

**COSMOS Experiment on Proportionality and Rate of Change Using Bandwidth & Data Rate**

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| **Grade 6-8** | |  | |
| **Topic:**  Find out the relationship of bandwidth and data rate by applying the concepts of proportionality and rate of change. | | **Materials:**   * COSMOS toolkit * Post-it Chart Paper * Markers * Pencils * Graph Paper * Noise Sensor * Carbon Dioxide Sensor * Temperature Sensor | |
| **Science & Engineering Practices (SEPs)**  Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.  Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena. (MS-LS2-2) | **Disciplinary Core Ideas (DCIs)**  ETS1.B: Developing Possible Solutions There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (secondary to MS-LS2-5)  Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth’s environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3)  Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MSESS3-3),(MS-ESS3-4) | **Crosscutting Concepts (CCs)**  Patterns Patterns can be used to identify cause and effect relationships. (MS-LS2-2) Stability and Change Small changes in one part of a system might cause large changes in another part. (MS-LS2-5)  Science Addresses Questions About the Natural and Material World Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes. (MS-LS2-5)  The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (MS-ESS3-2),(MS-ESS3-3) |  |
| **Math Common Core Standards:**  **6th Grade:**  **[CCSS.MATH.CONTENT.6.RP.A.1](http://www.corestandards.org/Math/Content/6/RP/A/1/)**  Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities.  **[CCSS.MATH.CONTENT.6.RP.A.2](http://www.corestandards.org/Math/Content/6/RP/A/2/)**  Understand the concept of a unit rate a/b associated with a ratio a:b with b ≠ 0, and use rate language in the context of a ratio relationship.  **[CCSS.MATH.CONTENT.6.RP.A.3](http://www.corestandards.org/Math/Content/6/RP/A/3/)**  Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations.  **7th Grade:  [CCSS.MATH.CONTENT.7.RP.A.1](http://www.corestandards.org/Math/Content/7/RP/A/1/)**  Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units.  **[CCSS.MATH.CONTENT.7.RP.A.2](http://www.corestandards.org/Math/Content/7/RP/A/2/)**  Recognize and represent proportional relationships between quantities.  **[CCSS.MATH.CONTENT.7.RP.A.2.A](http://www.corestandards.org/Math/Content/7/RP/A/2/a/)**  Decide whether two quantities are in a proportional relationship, e.g., by testing for equivalent ratios in a table or graphing on a coordinate plane and observing whether the graph is a straight line through the origin.  **[CCSS.MATH.CONTENT.7.RP.A.2.B](http://www.corestandards.org/Math/Content/7/RP/A/2/b/)**  Identify the constant of proportionality (unit rate) in tables, graphs, equations, diagrams, and verbal descriptions of proportional relationships.  **[CCSS.MATH.CONTENT.7.RP.A.2.C](http://www.corestandards.org/Math/Content/7/RP/A/2/c/)**  Represent proportional relationships by equations.  **8th Grade:**  **[CCSS.MATH.CONTENT.8.F.A.1](http://www.corestandards.org/Math/Content/8/F/A/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.1  **[CCSS.MATH.CONTENT.8.F.A.2](http://www.corestandards.org/Math/Content/8/F/A/2/)**  Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).  **[CCSS.MATH.CONTENT.8.F.A.3](http://www.corestandards.org/Math/Content/8/F/A/3/)**  Interpret the equation *y = mx + b* as defining a linear function, whose graph is a straight line; give examples of functions that are not linear.  **Algebra 1**  **HSA.CED.A.2**  Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.  **HSA.REI.D.10**  Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).  **S-ID.7** Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data. ★  **S-ID.8** Compute (using technology) and interpret the correlation coefficient of a linear fit.★ **S-ID.9** Distinguish between correlation and causation. | | | |
| **Essential Question:**  How do we observe and describe relationship between the Signal Bandwidth and Data Rate? | | | |
| **Learning Target** | Today I am doing an experiment to investigate whether the rate at which we send data on an electromagnetic wave is proportional/ non-prorpotional to the bandwidth it occupies. | | |
| **Engage** | 1. Students will be given a word problem of hose/faucets of different diameters. They will be solving the amount of water in a tank given their rate at a specific amount of time. 2. Students engage in a see, think, wonder of the amount of water in each tank given the different diameters/radius of the faucet/hose used at a given time.    1. See: What do you notice?    2. Think: What do you think your noticing mean?    3. Wonder: Create a question that you would like to explore further based on your noticings and conjectures? 3. Discuss with the students their conjectures and wonderings. | | |
| **Explore** | They will relate the same activity to the experiment on bandwidth and data rate by using the COSMOS Toolkit.  Students will take note of the rate of data passing through different size of bandwidth.  Graphic Organizers will be used to show the amount of data flow given the size of the bandwidth with screenshots used as evidence. | | |
| **Explain** | 1. In small groups, the students will discuss their observations, their findings, questions, multiple representations of the results and trends based on the data rate and bandwidth. 2. In a gallery walk, students will present all of their data and make connections across the different groups. They can use this space to discuss results and trends across the groups. \*Peer evaluations\* | | |
| **Extend** | **Relate Project to Science:**  Students can study different streets or highways of different size based on the number of lanes.  Observe the number of cars/vehicles that can pass through it at a given time (peak hours vs non-peak hours)  Using the noise, temperature and carbon dioxide sensors, they will test how the number of vehicles passing by in a certain place affects the noise and the accumulation of heat and carbon dioxide in the area.  Given the levels of noise, heat and carbon dioxide, they will research how these affects the health of the community and share results to the school/students. | | |
| **Evaluate** | Find out if the students were able to accomplish the main goal/learning target/essential questions posted before the experiment started.  Post the projects on the walls and the class will discuss the finding and the results of their experiments after the gallery walk they did on this activity on day 1-2  Feedbacks/questions will be entertained regarding the whole experiment and what they found out. | | |
| **Differentiation** | 6th -7th Grade (regular classes) can perform the activity and the bandwidth experiment  7th Grade Honors, 8th and 9th Grade can do the project extension to investigate the effect of the accumulation of cars/vehicles in a given area. | | |