Olin College of Engineering

Teacher's Guide for **Cow Evolution**

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Workshop Description

Math is everywhere - especially in video games! We'll take a look at how to make predictions and strategic choices in a super simple phone game called Cow Evolution.

In part one, we'll recognize that this game is fundamentally based on exponentials and use that observation to predict how long it takes to beat the game in its most simplistic form. We'll also gain intuition for just how fast exponential functions grow.

In part two, we'll talk about modeling. What parts of the game can we extrapolate away and what parts do we need to keep to answer questions about game strategy? Students will see how to simplify a complex system to a solvable problem, and understand how to transfer the ideas to the video games they know and love.

Workshop Requirements

Part 1*

- **Runs about 45 minutes**
- **Suggested ages/grades:** middle school → early high school
- **Prerequisite knowledge:**
    - Experience creating functions from data points
    - Experience graphing basic functions
    - Exposure to exponentials. (This workshop could serve as an introduction to exponentials, but this would likely increase the run time.)

Part 2

- **Runs about 30 minutes**
- **Suggested ages/grades:** early high school
- **Prerequisite Knowledge:**
    - Learnings from Part 1
    - Experience with proportions

*Part 1 can be run without Part 2, but Part 2 requires Part 1!

Workshop Slides

Learning Goals

Part 1

- ➢ See how functions can help solve real-world problems in the context of video games
- ➢ Gain experience with exponential functions
- ➢ Become more comfortable going from data points to graphs to functions
- ➢ Gain an intuition for how rapid exponential growth truly is

Part 2

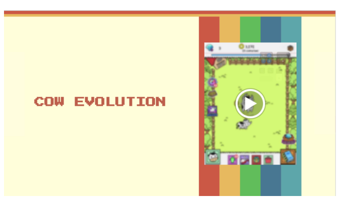
- ➢ Understand that decision-making goes into many real-world estimates
- ➢ See how extrapolation can make an impossible problem approachable
- ➢ Understand the process for isolating specific variables to answer a question
- ➢ Recognize that modeling can be used to determine strategies in many video games

Suggested Notes and Tips for Running

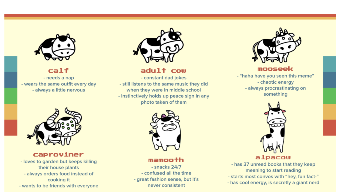
The slides have detailed speaker notes. This section has some additional tips based on running the workshop with students.

Part 1

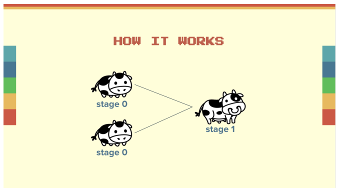
- ➢ **Slide 2:** As the video plays, verbally describe how the game works. Basically, baby cows fall from the sky, and you can combine them to get the next "evolution." Only cows that look the same can be combined, and the goal is to get bigger and bigger cows!

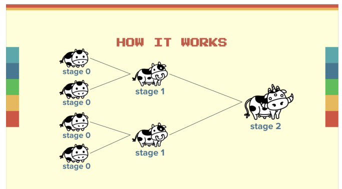


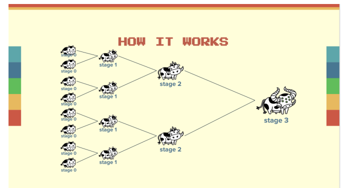
- ➢ **Slide 3:** This is meant to be a fun and interactive mini activity. Be sure to tag yourself as well to get students participating.



- ➢ **Slides 4-6:** Reiterate how the game works again. This time, call out how many baby cows go into each subsequent evolution (2, then 4, then 8). The relationship between evolution number and how many cows go into that evolution is what we will be graphing.

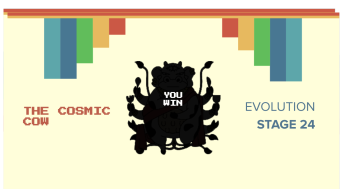


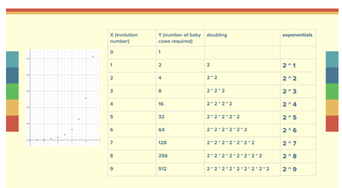


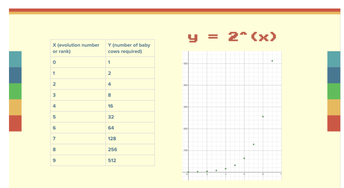


➢ **Slide 7:** Explain that the win condition is getting the 24th evolution.

➢ **Slide 11-13:** We use a special desmos template https://www.desmos.com/calculator/squxbe3yp3 to allow students to play around with graphing. You can use whatever graphing tool students are familiar with.





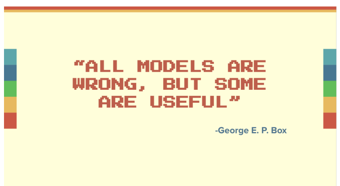


➢ **Slide 15:** Ask students to guess how long it would take to get to Stage 24, then emphasize how crazy it is that it would take over a year and a half to beat this game if you only combined cows! A key learning goal here is building an intuition for how rapid exponential growth is.

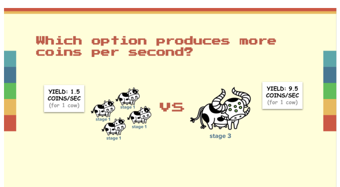
Part 2 (optional)

➢ **Slide 17:** Describe additional rules to show how overwhelming the math becomes. Example: Cows fall from the sky and we can combine them to get bigger cows. We can also buy them from the store, and we get money from the cows that we already have. Bigger cows are more expensive but they also generate more money. Oh, and the more cows we buy the more we get. *Pause* And all of a sudden things are way too complicated!

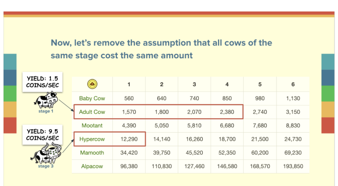
- **Slide 18:** Explain the idea of modeling - simplifying away lots of factors to answer a specific question.



- **Slide 20:** In the solution, explain that we can combine those 4 little cows to get the big one, so we can say they have a coin output of 9.5 coins/sec, even though their collective output as small cows is only 6 coins/sec.



- **Slide 22:** The goal here is to reintroduce some complexity and show how we can slowly take away modeling decisions to get more and more accurate answers.



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