the Binary Number System. Binary is what **all** computers understand.

23. So how do Binary Numbers come into the picture for computing systems? A computer is built with millions of components which are used to store information, transfer information and communicate with components and other computers or gadgets too. Most of the storing, transferring, and communication happens with electronic circuitry that works the Binary way. For the electronic parts to work, they must send either an OFF signal or an ON signal … 0 or 1. As we have seen, a combination of OFF/ON signals make up the Binary Number System. At the lowest level, the millions of components can all understand on/off signals which are then interpreted via programs, encodings and protocols into music, photos, video, text, and other kinds of data.

24. Let's recap what we have learned so far…

a. While the decimal numbering system is most common and familiar numbering system in this world, it is not the only system. Place values are bundles of ten.

b. The Binary Number System has two digits 0 (OFF) and 1 (ON). Place values are bundles of two. All binary numbers are a combination of zeros and ones.

c. The Binary Number System is the most extensively used system in the modern world because it is the underlying system used by all computers and gadgets in this world.

25. Let's go to our worksheets and apply what we have learnt so far.

Assessment:
Answer questions on the activity sheet
Information Broadcast: In Computer Science, the children learnt about Binary Numbers.