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Name of lesson: How Does A computer Remember?

Target grade(s): 7th – 8th

Time required preparing for lesson each time it is used: 30 minutes

Time required using or implementing lesson plan:
- 40 minutes for prior understanding
- 50 minutes for setup and exploration
- 50 minutes for findings review and active assessment (ideal electromagnet)
- 30 minutes for students to do lab write-up

Equipment or materials needed:
- White board, chalk board, or overhead for instructor use
- Paper and pencil: 1 each per student
- Lab notebooks: 1 per student
- Old 4.75” or 3.5” floppy opened to remove magnetic disk inside
- Long table or counter for materials
- Batteries, D-cell (or 9 volt): 1 per team
- Large Nails and Bolts with some iron content: 1 per team
- 4-6” Rods of pure elements, e.g. aluminum, copper, nickel, should not contain iron: 1 per team
- 4-6” Rods of compounds, e.g. brass, steel, should contain iron: 1 per team
- 18” lengths of small gauge solid Copper and Aluminum Wire: 1 per team
- 18” lengths of Speaker Wire split in 2 pieces: 1 per team
- 18” lengths of stranded Copper and Aluminum Wire: 1 per team
- 20-40 small Paper Clips and/or very small Washers in a small cup, must be metal so that they can be picked up by a magnet: 1 per team
- Roll of electrical or masking tape

Safety precautions that should be taken or pointed out:
- Students can get a “buzz” from the batteries
- The ends of the stranded wire can puncture the skin fairly easily
- The wires, especially the thin ones, can get hot very quickly. It is recommended to use insulated wire and tape one end to the battery so that it is necessary to hold only one end of the wire.

Driving question:

How do scientists and engineers determine how to make improvements in how computers store information?

Relationship of the lesson plan to the driving question and how it is pointed out:

This lesson illustrates how an electric charge can be created, stored, and removed using an electromagnet. The students will hypothesize and then explore which materials create the best electromagnets. Computers store internal data electromagnetically. The principles behind how an electromagnet works are very similar to the principles of computer data storage: RAM, ROM, hard drives, and floppy disks. The tie between the scientific inquiry the students perform during this activity and how scientists and engineers determine how to make improvements will be pointed out at both the set up of the activity and during the findings review at the end.
Learning objective(s):

- Students will create a magnetic charge using an electric field.
- Students will change the strength of the magnetic charge by changing what materials are used to make the electromagnet.
- Students will determine which materials make a stronger magnetic charge.
- Students will discover that it is possible to create a permanent charge.

Concepts or inquiry skill(s) the students will develop:

- Ability to build a simple electric circuit.
- Ability to apply principles of electron flow to change the electric field created.
- Identification of which elements work best as electromagnets.
- Locate the elements with electromagnetic properties on a periodic chart.
- Creation of hypotheses based on observation.
- Identification and/or creation of investigable questions.
- Documentation of experimental process (lab write-up).

State Science and Technology Academic Standards covered or fulfilled by this lesson:

- SSC1 SP06 Explain the systematic organization of the periodic table.
- SSC1 DP02 Explain the interactions of the parts of the atoms.
- SSC1 SP07 Investigate how the transfer of energy can affect the physical and chemical properties of matter.
- S1C1 SP01 Formulate questions based on observations that lead to the development of a hypothesis.
- S1C1 DP01 Formulate questions about the world around you.
- S1C1 SP03 Generate a hypothesis that can be tested.
- S1C2 SP01 Demonstrate safe behavior and appropriate procedures in all science inquiry.
- S1C2 SP02 Design a controlled investigation to support or reject a hypothesis.
- S1C2 SP03 Conduct a controlled investigation to support or reject a hypothesis.
- S1C2 SP05 Keep a record of observations.
- S1C3 SP01 Analyze data obtained in a scientific investigation to identify trends.
- S1C3 SP05 Explain how evidence supports the validity and reliability of a conclusion.
- S1C4 SP01 Communicate the results of an investigation.
- S1C4 SP05 Communicate the results and conclusion of the investigation.
- S2C2 DP01 Using the scientific process from beginning to end; create a hypothesis, plan how to test the hypothesis, conduct the experiment, analyze the data and present the findings.

Other subjects that this lesson plan addresses:

- Writing investigable questions.
- Writing lab write-ups.
- Magnetic properties of matter will be the tie-in to the required 8th grade curriculum topic of Matter – atomic structure, properties, and the periodic table.
- Computers, which are one form of an embedded system will be a tie-in to my research topic: Quality Attributes of Embedded Systems.
- A second tie-in to my research is the discussion on the advantages and disadvantages of different storage media. These are also known as quality attributes.
Lesson Plan Procedure

A. Instructional strategies:

• Determine students’ prior knowledge of the content;

It can safely be assumed that all of the students have used a computer and understand that the computer must “remember” or store data in order for it to work. The 7th and 8th grade curriculum requires all students to attend a computer/technology course 4 out of every 6 days all year long both years.

The lesson is started with a large group discussion/activity to ensure that all students have the basic knowledge needed about how data travels through a computer and how it is stored. Students will be asked to individually sketch and label a computer showing where data enters the computer (keyboard and mouse) and exits the computer (display and printer) and where it is stored (hard drive, RAM, CD, thumb drive, floppy disk, etc.). The instructor will sketch a compilation of the ideas on the board based on student inputs. The advantages and disadvantages of the different storage media will be discussed using student input as a driver.

• Introduce the lesson and capture the students’ attention;

The instructor will move the discussion to focus on data storage on magnetic media, i.e. hard disks and floppy disks. The magnetic disk from inside a floppy disk that has been opened will be shown to the students. Questions on how much data there is on the disk and how it is actually stored will be raised, e.g. Can we see the writing with a magnifying glass? Is data erased using an eraser? The disk can be passed around for students to examine.

• Link the activities to the driving question of the lesson plan;

Next the discussion moves to how data is stored electromagnetically on the hard drive (and floppies) of the computer. The idea that every character, number, punctuation mark, etc. is stored as a code consisting 8 bits of data is presented. This means that each code is stored using 8 extremely tiny electromagnets. The smaller and better the electromagnets are, the better the computer memory. Students are told they will build a single electromagnet and then use hypothesis and experimentation to improve the strength of their electromagnet. This is the same process used by scientists and engineers in industry.

• Assess if the learning objective(s) was/were met;

A formal lab write-up for the experiments each group ran will be required.

Results from all experiments will be presented and combined to predict the materials that should be used for the “best” electromagnet. If time permits, this electromagnet can be built and demonstrated.

B. Step-by-step procedures:

1. Put the materials needed for the activity out on a long table or counter. Arrange them in the groups listed in the list of materials, i.e. solid wires are together, stranded wires together, etc. Having the material out will automatically create an interest in what is going on.

2. Have the students get out a sheet of paper and a pencil.

3. Open a discussion about computers starting by asking how many students have used a computer and how many have seen the inside of a computer. This will help to identify any students that might need additional help later. Briefly introduce the concept of data storage in the computer: files, pictures, programs, etc.

4. Have the students draw a 1-3” box in the center of their paper and label it “computer”. Draw a larger version on the chalk board for them to see what you are asking them to do. Explain that they will be
Students will explore magnetic properties of matter using electromagnets. Electromagnets are made from material that does not normally carry a charge but has properties that will allow it to take a charge. The material is given a charge by running an electric field around it. Although this is not an exact duplicate of what is done in a computer, the principles are similar enough to illustrate the properties of matter that are needed.

Show the students a nail made with iron that has no magnetic charge. Make it into a simple electromagnetic using a 9-volt or D-cell battery and a length of wire. This is done by wrapping the wire tightly around the nail leaving about 8” of wire at each end and then touching a wire to each end of the battery. While the battery is connected, use the electromagnet (the nail) to pick up aluminum paper clips.

Working in small groups, have the students make an electromagnet using a pre-defined set of materials. This should increase interest as well as ensure that everyone has a basic grasp of how to make an electromagnet. Have them record how many paper clips their electromagnet picked up.

Discuss the results of the initial activity. Draw a table on the board to use to record the number of paper clips lifted by each group. Lead the students in a discussion as to what they think might be going on. Review of the periodic table as part of the discussion. Focus specifically on the metals and the transition elements and their properties. NOTE: This is a quick review. The material needs to have been taught previously. In addition, the concept of an electric field will need to be introduced. A simple diagram should be sufficient.

Record the students’ hypotheses about how the electromagnet works and how it might be made to work better (pick up more paper clips) on the board. The variables available to change are the wire and the core (nail). There will only be one type of battery available for their experiments. Longer and shorter wire, thinner and fatter wire, and a variety of nails, some without iron will be available for them to explore. They will probably also want to try different ways of winding the wire and changing which direction the battery is connected.

Tie the hypotheses to questions that the students might want an answer to. Do this as a large group and record the questions on the board. Assess each question as to whether it is investigable or not. Based on the discussion, create a final list of investigable questions.

Working in groups of two or three, the students are given time to investigate one or more of the questions by experimenting and recording their findings. They are required to record the materials used for each experiment, why they chose them – what they are hoping to find out, the specifics of the set up, as well as how many paper clips could be picked up. This reinforces curriculum topics relating to scientific process.

After the experimenting is complete, review the findings. Each group should present one finding. Record the findings on the board. As the information is recorded, similarities and differences should be noted. After all findings are recorded, the group should attempt to come to a single finding of the ideal
diameter and length of wire, the best way of winding the wire, and the best core material to produce the strongest electromagnet. Additional observations such as the core maintaining a charge even after the battery is removed can be discussed. The notion of quality attributes should be revisited.

17. (Optional) Using the parameters defined for the “best” electromagnet, build an electromagnet and try it. It should pick up more paper clips than any of those created by the students. If it does not, discuss what might be causing the electromagnet to have a lower performance – weak battery, poor wire connections, wrong choice of materials. Compare the "best" electromagnet to the one the students created that had the best performance.

18. As an assessment, the students are to create a lab write up that includes their hypothesis, the materials used, their procedure, a table of their data, and a conclusion.