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| **Fellow Name: Emma Stumpf** | **Contact Info: 9373043434** | **Date: 12/12/16** |
| **Teacher Name: Sam Mizener** | **School Name: Kings High School** | **Grade and Class: 9th grade Algebra**  |

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| **Activity Title:** | **Exploring exponential functions in cell growth and zombie apocalypse** |
| **Estimated Activity Duration:** | **2 days**  |

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| **Setting:** | **Classroom** |

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| **Activity Objectives:** |

The student will be able to:

1. Graph Exponential functions
2. Describe the difference between exponential and linear functions
3. Provide examples of exponential growth in real life

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| **Activity Guiding Questions:** |

**Objective #1:** What characterizes exponential growth and decay graphically?

**Objective #2:** How can one differentiate an exponential model from a linear model given a real world data set?

**Objective #3:** What are real world models of exponential growth and decay?

| **Next Generation Science Standards (NGSS)**  |
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| **Science and Engineering Practices (Check all that apply)**  | **Crosscutting Concepts (Check all that apply)** |
| ☐ Asking questions (for science) and defining problems (for engineering) | ☐ Patterns |
| ☐ Developing and using models | ☐ Cause and effect |
| ☐ Planning and carrying out investigations | ☐ Scale, proportion, and quantity |
| ☐ Analyzing and interpreting data | ☐ Systems and system models |
| ☐ Using mathematics and computational thinking | ☐ Energy and matter: Flows, cycles, and conservation |
| ☐ Constructing explanations (for science) and designing solutions (for engineering) | ☐ Structure and function.  |
| ☐ Engaging in argument from evidence | ☐ Stability and change.  |
| ☐ Obtaining, evaluating, and communicating information  |  |

| **Ohio’s New Learning Standards for Science (ONLS)** |
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| **Expectations for Learning - Cognitive Demands (Check all that apply)** |
| ☐ Designing Technological/Engineering Solutions Using Science concepts **(T)** |
| ☐ Demonstrating Science Knowledge **(D)** |
| ☐ Interpreting and Communicating Science Concepts **(C)** |
| ☐ Recalling Accurate Science **(R)** |

| **Common Core State Standards -- Mathematics (CCSS)** |
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| **Standards for Mathematical Practice (Check all that apply)** |
| ☐ Make sense of problems and persevere in solving them | ☐ Useappropriate tools strategically |
| ☐ Reason abstractly and quantitatively | ☐ Attendto precision |
| ☐ Construct viable arguments and critique the reasoning of others | ☐ Look for and make use of structure |
| ☐ Model with mathematics | ☐ Look for and express regularity in repeated reasoning |

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| **Unit Academic Standards (NGSS, ONLS and/or CCSS):** |

CCSS

F-IF 7.e Graph exponential functions, showing intercepts and end behavior

F-BF 2. Write geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.

F-LE 1. Distinguish between situations that can be modeled with linear functions and with exponential functions.

1. Prove that exponential functions grow by equal factors over equal intervals

F-LE 3. Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly

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| **Materials**: (Link Handouts, Power Points, Resources, Websites, Supplies) |

**Lecture Day 1:** Lecture1.pptx

**Activity Day 1** : Based off activity from: <http://search.proquest.com/openview/00ab53c9ab06b158a0b9ae6ec577b771/1?pq-origsite=gscholar>

**Intro Day 2:** Verbal Formative Assessment (FormAssess\_Verbal.docx)

**Activity Day 2:** Based off activity from:<https://docs.google.com/document/d/118I73DU4j2JsRPZqO8Vx3XmxKvV3MQX0-zeWu6_efBA/edit>

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| **Teacher Advance Preparation:** |

**Day 1**

-Collect enough dice for all students.

-Provide worksheets for activity 1

-Create table and graphical representation on SmartBoard

**Day 2**

-Test all combinations of numbers to ensure that all uphold the same trend the activity is deisgned to demonstrate (decreasing the rate, even with an increased population will provide the most effective measure to control the zombie population)

-Cut apart all city assignments from FormativeAssessment\_Activity2.docx

-Prepare smartboard table and graph for quick comparison in the middle of the activity

-Ensure correct grouping for final comparison between drug choices (if uneven number of groups, Emma or Sam can do calculations for missing group to provide opportunity for comparison).

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| **Activity Procedures:** |

Day 1

**Activity: Exponential Cancer Cell Growth**

1. Introduction/Lecture (20 min)
	1. At end of lecture, students will be introduced to the topic of exponential cell growth within cancer cells
	2. Ask students why they think it’s so hard to treat cancer cells, why do they reproduce exponentially, etc.?
2. Activity (35 min)
	1. One student will be chosen as the “founder” cancer cell and will be given a die. He/she will roll the die until he/she rolls a 3. Each roll of the die can be considered one year.
	2. Once the student rolls a 3, they are allowed to infect one other person in the classroom who is then given a die. They each roll at the same time and once another 3 is rolled, another student becomes infected.
	3. The entire time, I will be tabulating the infected persons versus the number of years (rolls) on the smartboard.
	4. The process continues until all students are infected.
	5. We will now take these data from the table and create an exponential graph demonstrating growth of these cancer cells. Each student can fill in their own tables on their worksheets and graph the exponential growth themselves.
	6. 3 follow-up questions relating to the validity of the model can be filled out at home or during class.

Day 2

**Activity: Zombie population versus resources**

1. Recall Session (10 min)
	1. Verbal formative assessment regarding linear vs exponential growth
	2. What are some examples of each?
	3. What are the parts of the exponential equation (initial value, rate, etc.)
2. Activity (45 min)—Zombie Apocalypse
	1. Students are paired into groups of 2 (with 1 group of 3 if necessary)
	2. Each group is the mayor and Center for Disease Control director of a major city in the US which is currently under attack by zombies
	3. I will provide each group with a specific initial population of zombies and rate; there will be two groups that have each population and rate.
	4. Students are to create an exponential model incorporating their variables. They will then calculate the zombie population in their city after 10 days and graph it.
	5. We will compare groups with similar rates and similar initial populations to show the difference between the starting population and end population in each case.
	6. Tell the students…The CDC labs across the nation have been investigating two novel methods to combat the spread. Newly infected cities are trying to decide which to use!

Each is a drug that is sprayed into the air and either 1) **kills off half of the starting zombie population, but increases conversion rate** OR 2) **increases the initial population, but decreases the conversion rate.**

* 1. One group from each of the two groups with the same initial parameters will be provided with each of the novel drugs, and therefore given new parameters.
	2. They will model (graph and tabulate) this new situation using their provided drug and compare it to the group who was given the other drug option.
	3. The two groups will determine which drug option was more effective and why they thought this was true.
	4. The two groups will then come together to discuss which drug they would recommend for use in the newly infected cities/ what they would do differently if they were given the option initially. And Why they chose that method.
	5. Do we anticipate that the people would be able to get rid of the zombies faster than they are reproducing?

**Formative Assessments:** Link the items in the Activities that will be used as formative assessments.

Cancer Cell growth Activity: FormativeAssessment\_Activity1.docx

Day 2 Review: FormativeAssessment\_Verbal.docx

Zombie Apocalypse Activity: FormativeAssessment\_Activity2.docx

**Summative Assessments:** Prepare a Pre-Test and Post-Test with the input of the RET Teacher. This should be a simple 10-12 question assessment tool. These questions will cover the content related to the Standards. The Pre and Post Test will be identical. There may be several summative assessments at the end of this Activity. Besides the Pre and Post Tests, the students might create a product for which this is a rubric developed. The rubric is also a summative assessment tool. Link the assessment tools.

Summative Assessment will be given on Friday Feb 3rd as a pre-test.

See SummativeAssessment.docx

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| **Differentiation:** Describe how you modified parts of the Lesson to support the needs of different learners. Refer to Activity Template for details.***Day 1***Lecture: Auditory, Visual learnersActivity #1: Incorporates hands-on learners with interactive portion, visual and auditory learners with graphical representation and interactive plotting of data***Day 2*** Formative Review: Auditory LearnersActivity #2: Hands-on learners (modeling zombie growth), visual learners (graphical representation of zombie growth) , auditory learners (verbal cues from teacher); students are required to interact with each other in group work and then discuss their opinions of the model with other groups |

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| **Reflection:** Reflect upon the successes and shortcomings of the Activity. This is done after the Activity is implemented. |



Overall, I was extremely impressed by the students’ increase in understanding. As a whole, the class demonstrated improvement on both the conceptual as well as the concrete answers with 76% of the students demonstrating improvement, 6% remaining the same, and 12% decreasing. Although I was hoping to not see any students decrease, I was comforted by the fact that only 2 students received a lower score. Not surprisingly, these students were also ones who did not seem to take the activity seriously, or were found to be copying their group member’s work.

 Looking at each question individually allowed me to see where students were struggling initially (i.e. calculating $2^{0}$ in question 3) and whether or not they improved after receiving instruction. It was interesting for me to see that even though I explained through a rather in depth process why $2^{0}$ was equivalent to 1 and not 0 or 2, still half of the class missed the question again when given the same quiz a day later. This demonstrated how easily students can miss information or interpret it incorrectly if it is not presented a variety of ways at different times throughout the lesson. Processes and equations used at multiple time points throughout the two day lecture and subsequent activities scored much higher during the second assessment (Questions 5 and 8). Both questions inquired about the equation used to create an exponential function; this equation was used more than 4 times during the activity on the second day, thus ideally ingraining its construction and how it is used into the students’ brains.

 In the event that I was able to redo these activities, I would most likely spread them out over a period of 3 days just so there is more time for reflection on what the second activity showed and how we could relate this simulation to other events that we see in the world. My class is extremely motivated by relating mathematical concepts to real life situations and I think the lesson would have made a larger impact if I was able to focus on this relationship a little longer. Overall, I was extremely proud of how the students rose to the challenge of an alternative method of learning over the course of my two day lesson. I was challenged by creating a lesson plan that encompassed their curriculum as well as my capstone project, but enjoyed working with Sam and the students to create a cohesive lesson.