**Lesson 4: Pay it Forward**

Adapted from NCTM

**Problem statement:**

Imagine you are an epidemiologist--someone who studies the spread and control of diseases. You work for the Centers for Disease Control and Prevention in Atlanta, GA. Reports of middle school students out sick have been pouring in from all over the country at an alarming rate. Few things are known about this mystery disease: victims are experiencing chills and high fever, and the disease is spreading quickly. There are no recorded fatalities, but there are reports of more extreme symptoms such as paralysis. Your team has been tasked with understanding and containing this new infectious disease. Your director has handed you a document with notes to start with, but it is up to you to come up with a plan to prevent, contain, or cure the disease. Time is of the essence, as symptoms are starting to appear in adults and high school students as well.

In this lesson, students will be able to represent exponential growth in different ways.

**Learning objectives:**

Students will be able to represent exponential growth in different ways

**Lesson standards (NGSS, CCSS, CTE):**

**Common Core State Standards Connections:**

|  |  |
| --- | --- |
| *Mathematics -* | |
| MP.1 | Make sense of problems and persevere in solving them |
| [MP.2](http://www.corestandards.org/Math/Practice/MP2) | [Reason abstractly and quantitatively. *(5-LS2-1)*](http://www.corestandards.org/Math/Practice/MP2) |
| [MP.4](http://www.corestandards.org/Math/Practice/MP4) | [Model with mathematics. *(5-LS2-1)*](http://www.corestandards.org/Math/Practice/MP4) |
| MP.5 | Use appropriate tools strategically |
| MP.6 | Attend to precision |
| MP.7 | Look for and make use of structure |
| MP.8 | Look for and express regularity in repeated reasoning |
| 6.EE.A.1 | Write and evaluate numerical expressions involving whole-number exponents. |
| 8.FA.1 | Understand that a function is a rule that assigns to each input exactly one output. The graph of a function is the set of ordered pairs consisting of an input and the corresponding output. |
| 8.FA.2 | Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). |

**Career and Technical Education:**

|  |  |
| --- | --- |
| H2.W3.7 | Work productively in teams while using cultural/global competence |

**Soft Skills:**

|  |  |
| --- | --- |
| 9.B.1  10.B.1 | Work effectively with diverse teams  Produce results |

**Materials:**

* Video link - <https://goo.gl/c5HndJ>
* [Student worksheet](https://docs.google.com/document/d/12K1KZe_dex9ZHS7nJjoAgcEJg0MnnNNle8-HVUgI1HU/edit?usp=sharing)
* [Teacher Presentation](https://docs.google.com/presentation/d/1rYLbtSSHOMpN2fq7x4Xe1p_YwnNNFpvSyvGZsnnnojM/edit?usp=sharing)

**Lesson preparation:**

* Students should have at least a basic understanding of exponents
* The lesson has been adapted for 6th graders from an 8th grade lesson
* Copy student handout
* Que up video clip

**Time required:** 45 minutes

**Grouping of students for instruction:**

Small groups (4-5 students per group)

* Consider whether or not you would like to group students by ability or mixed ability

Protocol that will help groups function smoother:

* Everyone leaning in
* Shared speaking time - equal voice
* No cross talk

**What is the instruction? Consider the PBL Procedure that is being addressed here:**

**Understanding the Problem**

|  |  |  |
| --- | --- | --- |
| **Time** | **Teacher** | **Student** |
| 3 min | Hook:  Show [video clip](https://www.youtube.com/watch?v=TlZDDACt8Nw) of the trailer for the movie *Pay it Forward*  <https://goo.gl/c5HndJ> | Watch video clip |
| 2 min | Introduce the Problem:  In the movie *Pay it Forward* a student, Trevor, comes up with an idea that he thought could change the world. He decides to do a good deed for three people and then each of the three people would do a good deed for three more people and so on. He believed that before long there would be good things happening to billions of people. At stage 1 of the process, Trevor completes three good deeds.  Students will need to answer:   1. How does the number grow from stage to stage? 2. How many good deeds will be completed by stage 5? 3. Model the *Pay it Forward* process in as many ways possible 4. Extension/Challenge question: Describe a function that would model the *Pay it Forward* process at *any* stage | Ask questions |
| 25 min | Facilitate group work  Pass out [student handout](https://docs.google.com/document/d/12K1KZe_dex9ZHS7nJjoAgcEJg0MnnNNle8-HVUgI1HU/edit?usp=sharing)  Ask questions as students work:   1. How did you get that? 2. What does that represent? 3. Can you show it in another way? 4. How do the good deeds increase at each stage? 5. How do you know   Make note of strategies being used by students | Work time   * Students should be representing their work in a variety of ways * Graphs, equations, charts, pictures/diagrams |
| 10 min | Share  Facilitate group share   * Determine which groups will share first based on accuracy of models * Make sure to have a variety of models represented | Share |
| 5 min | Connect to unit problem statement   * Restate problem statement * Ask: “how do you think this connects to the problem we’re dealing with?” * Students should come up with how the growth of good deeds grows in a similar rate to the number of people infected |  |
| 1 hour | OPTIONAL:  [Exponential Outbreaks: The Mathematics of Epidemics](https://mobile.nytimes.com/blogs/learning/2014/11/05/exponential-outbreaks-the-mathematics-of-epidemics/?referer=) |  |

**Accommodations:**

* Students with visual or auditory impairments should be situated close to the board
* Read directions and questions to the class

**Extensions:**

* Have students describe a function that would model the *Pay it Forward* process at *any* stage

**Assessment:**

* Student handout with exponential growth modeled in multiple ways

**References/Resources:**

* Instructional plan adapted from National Council of Teachers of Mathematics
* [Student Handout](https://docs.google.com/document/d/12K1KZe_dex9ZHS7nJjoAgcEJg0MnnNNle8-HVUgI1HU/edit?usp=sharing)
* [*Pay it Forward* video clip](https://goo.gl/c5HndJ)
* [Teacher Presentation](https://docs.google.com/presentation/d/1rYLbtSSHOMpN2fq7x4Xe1p_YwnNNFpvSyvGZsnnnojM/edit?usp=sharing)