

Investigation 6

Rolling On

Authors

Theron Blakeslee, David Bydlowski, Tom Green, Bill Welch, Tom Wessels

Subject

Life Science

Grade Level

Grades 5-8

Driving Question

Is tongue-rolling an inherited or acquired trait?

Abstract

Students try tongue-rolling and discuss what they find. Next, they hypothesize about whether the ability to roll the tongue is an inherited or acquired trait. Student groups then design experiments to test their hypotheses. Groups present the research methods, data in graphic form, and conclusions. Students are encouraged to develop their own question about natural phenomena and research the answer to it.

Michigan Curriculum Framework Science Benchmarks

<http://www.miclimb.net/content/main.html>

Constructing New Scientific Knowledge Benchmarks:

I.1.M1 Generate scientific questions about the world based on observation.

Key concepts: Scientific questions can be answered by gathering and analyzing evidence about the world.

Real-world contexts: Any in the sections on Using Scientific Knowledge.

I.1.M2 Design and conduct scientific investigations.

Key concepts: The process of scientific investigations—test, fair test, hypothesis, theory, evidence, observations, measurements, data, conclusion. Forms for recording and reporting data—tables, graphs, journals. See C-I.1 m-3 (tools).

Real-world contexts: Any in the sections on Using Scientific Knowledge; also, recognizing differences between observations and inferences; recording observations and measurements of everyday phenomena.

I.1.M3 Use tools and equipment appropriate to scientific investigations.

Tools: various data collection tools suitable for this level, including computers.

Real-world contexts: Any suggested in Using Scientific Knowledge benchmarks for which students would design and/or conduct investigations.

I.1.M.5 Use sources of information in support of scientific investigations.

Tools: Periodicals, reference books, trade books, web sites, computer software; forms for presenting scientific information, such as figures, tables, graphs. See R-II.1 m-1 (evaluate strengths/weaknesses of claims).

Real-world contexts: Libraries, projects where research is needed.

I.1.M.6 Write and follow procedures in the form of step-by-step instructions, formulas, flow diagrams, and sketches.

Key Concepts: Purpose, procedure, observation, conclusion, data.

Real-world contexts: Listing or creating the directions for completing a task, reporting on investigations.

Reflecting on New Scientific Knowledge Benchmarks:

II.1.M.1 Evaluate the strengths and weaknesses of claims, arguments, or data.

Key concepts: Aspects of arguments, such as data, evidence, sampling, alternate explanation, conclusion; inference, observation.

Real-world contexts: Deciding between alternate explanations or plans for solving problems; evaluating advertising claims or cases made by interest groups; evaluating sources of references.

II.1.M.2 Describe limitations in personal knowledge.

Key concepts: recognizing degrees of confidence in ideas or knowledge from different sources, evaluating dates and sources of references.

Real-world contexts: Any in the sections on Using Scientific Knowledge.

Using Life Science Knowledge Benchmarks:

Heredity III.3.M.1 Describe how characteristics of living things are passed on through generations.

Key concepts: Reproductive cells—egg, sperm. Chromosome, gene, hereditary information.

Real-world contexts: Common traits controlled by a single gene pair, such as wrinkled or smooth seeds in a pea plant, color of horse hair, human traits such as tongue rolling.

Big Idea

Some characteristics of living things are passed on through generations (inherited), while others are learned (acquired) by individuals.

Prerequisites For Students

A basic understanding of sexual reproduction would be helpful, since the target benchmark in life science (III.3.M.1) requires students to understand about egg and sperm cells.

Estimated Time Needed

Four class periods of approximately 55 minutes each.

Background Information

We all know that everyone is different. Looking at the students in your classroom will confirm this. But why is this so? And how does it happen? Students can make the connection between inheritance and human traits with their own investigations. Many physical traits such as hair type, skin color, body type, and facial features distinguish people from one another. However, all this variety is limited by degree; despite all these possible physical differences, we can still recognize both strangers and family members as members of our species, *Homo sapiens*.

A key to inherited patterns is the process of meiosis. Meiosis is division in the nucleus of a cell that results in the production of gametes – egg and sperm cells. Each gamete carries genetic information from one parent. When gametes combine during fertilization, a full complement of chromosomes results. These have the genetic material from both parents in them to determine a number of physical traits. Such traits as handedness, eye color, free or attached earlobes, presence of a widow’s peak, hair on fingers between the first and second knuckles, and a cleft chin are all inherited in this way.

While inherited traits all result from meiosis, they are not all inherited in the same way. Some inherited traits are autosomal recessive—they only show up if two recessive genes are inherited (such as the diseases Tay Sachs, Cystic Fibrosis, and Sickle Cell Disease). Some traits are X-linked recessive, and show up in all males with this type of gene, but in females only when inherited from both parents (color-blindness is an example of this). Some, such as eye color, are inherited gradations. Some, such as tongue-rolling ability, the trait studied in this lesson, are autosomal dominant. They show up whether inherited from one or both parents. (When we speak of tongue-rolling in this Investigation, we mean the ability of a person to roll the sides of their tongue up, making the tongue into a long, skinny U-shape.)

Inherited traits are important for the continuity of species, and for the ability of any species to make adaptations that help it survive in its environment.

Acquired traits are learned after birth. They include, for example, the ability to ride a bicycle or a person’s taste in clothing. In this Investigation, students will be distinguishing between inherited and acquired traits by designing their own investigations.

The investigation by itself does not teach the principles of heredity at the cell level, as required by Michigan Benchmark III.3.M.1. Instead, it provides a context and motivation for learning the abstract concepts of inheritance of genetic material. Students are challenged to explain the results of their investigations, which leads to the need to understand how inherited traits are passed on through generations.

Teacher Page 6-1 gives a sample of how a student group might fill out Student Page 6-1, involving investigation design. Teacher Page 6-2 is an example of a Research Methods Page. Teacher Page 6-3 gives an example of the group’s Conclusion (Student Page 6-2). These are meant to be used as examples, not as instructions for any group’s investigation.

Materials List***For each student group***

Colored markers

Newsprint

Graph paper

Rulers

1 copy of Student Page 6-1 (have extras on hand)

1 copy of Student Page 6-2

Advance Preparation

None

Procedure

Part 1: Student Exploration (Day 1)

1. Ask students if they can roll their tongues. Let everyone try. Some students will be able to do it, others won't.
2. Ask why students think some can do this and some can't. Let students discuss this fully. Record their ideas on the board. Ask follow-up questions to get students to elaborate on their ideas.

Part 2: Question or Statement

1. Ask students to discuss their ideas about what an inherited trait is and what an acquired trait is. They may know the distinction between these terms, but use some examples to help them understand each term. Inherited traits include hair color, and eye color. Acquired traits include the ability to read, the ability to solve math problems, and the ability to hit a baseball with a bat. Speech is an inherited trait, but the language you speak is an acquired trait.
2. Ask: do you think that the ability to roll your tongue an inherited trait or an acquired trait? Why do you think this? Let students explain their thinking in an open-ended discussion.

Part 3: Method for Gathering Data

1. Ask students how they can figure out an answer to the question: Is the ability to roll your tongue an inherited trait or acquired trait?
2. Divide students into groups of four or five according to their opinions (have all who think tongue-rolling is an inherited trait in the same groups, and all who think it is acquired in the same groups). Make sure there is at least one group for each opinion.
3. Explain brainstorming to the students: Brainstorming is an idea-generating process. There are no right or wrong answers. One person in the group writes down all the ideas that people

have. It is OK to “piggyback,” or develop someone else’s idea. They do not all have to be original ideas. Repeating ideas is OK, too.

Have students brainstorm a method for finding out whether tongue-rolling is inherited or acquired.

4. Hand out a piece of newsprint and a marker to each group and let them brainstorm for 5 or more minutes. One student should be the recorder and write down all the brainstorm ideas for her or his group.
5. After an appropriate amount of time, have groups evaluate their brainstormed methods, putting a star by the one they think will work the best.
6. Have groups present their methods to the whole class. Possible methods might include:
 - Surveying students who can and can’t roll their tongues, to find out whether their parents can or can’t, then drawing some conclusions about inheritance.
 - Trying to teach students tongue-rolling who can’t do it, to determine if it can be acquired.Students may come up with other valid methods. Allow students to try other approaches if they seem reasonable.

Part 4: Prediction/Hypothesis

1. After groups develop their method, have them make a prediction or hypothesis about the outcome of applying their method to the question. You may need to model one for the entire class. It should be something like: If we try to teach students who can’t roll their tongues how to do it, they should be able to do it independently if we use an appropriate teaching approach. (This is a prediction for students who believe that tongue rolling is acquired. They may decide to expect some variation in learning this, as in learning all things, and develop a hypothesis that says that perhaps 75% of students who are taught will learn to do it.) Each group will have a different prediction, depending on the question they have chosen to investigate.

Students who are investigating whether tongue rolling is inherited by surveying students and their parents (making a family history) will possibly develop a hypothesis like this: If we survey students who can and can’t roll their tongues, we should find that students who can have parents who can, and students who can’t don’t have parents who can. However, inheritance of tongue-rolling is more complex than this – but it’s a beginning hypothesis for students who are now just learning. Students who collect and examine this data will have to distinguish between *how many* students in each category have parents who can or can’t – those who can will have more parents who can. This will be a good puzzle for them to figure out.

2. Have students complete the Investigation Design student pages. See Teacher page 6-1 with sample student responses.

Part 5: Research Details

1. Using a page titled “Research Methods,” have students write a detailed plan for conducting their investigation. The plan should list every step they intend to take. (A sample Research Methods page is attached, Teacher Page 6-2.) They will need sufficient time to brainstorm different possible approaches to collecting the data. The methods they develop should allow them to find out whether their hypothesis or prediction is correct.
2. Have groups hand in their Research Methods and Student Page 6-1 for your review. Check each group’s design to make sure it includes a hypothesis and that there is a clear method for recording data. Give guidance as you review the materials, but try not to dictate specific changes. This is best done by asking critical questions such as, “How will you measure that?,” and “What things will you keep the same?” Then groups can come up with changes that answer your questions and critiques.
3. **(Day 2)** Return the Research Methods with your comments and let groups re-design or alter their research methods as needed.

Part 6: Data Collection

1. Ask each group to think about the type of data it will collect. Have students develop a data collection form that has room for the information they wish to collect. Circulate through the room as students are designing the data collection forms and offer assistance. Often, a simple chart works best.

Groups will compile several forms and record-keeping pages in this investigation. They may need a file folder or binder of some kind to manage their papers.

2. Have students do their investigations and collect their data on the data collection forms they have designed.

Part 7: Data Analysis, Use and Communication of Results

Note: Student data will show that every student who can roll their tongue has at least one parent who can. It will also show that some students who can't roll their tongue may also have at least one parent who can. It will show that tongue-rolling cannot be taught to people who are not able to do it before teaching.

1. **(Day 3)** Explain to the class that graphing often makes patterns emerge from the data. Have each group graph their data. Graphing forms may vary, depending on the type of data. Bar graphs are probably appropriate for most of the comparisons that students will make.
2. Ask groups to discuss the data and look for patterns. Does their data support their hypothesis? What conclusions can they draw?

3. Have students complete questions 1-4 on Student Page 6-2, the Conclusions page. Question 4 asks them to compare their work to other groups in the class who have tested similar hypotheses. Facilitate the exchange of data and conclusions between similar groups.
4. Hold a class discussion to *use* the knowledge they have gained from the investigations to think about how traits can be passed on during reproduction. Review the idea that in reproduction the mother's egg cell combines with the father's sperm cell to create a fertilized cell (but don't tell students that the fertilized cell is "complete." They will figure this out.) Identify the nucleus of each reproductive cell as the site where genetic information is stored, in chromosomes. Draw a picture of two cells, one egg and one sperm, with a nucleus in each showing chromosomes as something like little worms. Explain that in each individual, genetic information is contained on the chromosomes, as genes. Many, many genes strung together make up each chromosome. You might tell students about the Human Genome project, which has mapped all of the genes on humans' chromosomes. (See their website at http://www.ornl.gov/TechResources/Human_Genome/home.html.)

Ask students to consider the data they have from their investigations and how it might be explained in terms of genes and fertilized cells. Help facilitate the discussion so that students recognize how genes are passed from both parents, and sometimes combine to produce the inherited trait, while sometimes their combination does not produce the trait – but certain traits (like tongue rolling) require at least a "tongue-rolling" gene from one parent. If a trait can't be taught (like tongue-rolling), then it must be controlled by inheritance of genetic information.

5. Have students finish the Conclusions page based on the discussion. The fifth question used in the conclusion is "How can you explain what you found out?" The last question asks students to reflect on their investigation and suggest ways they might improve it. Before writing this part of the conclusion, allow students to discuss the last question in their groups.
6. **(Day 4)** Have each group present its question, hypothesis, research methods, graphic representation of data, and conclusion to the class. Every group member should have a part in the presentation. Presentations should include these parts (write them on the board):
 1. The group's question
 2. The full hypothesis
 3. The research methods
 4. The data, presented as graphs, charts, or drawings
 5. The conclusion
 6. Participation by each group member
7. Have students turn in all Student Pages, the Research Methods, and the graphic representations of data for assessment purposes. If you wish, you may have groups put these together on posterboard as a display that can be set up where others in the school can see it.

Part 8: Guided Questions for Reflection

1. Ask the class to discuss any problems with their research design or data collection that could have kept them from getting good results. Ask how they could correct those problems for future investigations.
2. Ask the class to discuss how the results from different groups supported or did not support each other's work.
3. Have students answer questions individually on Student Page 6-3, then discuss their answers as a group. Questions are listed here with possible student responses. Students should be prepared to answer these questions from the discussion held in Part 7. However, individuals may need teacher support.
 - What evidence is there that tongue-rolling is an inherited trait? (Students who can roll their tongue have at least one parent who can. Students who cannot roll their tongue cannot be taught how to do it.)
 - How are traits passed on through generations? (Student responses should be similar to the explanation given above, in Part 7, #4.)
 - What other traits are probably inherited? (answers vary)
 - What other traits are probably acquired? (answers vary)
 - How are acquired traits passed on to the young? (Parents or others teach the traits to the young, or individuals learn on their own.)
 - What are two characteristics of a fair investigation into inheritance? (1. The same method must be used in all cases. 2. Conclusions must be based on the data collected. Other responses might be acceptable.)

Part 9: Student questions for additional inquiry

1. Ask students to list further questions they have, and how they might determine the answers to these questions. As time permits, let them perform these subsequent investigations.

Assessment

Group assessment can be done by ranking proficiency in each of the parts of the final presentation: the hypothesis, the Investigation Design page, the step-by-step Research Methods, the graphic presentation of the data collected, the conclusion, and, finally, the participation of all members. Individual assessments can be done by interviewing individual students about their group's project and assessing their understanding of what the group did and why it was done. If desired, you may require each student to fill out their own copy of the Student Pages. You can evaluate students' responses on Student Page 6-3, "Thinking About the Data."

Names _____

Investigation Design

1. What is our question?

2. What do we know? – How are inherited and acquired traits different?

3. What will we do? – to determine if tongue-rolling is inherited or acquired?

4. What data will we collect?

5. What is our hypothesis?

6. The things we keep the same on purpose are:

Names _____

Conclusion

Answer all of these questions in your conclusion:

1. What was the purpose of the investigation?
2. What did you find out?
3. Was the hypothesis supported by the data?
4. How does what you found out compare with what other researchers have found out?
5. How can you explain what you found out?
6. What else would you like to do with this investigation, and how would you make it better?

Name _____

Thinking About the Data

Answer all of these questions in your conclusion:

1. What evidence is there that tongue-rolling is an inherited trait?

2. How are traits passed on through generations?

3. What other traits are probably inherited?

4. What other traits are probably acquired?

5. How are acquired traits passed on to the young?

6. What are two characteristics of a fair investigation into inheritance? _____

Names (Sample student responses)

Investigation Design

1. What is our question?
Is the ability to roll your tongue an inherited or acquired trait?
2. What do we know? – How are inherited and acquired traits different?
Inherited traits are passed down from parents. Acquired traits are learned.
3. What will we do? – to determine if tongue-rolling is inherited or acquired?
We will try to teach some people who can't roll their tongues how to do it, and record the results.
4. What data will we collect?
We will keep track of how many people we are able to teach to roll their tongues.
5. What is our hypothesis?
If we try to change tongue-rolling by teaching it to some people, then the number of people who can't do tongue-rolling at first but learn it when we teach them will increase.
6. The things we will keep the same on purpose are:
The method we use for teaching how to roll tongues, the person who is doing the teaching, the amount of time we devote to trying to teach someone.

Research Methods

(Sample student responses)

1. Find out and write down the names of all the kids in the class who can't roll their tongues.
2. Have a certain way to teach them how to do it. For each person, say, "We are going to teach you how to roll your tongue. Open your mouth. Lift up your tongue. Push on one side of your tongue with your finger, like this." (Now the tongue-rolling teacher shows them how to push up on one side by doing it to themselves.) Say, "Push up the other side of your tongue like this." (Show them again.) Say, "Now do it yourself."
3. Write down on the data collection page whether each person learned how or not.
4. Do this for each person on the list.

NOTE: For their data collection page, this group had a chart with two columns. The first had the tongue-rolling student's name. The second was used as a yes/no box, indicating whether the student learned tongue-rolling when they were taught it. For their graphic representation of data, this group did a chart of the number of people they tried to teach tongue-rolling to (12) and the number of people who learned it (0).

Names (Sample student responses)

Conclusion

Answer these questions in your conclusion:

1. What was the purpose of the investigation?
2. What did you find out?
3. Was the hypothesis supported by the data?
4. How does what you found out compare with what other researchers have found out?
5. How can you explain what you found out?
6. What else would you like to do with this investigation, and how would you make it better?

The purpose of our investigation was to find out if tongue-rolling was an acquired trait, by trying to teach it to people who could not do it at first. We found out that it cannot be taught, at least not the way we were doing it. Our hypothesis was If we try to change tongue-rolling by teaching it to some people, then the number of people who can't do tongue-rolling at first but learn it when we teach them will increase. The hypothesis was not supported by the data. Other researchers in our class found the same thing. We would conclude from our data and other data in the class that tongue-rolling is an inherited trait – it cannot be taught. But our experiment did not prove that it is inherited, it just proved that it cannot be taught the way we were teaching it. We would like to find out the whether parents of tongue-rolling students could roll their tongues. If both parents couldn't, this would make us doubt that having tongue-rolling ability is an inherited trait, and we would try to find another way to teach this – perhaps it just takes longer to learn than the time we allowed.