Math G8 Binary Systems and Computers

By Earthschooling

A common theme running through the Waldorf math blocks this year is exploring more practical applications of math. This is similar to when the student explored business math in 6th grade. The lesson blocks this year all have practical, daily applications. This year, however, the 8th grader will be applying not just arithmetic and algebra but also plane and solid geometry, graphs and the measurement of surfaces and volume. How this fits into modern industry will be connected. This binary system is part of the student's understanding of the industry around them and part of their process in applying this knowledge later, when they build a computer.

As is the method since early childhood, students are lead into larger projects and ideas slowly to ensure they know what they are learning before they move on to the next step. Scientific studies have shown that time is an often unused factor in learning. Students need time to absorb material before they can move on to later stages. Modern educational methods often forget this step in the rush to "move on to the next step". Honoring and recognizing this in Waldorf education will allow your student(s) an educational advantage. In the case of Binary Systems and Computers keep in mind that your students will be building simple computer boards in a later grade and that this information is essential for them to understand for this later project. Letting them know that this "big project" is coming can also help motivate them and help them find a deeper meaning in this lesson.

Waldorf critics have often cited "lack of computer exposure" as a negative in Waldorf schools. However, this lesson, combined with the later lesson on building a computer, illustrate that students actually have more computer exposure than mainstream students, because they understand the *inner-workings* of the machine. However, each Waldorf school is unique in how they approach the question of computers. What is right for your classroom may not be what works for another classroom. Read the following article by Jamie York and Shining Mountain Waldorf School (Winter 2006) to help you become familiar with how other Waldorf schools deal with the "Computer Question":

Results from a Survey on Computer Curricula in US Waldorf Schools **by Shining Mountain Waldorf School**

Background
In the Fall of 2005, the College of Teachers at Shining Mountain Waldorf School asked me to find out what other Waldorf schools in the country had for a computer curriculum. This was part of our first review of our new computer curriculum. I decided to survey (via e-mail) the various Waldorf High Schools in the country in order to gather the information.

Method
The survey consisted of six quick questions. Most of those who responded did so via e-mail. A few of the responses (Washington, Kimberton, San Francisco) I typed in after a brief phone or e-mail conversation. The completed surveys are attached at the end of this report.

Participation
Fourteen Waldorf high schools in the country responded. These schools were: Saratoga Springs, High Mowing (Wilton, NH), Santa Fe, Ann Arbor, Austin, Rudolf Steiner (NYC), Sacramento, Shining Mountain (Boulder, CO), Kimberton, Washington, Green Meadow (NY), Massachusetts Bay, San Francisco, Chicago.

Summary of results
(Note that 14 schools responded to the survey
Number of schools having *no* required computer courses: 5
Number of schools having *at least one* required computer course: 9
Number of schools offering *at least three* computer courses: 5
Number of schools having a *keyboarding (typing) course*: 5
Number of schools having a *intro to computers/applications course*: 4
Number of schools having a *circuits course*: 7
Number of schools having a *programming course*: 3
Number of schools having a *film/graphics course*: 3
Number of schools having a *web design/internet course*: 4
Number of schools having a *"media" course*: 4
Number of schools having a course with a *man & machine theme*: 2
Number of schools having a dedicated computer lab: 6
Number of schools reporting that they use a mobile stock of laptops: 3

Some of my Reflections

Several Waldorf high schools in this country, if not most of them, are struggling with what to do with computers. What is offered varies greatly. Some schools have a relatively mainstream offering of computer courses; other schools' computer courses are very "Waldorf". In total there seem to be six schools that have a fairly well developed curriculum. Even with most of these schools I get a sense that their computer curriculum is in flux; next year's offerings may be completely different than this year's. And this seems to have less to do with the rapidly changing technology, and more to with the school's struggling to figure out how computers fit into a Waldorf school setting. Of these, only three (High Mowing, Ann Arbor, and Austin) require more than 40 classroom hours of computer study (which is about as much as two main lessons and a bit less than having one course that meets four times per week for a semester). The Austin Waldorf School has the most offerings with 9 required courses totaling about 180 classroom hours. Two schools (Steiner School in New York, and Saratoga Springs) have found quite creative ways to work their computer curriculum into their school schedule without it taking up a great deal of classroom time.

Resources

Bryan Whittle has written a paper on a computer curriculum which can be found at www.waldorflibrary.org/pg/research/research.asp. Also in February 2002 ASWNA's David Mitchell organized a three-day computer colloquium. The transcript from this colloquium is titled "Colloquium on the Computer and Information Technology", and can be found at www.waldorflibrary.org. John Kirkilis runs the digital arts program in Austin, and can be contacted at john@austinwaldorf.org for more info. Cedar Oliver (High Mowing) has a paper on digital arts posted at http://24hourhtmlcafe.com/cedar. Note from Earthschooling: We strive to avoid posting links in our materials as they often become broken or outdated. However, the information above was part of the original article and we feel it is important to parents/teachers wanting to do additional research on the subject. You can find the student's main lesson for this block below on the next page.

Why Computers Use Binary

As with all Earthschooling lessons this lesson can be “read” to the class (public speaking method where you don’t look at the paper constantly and read directly) or can be interpreted into your own lesson. Blue font represents your interactions or lessons with the student(s).

Remember when we learned about the history of numbers in 6th grade and how some cultures didn’t use a “base ten” system like we did (tie-in)? Computers are the same – they don’t use a “base ten” system. They use what is called Binary numbers – a “base two” system - what we see as a string of 0s and 1s. These 0s and 1s are also known as binary digits or *bits. Remember this later when we talk about bytes. People often mix up the two terms – bits and bytes.*

The first thing that comes to our minds when we see these long string of numbers is – isn’t that really inefficient? It takes up so much space and isn’t a computer’s goal to be as efficient as possible?

Can anyone tell me why? Or guess why?

Let’s go through this step-by-step:

1. Modern day digital computers function on the simple principle of “on” and “off” (tie in: we learned about this in our lesson block on electricity in seventh grade). The state of “on” is assigned to the value 1 while the state of “off” is assigned to the value 0. This is easy to remember because off being associated with zero seems to be a logical correlation.
2. Functioning on a system of “two” is where the term Binary comes from (BI meaning two).
3. Each time you have a circuit go “on” and “off” you are switching something “on” or “off” like you switch on or off a light (although as we learned in G6 when you switch a light on you are actually switching the circuit to “off”) so each of these is called a switch because that is what it does.
4. If you add enough of these switches together you can represent more than just numbers. In fact 8 of these switches equals what is called a “byte”. Bytes are the very basis of what computers use to store data.
5. On first glance, it seems like the binary representation of a number 10010110 uses up more space than its decimal (base 10) representation 150. The first is 8 digits long and the second is 3 digits long. However we have to remember that once a number or item reaches our computer screen it is already stores in binary so since everything is stored in binary the only reason that 150 is "smaller" than 10010110 is because of the way we write it on the screen (or on paper).
6. And here is the final surprise – of course it is logical if you think about it but we

don't usually spend time thinking about numbers outside of base-ten. Increasing the base *will* decrease the number of digits required to represent any given number, but it is impossible to create a digital circuit that operates in any base other than 2, since there is no state between "on" and "off". So, yes, it would be more "efficient" if you were just writing computer code and not expecting it to work, but once it was written out in any base other than two-base it would not function. So it would be really "efficient" written out but would be useless. Some day in the future we might be able to create "quantum" computers that could access more states than "on" and "off" but this is an idea for science fiction right now.

Does anyone know how the byte system works?

What is interesting is that although kilobytes, megabytes and gigabytes come from the byte they do not come in blocks of 1000 as we are told on the manufacturer's packaging – they come in blocks of 1024 – because 1024 is a power of 2 and not 1000. Remember – we are using a base-2 system.

If you use computers you may already be familiar with this issue and not realize it. Have you every purchased an external hard drive or jump drive and wondered why it starts out without the full data storage limit? This is because the drives are actually not labeled correctly. They are labeled to be more familiar to humans using a base-ten system but they are really base-two drives. So, for example, a drive labeled 8.4 Megabytes (8,400,000,000 Bytes) actually holds 7.82 Megabytes. This is because you need to divide by 1024 (as I mentioned before) and NOT by 1000 like we do in the base-ten system. So from now on when you buy a computer drive divide the number of Bytes it has by 1024, then multiply that by 1000 and you will see how many Megabytes you actually have!

Write this in your main lesson books…

8 digits in the circuit = one byte
One kilobyte = 1024 bytes

So let's review a little about the base-ten system and compare it to the binary system…

Like we learned in Fifth Grade a system is "based" on how many possible digits it can have. So a base-ten (decimal) system has ten possible digits and everything else is a derivative of those ten digits. So a base-two system only has two possible digits and everything is a derivative of those two digits.

Do you know what the ten possible digits in the decimal system are?