WAMC European Rat Population Lab

Math Concept: Introduction to exponential functions

Source / Text: https://www.rapidtables.com/calc/math/exponential-growth-calculator.html, https://elifesciences.org/articles/50651

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Attach the following documents:

- Lab Instructions
- Student Handout(s)
- Rubric and/or Assessment Tool

Short Description (Be sure to include where in your instruction this lab takes place):

In this lab, students will predict the number of European Rats, Rattus norvegicus, that will be produced from one pregnant rat in a 54 week period. They will then participate in a simulation that allows them to calculate that number. This lab will take place in small groups of 2 or 3 students at a table in the classroom.

Lab Plan:

Lab Title: European Rat Population Lab

Prerequisite skills:

- Ability to collect data in a table
- Ability to graph that data
- Understanding of probability created by rolling two dice

Lab objective:

Students understand that algebra is useful in understanding the natural world. Students will also see how an exponential functions are useful in predicting phenomena in the natural world.

Standards: *(Note SPECIFIC relationship to Science, Technology, and/or Engineering)*

Mathematics K–12 Learning Standards:

- F.LE.A.1 Distinguish between situations that can be modeled with linear functions and with exponential functions.
  - 1a Prove that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals.
  - 1b Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.
  - 1c Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.
- F.LE.A.2 Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).

Standards for Mathematical Practice:

- Making sense of problems and persevere in solving them
- Model with mathematics
- Reason abstractly and quantitatively
- Look for and make use of structure

K-12 Learning Standards-ELA (Reading, Writing, Speaking & Listening):

- RST.9-10.3 Follow complex multistep procedure while carrying out experiments, taking measurements or performing technical tasks, attending to special cases or exceptions defined in the text
- RST.9-10.4 Determine meaning of symbols, key terms, or other domain specific words and phrases as they are used in specific technical context.
- Translate qualitative or technical information expressed in words in a text into visual form and translate information expressed verbally or mathematically into words.

K-12 Science Standards

- HS-LS2-2 Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

Technology

- 1.2.1 Communicate and collaborate to learn from others.
- 2.4.1 Formulate and synthesize new knowledge.

Engineering

- HS.ETS1-2 Design a solution to complex real-world problem by breaking it down into smaller, more manageable problems that can be solved by engineering.

Leadership/21st Century Skills:

21st Century Interdisciplinary themes (Check those that apply to the above activity.)
Global Awareness
Financial/Economic/Business/Entrepreneurial Literacy
Civic Literacy
Health/Safety Literacy
Environmental Literacy

21st Century Skills (Check those that students will demonstrate in the above activity.)

LEARNING AND INNOVATION
Creativity and Innovation
xThink Creatively
xWork Creatively with Others
Implement Innovations
Critical Thinking and Problem Solving
xReason Effectively
Use Systems Thinking
Make Judgments and Decisions
xSolve Problems
Communication and Collaboration
xCommunicate Clearly
xCollaborate with Others

INFORMATION, MEDIA & TECHNOLOGY SKILLS
Information Literacy
xAccess and Evaluate Information
xUse and manage Information
Media Literacy
Analyze Media
Create Media Products
Information, Communications and Technology (ICT Literacy)
Apply Technology Effectively

LIFE & CAREER SKILLS
Flexibility and Adaptability
Adapt to Change
Be Flexible
Initiative and Self-Direction
Manage Goals and Time
Work Independently
xBe Self-Directed Learners
Social and Cross-Cultural
xInteract Effectively with Others
xWork Effectively in Diverse Teams

Productivity and Accountability
Manage Projects
xProduce Results
Leadership and Responsibility
Guide and Lead Others
xBe Responsible to Others

Teacher Preparation: (What materials and set-up are required for this lab?)

Materials:
2 dice for each lab group
Rat Lab data sheet
Graph Paper

Set-Up Required:
Each student group of 2 or 3 will be given two dice, a data sheet, and graph paper.

Lab Organization Strategies:

Leadership (Connect to 21st Century Skills selected):

- Individual students will take a leadership role in their lab group. Because the group size is small, all students must take leadership in their roles of recorder, facilitator, data collector, and producing the finished data sheet and graph.
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At Cedar High School three of our five learning outcomes that are assessed for the report card are:
Collaboration - Collaboration is stress in the projects we produce. Students have a well developed sense of what collaboration is and how the leadership role effect the quality of the project and importance of "pulling their own weight".
Oral Communication: As a member of any group, either as the leader or as a member, it is critical that a student communicate well orally. With an emphasis in the school on both Collaboration and Oral Communication it allows students to rotate in and out of leadership roles to be a good partner on projects.
Agency: Seeking challenge, personal growth and building confidence is part of the third outcome that is evaluated for the student report card.
These three learning outcomes help build leadership at Cedar High School.

Cooperative Learning:

- Each lab group will need to decide the roles they will share in all the lab tasks assigned.

Expectations:

- Each lab group will be responsible for completing the hypothesis, the data table, and the graph of the data.

Timeline:

- This lab can be completed in one block period, one and a half hours.

Post Lab Follow-Up/Conclusions:

Discuss real world application of learning from lab

- Population growth of plants and animals in most cases is an exponential function. This lab is the introduction to that concept.
- Students will take the knowledge learned in this lab to begin using exponential equations to determine potential exponential growth of plant and animal species of Earth.

Career Applications

- Students that are interested in career in fish and wildlife related industries will learn about exponential functions and how that affects invasive species.
- Students that are interested in STEM careers will be introduced to an real-world application of exponential functions.

Optional or Extension Activities

- The next lesson will be the Exponential growth/decay formula $x(t) = x_0 \times (1 + r)^t$. Students will use this webpage, https://www.rapidtables.com/calc/math/exponential-growth-calculator.html, to understand how different growth rates affect population size.
- Students can also use this as a review of exponential functions. https://mathbitsnotebook.com/Algebra2/Exponential/EXGrowthDecay.html

**********End of Lab**********

Attachments below:

Rat Lab Data Sheet
https://docs.google.com/spreadsheets/d/17wwy4-B_RemwimHv465-EVSTiFHBrKaoAbZM0J4dRHg/edit#gid=0

Lab Instructions and Assessment Tool for European Rat Population Lab

Abstract

In this lab, you will predict the number of European Rats, Rattus norvegicus, that will be produced from one pregnant female rat in a 54 week period. You will then participate in a simulation that allows you to calculate that number based on probability of litter size.

Introduction

European Rats, Rattus norvegicus, are found on all seven continents of the world. They are one of the most successful species on Earth, and thrive in urban and rural areas that have been disturbed by humans. It is estimated that there are billions of European Rats in the world and their population outnumber Homo sapiens sapiens.

Information

Rattus norvegicus females become sexually mature at the age of twelve(12) weeks. Once sexually mature, females of this rat species has the potential to produce a litter of between 5-12 pups approximately every twelve(12) weeks.

Assumptions

For this lab simulation we will make the following assumptions about female European Rats.

- A female rat will reach sexually maturity 12 weeks after being born.
- A female rat will produce between 2-12 pups every twelve weeks
- The life span of a female rate is 84 weeks
- There is zero percent mortality for the life span of the rats in this simulation.

Hypothesis

If you have one pregnant female European Rat that produces on the average 7 pups every 12 weeks, how many European Rats will you have after 84 weeks? Use this space to make an estimation based on the assumptions above.

Your hypothesis: _____ European Rats will be be present after 84 weeks, 7 time periods of the simulations.

Simulation

In a group of 2 or 3 students use the data sheet provided to determine the number of rats present after 84 weeks, 7 time periods.

Once your lab sheet is completed, graph your results. Graphs should have a title and be labeled appropriately.

Questions

Compare your hypothesis with the answer you found in the simulation. How accurate were you? Have you ideas about population growth changed during this lab? Why?

Assessment Tool

When you complete this lab you should have the following documents:

- Completed Data Sheet
- Graph of the Population over 7 time periods
- Answer to the Questions

Students will be assessed on the accuracy of their data sheet and graph. An accurate table and graph will receive full credit. If a table or graph is not accurate, the lab group will be asked to redo their results. Finally, students will be graded on their answers to the three questions.