Lesson 1: History of Semiconductors

**Goal:** Students will describe the advancement of semiconductor technology since its beginnings in 1947.

**Exploration:**

**Objective:** Students will make inferences about the operating systems existing within samples of modern technology.

Materials per group: several items containing microchips (e.g. radio, wristwatch, calculator, birthday card with a sung greeting, hair dryer, lamp timer, a thermometer that beeps when it has read your temperature, a programmable thermostat, a child’s game)

Procedure: Place students in groups of three: materials manager, recorder, reporter. Have each student examine one of three items. Ask: What do you think each item looks like inside? What system is used to make it do what it is supposed to do? Ask students to draw their idea of what the item looks like inside. Share and discuss drawings and ideas in their groups. Report ideas to whole class and discuss.

Evaluation: Examine students drawings to determine whether they are focusing on older, mechanical technology or suggesting semiconductor technology.

**Invention:**

**Objective:** Students will describe technological change as a complex process.

Materials per group: A picture of a vacuum tube, a selection of pictures similar to the following -- television sets from the 1950’s and 1990’s, 1930’s and 1990’s radios, an adding machine and a calculator, modern toys using microchips such as computer games. One or more items with the interior exposed and/or pictures of the insides of technical devices.

Note: check http://intel.com/intel/educate for sources such as the third
edition of *The journey inside: the computer*, a free curriculum about microprocessor technology available from Intel Corporation.

**Procedure:**
A. Have groups sort pictures and place them in order along a time line. Ask students to list the characteristics they used to place each item on the time line. Share ideas in class, creating a class list of time-technology characteristics.
Refer to students earlier drawings of the internal system of a piece of technology. Examine insides of the various technical products. Note characteristics and differences between old and new products such as size of the internal operating system, referring to class list of time-technology characteristics.
B. Give students a handout on the history of transistors and semiconductors derived from the section above in this article, or describe this history. Discuss the historical information relating it to the student time lines. Focus on: 1) problems that had to be solved that were significant for product change, 2) continuing problems today that need a solution, 3) Examine the number of years between solutions of various problems, 4) note contributions of specific individuals to the effort, and 5) identify technical limitations in the past and today.

**Closure:** Work with students to formulate the conclusion that modern semiconductor technology resulted from the efforts of many people who gradually solved several problems in order to create a technology that was radically different from technology available in earlier times.

**Evaluation:** Ask students to complete the following with a paragraph, “Change in technology is complicated because . . .” Evaluate responses to determine which of the characteristics focused on in the procedure above are described.

**Expansion:**

**Objective:** Students will examine an instance of technological change in the past, comparing its characteristics with those of the change to semiconductor technology.

**Materials per group:** Photographs of one or more of the following or similar examples of changes in technology prior to the development of semiconductor technology -- a steam locomotive from the 1920’s and a current locomotive; a carriage and a car; a mill, grindstone, or metate and a blender; a clipper ship and a modern ship, wooden beam construction in old office buildings and steel beam construction.
**Procedure:** Give each group a photograph set to examine. Tell groups these represent a change in technology. Ask each group to research the technological change, prepare, and give a presentation regarding this change to the class. They should investigate and report on four aspects: 1) problems that had to be solved, 2) gradual solution of various problems, 3) contributions of several individuals to the effort, and 4) technical limitations of the newer technology. Emphasize the limitations they will face in finding appropriate evidence. Ask them to identify the limitations of the available evidence in addressing each of the four aspects. Have them use pictures and objects as possible to make their report as concrete as possible.

**Lesson Summary:** Briefly describe the lesson’s activities, creation of drawings of the interior of a modern technical device and consideration of how it works, development of a time line of technical devices, discussion of the history of transistors and semiconductors, identification of characteristics associated with technological development, and application of those characteristics to earlier technological development. Summarize change in technology as a complicated process.

**Evaluation:** Determine whether students have addressed each aspect and the extent of their understanding of the limitations of the evidence.

**Lesson 2: Perceived Impacts of Semiconductor Technology**

**Goal:** Students will investigate the range of perceived impacts of semiconductor technology.

**Exploration:**

**Objective:** Students will describe people’s perceptions of new technology.

**Materials per group:** A selection of technological items and pictures from Lesson 1 above.

**Procedure:** Assign students to groups of four: materials manager, recorder, reporter, and discussion leader. Discuss key questions: What do people think about new technology? How do they react to it? Ask students to use the technological items and pictures to support their ideas with examples. Have them create a listing of ideas and examples upon which the group agrees. Share group ideas with class. Decide whether there are any patterns in the ideas and examples being presented. If so, record these on the board.

**Evaluation:** Determine whether students addressed the questions and
utilized relevant examples.

**Invention:**

**Objective:** Students will develop and test hypotheses about perceptions of the effects of semiconductor technology on life at home and at work.

**Materials:** chart paper, markers, Internet access if possible.

**Procedure:**
A. Assign groups of students to carry out one of the following activities as an out of class assignment. Each group member should do the assigned activity individually and share the results with the group. Activity one: interview an adult about items of semiconductor technology that have made life easier. Activity two: interview an adult or a fellow student about new things to do created by semiconductor technology. Activity three: interview an adult about new jobs created by semiconductor technology. Activity four: interview an adult about new responsibilities created by semiconductor technology. Activity five: interview an adult or a fellow student about problems created by semiconductor technology at home. Activity six: Interview an adult about problems created by semiconductor technology at work. Have each group share its findings with the class.

B. Ask each group to consider the topic of the activity they were assigned and to generate some hypotheses in relation to it. Then, ask them how they might go about determining whether there is evidence for their hypotheses. The interviews they have carried out give them some evidence with which to test their hypotheses. However, their evidence has been collected from a limited group of people. How could they collect additional evidence? Should they repeat the activity with more people? Is there another source from which they might obtain evidence? Encourage them to collect evidence through surveys, interviews, and job statistics as appropriate to their topic.


C. Help each group devise a data gathering plan in which each group member has a specified and equal role. Then, assist them in deciding how they might best organize their evidence so that it will best help them test their hypotheses and communicate their efforts to the whole class. For example, charts and graphs may be useful.

D. After students have completed their investigations and organized their
evidence have them share it with the class. As a class, decide whether a clear pattern is emerging from the evidence. Discuss whether the evidence supports the hypotheses.

**Closure:** As a class, develop a statement in answer to the problem with which each group worked. Write the problem and the summary statement on separate sheets of chart paper or transparencies. State the idea: semiconductor technology has had an effect on all of us that is sometimes good and sometimes questionable.

**Evaluation:** Consider whether each students fulfilled his or her role in the group’s work. Ask each student to complete the following sentences. Semiconductor technology has these three big effects on me: ____________________. Semiconductor technology probably has these three big effects on the school principal: ____________________.

**Expansion:**

**Objective:** Students will develop a case study of the effects of modern technology on the work of an individual.

**Procedure:** Assign pairs of students an interview task. They are to interview an individual and construct a case study describing how semiconductor technology has influenced and changed his or her work. Among those who might be interviewed are: school principal, school secretary, school librarian, school nurse, cafeteria worker, school custodian, school coach, teacher, school bus driver, hair stylist, discount store manager, cashier, fast food worker, travel agent, construction worker, engineer, or bank teller. If possible, have the interviewee assign years to changes in the work. Have students ask the question “How has modern technology changed your job since you started working at it?” After you tell me about a change, can you tell me about what year it happened? How did this change make your job easier? How did it make your job harder? Have the pairs of students devise a time line illustrating the chronology of technology effects on this individual’s work.

**Alternative:** Invite an industrial engineer or the managers of a business to the classroom to describe how modern technology has effected two workplaces: the factory and another industry (fast food, hospitals, city government offices, etc.) Have students, in groups, prepare questions beforehand to be asked of the speakers. Afterwards create a web for each workplace described showing the effects of modern technology.

**Lesson Summary:** Discuss results of individual interviews. Ask students to make concluding statements that resemble the key idea: people perceive
modern technology as having a range of effects on their lives.

Evaluation: Ask students to write a summary statement about the effects of technology on the work of the individual interviewed. Examine the statement to determine whether students perceive and report technology as having a range of effects.

Lesson 3: Issues Today and in the Future

Goal: Students will investigate issues raised by the use and growth of semiconductor technology in society.

Note: The previous lesson may identify issues that students wish to investigate further. The lesson below suggests some issues that may be investigated, but others can replace these or be added to them.

Exploration:

Objective: Students will construct a list of problems that might occur if semiconductor technology stopped advancing.

Materials per group: chart paper and markers or computer access

Procedure: Form small groups: materials manager, group manager, reporter, and recorder. Review lesson two with students and summarize the findings that semiconductor technology has had an effect on peoples lives both at work and at home. Review some of the problems and limitations faced by semiconductor technology. Tell students this may mean that the technology could stop its advance by 2020. Ask the key question: Do they think there will be any What might be some problems that would result if semiconductor technology stopped advancing? Have each group construct a list of its ideas in response to the question and support each idea with at least one piece of evidence. Share lists and record a class list on chart paper or on a computer.

Evaluation: Evaluate group predictions for prior knowledge and monitor whether each person shares in the activity.

Invention:

Objective: The students will find and present evidence related to five issues raised by the growth of semiconductor technology.

Materials: copies of each of the five scenarios below to be placed in a work station. (If computers are available for each work station, the scenario can be presented to students on the computer’s screen.)
Procedure: Remind students that we have been talking about what would happen if semiconductor technology stopped advancing. That’s a tough question to think about because it is hard to figure out what would happen. Ask each group to visit stations illustrating different scenarios. Each scenario deals with a real world problem that comes from the life of a student in a middle school. The scenarios deal with the effects of semiconductor technology on people today. After your group reads the scenario, talk about your response to it, then have the recorder record your response on paper (or, if available, on the computer at the station.)

Scenario one. My family that can’t afford a computer. I can’t do my homework on the computer. I have to write out my papers. They don’t look as neat as other people’s papers and I can’t spell check them. I can’t play computer games at home. So, I am just not as good with the computer as are the other students in my class. I seem to be getting farther behind everyone else because I don’t have so much chance to work on a computer since I don’t have one at home. What can be done to help me keep up with the other students?

Scenario two. My Mom lost her job in a factory because the company put in new machines that can do the stuff she used to do. She decorated cookies and cakes for a factory that sells them to supermarkets. So, she lost her job because of the technology. She is going to night school now to finish high school and get her GED. But, she thinks she isn’t learning stuff about technology that might help her get a job. She is just learning basic math, English, and so on. So, modern technology is putting people out of jobs and maybe they won’t be able to get a job anymore unless they can get a lot of technology training. What can be done about giving people like my Mom training? What if someone doesn’t have much basic education? Can you train them to work at technological jobs?

Scenario three: Computers can store all kinds of information about people. Other people and businesses, like magazine companies, can get information about you. It helps them decide whether to send you a letter to get you to use their product, or buy their magazine. If you join a club or rent mystery movies at a video store, this information about you can be kept and given to someone who wants to know who likes mystery movies or belongs to a certain type of club. Then, they might send you advertising to get you to join a mystery club or buy mystery books. Why do some people believe computer stored information is a bad idea? What groups of people would be for and against such laws? What kind of laws could be passed so that information about you isn’t saved by everybody and to make sure nobody can get information about you unless you want them to? If such laws were passed what problems might they create? What is the chance of such laws being passed?

Scenario four. Some people in rural areas and small towns don’t personally see as much modern technology in use as do people around large cities. In some rural areas you don’t have cable television and you
have to pay a huge amount of money to get Internet connected to your house. So, where you live can make a difference. If these people don’t have as much new technology, there are some things they can’t do and some things that take longer to do than if you had the new technology. They just may not know how modern technology is used for some things because they don’t see it where they live. What things might be done to provide rural people with more experiences with modern technology? Note: teachers in rural areas may wish to rewrite this scenario with a focus on an urban area and the opportunities to interact with new technologies that are found in that setting.

Scenario five. In my family we have a computer, lots of software and an Internet connection. My sister and I always are using the computer. We fight a lot over it. We don’t read books or magazines much. I would rather play on the computer than read a comic book. My Dad says “you have a problem.” My sister and I don’t think we have a problem. Dad just doesn’t understand that you don’t need to do other stuff. There’s so much stuff on the computer and Internet so, why bother with other stuff? Dad is threatening to limit how much we use the Internet. How do you think the disagreement between us and our Dad should or could be solved?

After they have completed the stations, ask students to share their ideas. Which scenarios were the most difficult for them? What additional information would help them respond to the scenario questions? Point out that these are all issues that have been created by modern technology.

Assign one group to each scenario. This scenario represents an issue they will investigate. Each scenario has information in it which may or may not be well supported by evidence. Each group should try to find ways to obtain more evidence relating to the problem posed by the scenario.

In scenario one a student worries because the lack of a home computer is reducing his opportunities for experience with the computer and may affect his ability to carry out school-related tasks. Students might conduct a survey to determine whether all students have a computer at home. They might survey the types of activities for which a home computer is used. They might use Internet to find statistics on ownership of home computers by families in various income brackets. With this evidence they should be better able to decide how serious an issue this may be. This information probably will not help them come up with a much improved answer to the issue, but it will bring the issue into clearer focus and should highlight the difficulty of resolving such issues. As each group shares its work with the class, the impact of semiconductor technology on society should become more evident to students.

The following suggestions are presented to guide student evidence gathering for the other scenarios. Students and teachers may wish to pursue other means of gathering evidence. In scenario two, the issue raised is that of job loss from modern technology and the limitations of a worker’s low level of education. Students might examine U.S. Labor
Department’s Bureau of Labor Statistics job statistics and reports of trends of job loss among unskilled workers and job availability for workers with skills in new technologies. The Bureau can be accessed at http://stats.bls.gov. Students might talk with a counselor working with the local GED program or a representative from a community college that has worker retraining programs.

To gather evidence relating to scenario three which focuses on computer storage of information about people students might ask to view their families record at a video rental store they use. Or, they might note what sort of “junk mail” the family receives and consider where the sender might have gotten the names of the persons to whom the mail is addressed. Students can interview the manager of a supermarket about check cashing. Does the store have a service that uses an individual’s credit background to determine the level of risk in accepting a check? Such services maintain a record that enables them to determine risk factors.

Scenario four describes limitations rural citizens may have in interacting with technology. Students might talk with a telephone company representative to determine how expensive it would be to get an Internet connection to a rural town in their state, and to someone living a distance away from a rural town. If possible, a pen pal effort between a rural school and an urban or suburban school can be used to collect information about the newer technologies with which students interact on a frequent basis.

In scenario five, family members’ disagreement over how much the Internet is used is the focus. Students could survey family members to determine amount of usage. They could record the amount of time they use various newer technologies. They could ask family members how the disagreement in the scenario might be resolved.

**Closure:** Semiconductor technology has created issues that are not easy to solve. It affects us in many ways. It affects our incomes, our laws, and our education. There are lots of decisions that have to be made by individuals, businesses, and governments.

**Evaluation:** Determine the types of additional evidence each group obtained relative to the scenario they examined. Ask each student to make a web or outline of one of the issues another group worked with and the evidence indicating it was an issue needing to be addressed.

**Expansion:**

**Objective:** The students will predict how the issues identified as resulting from the growth of semiconductor technology would be affected by the successful development of organic semiconductor technology.

**Procedure:** Review information on work scientists are doing to create
semiconductors of new materials that will be faster, smaller, and contain more information. Might such a development be likely to make the issues in the scenarios even more worrisome? Which of these issues, if any, might be solved if new materials make technology cheaper? Discuss these questions in groups and share with the class.

**Alternative:** Investigate the issues that were behind the concerns of the Luddites who rioted against the introduction of textile machines around 1811 in England. Or, investigate the beliefs behind some religious groups’ preferences for the “old ways” where modern machinery is not used. An example is the Amish.

**Lesson Summary:** Technology has an effect on people and their lives. It raises issues that the society must address. There are many such issues. An issue should be investigated and evidence collected of its effects if it is to be solved.

**Evaluation:** Ask each student to list or web the steps he or she found to be important in helping to make an issue clearer and more understandable.

**Additional Lessons**

There are many other lessons that could be done. A set of lessons could accompany the first lesson examining student conceptions of technology. Students, for example, may associate semiconductor technology only with computers, not realizing that it is found in many other items. The reasons for the location of semiconductor manufacture in states such as New Mexico (Intel Corporation has a large presence in the state, see http://www.intel.com/intel/community/newmexic.htm#Applying) could be investigated. Engineers could come into the classroom and talk about semiconductors and their role in a wide range of items. There are many possibilities. This technology has had an enormous impact on societies around the world. That impact, and the issues raised by it, can be expected to continue.

**References**


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