

Lesson Summary: Procedural memory is the type of memory called upon when performing skills, learned behaviors, or procedures such as tying a shoelace or riding a bicycle. Students perform a task that involves procedural memory and discover that repetition is key to becoming efficient at the task.

Grade Level 4-12
Lesson Length
1 class period with extensions

Standards Alignment

Next Generation Science Standards

- 3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
- MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.
- MS-LS1-3. Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.
- MS-LS1-8. Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.
- **Framework for K-12 Science Education:** Science & Engineering Practices 1,3,6,8

National Science Standards – Project 2061: Atlas of Science Literacy reference

- a) Behavior/Heredit y and experience shape behavior – learning from experience (p.97, Atlas Vol. 1)

Research on student learning: “No relevant research available on Benchmarks.” (p. 96, Atlas Vol. 1)

Objectives—Students will

- understand that there are different types of memory.
- provide five examples of procedural memories.
- experience the process of establishing and strengthening procedural memories through repetition.

Assessment Options

- Engage students in a discussion about memory formation and memory storage.
- Enumerate or list examples of procedural memories.
- Perform the mirror image task and compare student drawings during the initial trial and after subsequent trials.

Terms

- *procedural memory* - memory involving the acquisition of skills and habits, which does not require a conscious effort to remember the activity
- *cerebellum* - one of the main structures involved in procedural memory; the structure located at the roof of the hindbrain that helps control movement, balance, and muscle coordination





Materials (for each student)

- index card
- worksheet (or list of questions on the board)
- copy of sheet with 6 different shapes to trace (or their own drawings to trace)
- copy of a sheet with 9 repeats of one shape to trace (optional)
- copy of a sheet with other types of shapes (optional - for extension)

Materials (for each pair of students)

- hand-held rectangular mirror
- stopwatch (optional - for extension)

Procedures

Engage

1. Review what the students know about memories - how they are formed, what helps them become and remain long-term memories, where memories are formed and stored.
2. Introduce and demonstrate the activity.
 - ❖ Place a mirror upright at a 90-degree angle to the table near one of the shapes.
 - ❖ Hold a pencil and place its point inside the two lines of the shape.
 - ❖ Look into the mirror and find the tip of the pencil. Trace the shape while keeping the pencil between the two lines. This will be challenging.

Explore

1. Students have a choice of working in pairs or by themselves
2. Distribute student guide, index cards, and mirrors.
3. Instruct students to poke a hole in the center of the index card and slide their pencil through the hole until the card is positioned at the halfway point on the pencil -- this is to make sure that they cannot see the tip of their pencil while drawing.
4. Let the students perform the activity described above. Give them 15 minutes if in pairs, 10 minutes if working individually.

Develop Questions

1. Discuss the activity: what makes it hard? Which shape is easiest? Hardest? What could make doing this easier (other than looking in the mirror)? Lead kids towards the idea that they could easily draw a triangle or circle or square WITHOUT a mirror -- and could draw them with their eyes closed -- but have trouble in the mirror. WHY is it harder with the mirror than with the eyes closed?
2. Discuss the parts of the brain and the kinds of processing that are involved in doing this activity. The *occipital lobe* processes seeing the shapes and the lines being drawn. *Motor cortex* and



cerebellum instruct nerves to send messages to the hands to draw the shapes. The *frontal lobe* gets involved trying to figure out the puzzle of what is different about the mirror shapes.

Explore and Explain

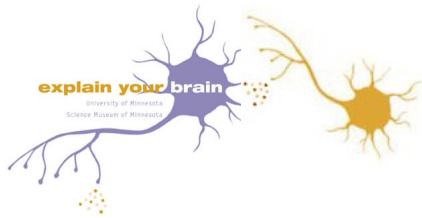
1. Give each student a sheet with one shape repeated multiple times.
2. Give students 10-15 minutes to do the entire sheet.
3. Discuss their experiences.
 - a. Let students know that drawing shapes is an example of a *procedural memory*, a knowledge of "how to do" something. Unlike other memories of facts and one's past experiences (*declarative memories*), procedural memories are stored in the cerebellum. Riding a bike is a procedural memory. It is difficult to explain how you do it and, once you have learned, you do not need conscious knowledge to perform the activity.
 - b. Have students find the *cerebellum* on their own heads. Use diagrams on the board, an overhead, a book, or notes to locate the cerebellum.
4. Relate the new information about procedural memory to the activity. One has difficulty doing the drawings because the cerebellar procedural memory for drawing the shapes was not formed for the left-right reversal produced by the mirror. So the commands from the motor cortex and those from the cerebellum are not always the same and this produces inaccuracies. With practice and attention, the commands to draw shapes backwards from the motor cortex dominate and the shapes are drawn correctly. With more practice, the neural commands become transferred to the cerebellum where they become a new procedural memory for drawing shapes seen in mirrors.
5. Discuss with students the importance of repetition for forming procedural memories. Practice helps improve the accuracy of these skills. Skills such as playing sports and musical instruments are improved by practice.
6. Ask students to think of other physical activities -- like drawing a circle or triangle -- that once they learn how, they can do without thinking. Examples: throwing a ball, riding a bike, playing a song on the piano, pouring a glass of water, doing a cartwheel on a balance beam, etc.

Expand

Have students time each other tracing a certain shape left-handed and right-handed. Count 5 seconds for every time the pencil hits a line. Restart drawing where the tracing line first hit the shape line.

Students could write this up as an experiment; plan on a whole class period including time to write it up. Or the class could simply do this as a short activity requiring ten extra minutes.

Encourage students to make and explain the reasoning behind their hypotheses.



Extension

Let students do any of the following as a short project:

- a. Write a non-fiction short story (2 pages double-spaced or the equivalent).
- b. Write a non-fiction poem (at least 15 lines).
- c. Write and illustrate a comic strip (at least eight frames).

The project should convey the experience of self or a sibling (in a. and b.) or a fictional character (in c.) struggling to learn a new physical skill.

The project should highlight the difficulty of performing a new complex physical skill, the necessity of practice, and the ease of performing the skill once learned.

