**Gap Time**

What is the accepted gap time at stop signs?

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**Connections to the Next Generation Science Standards**

**Practice Elements:**
- Asking Questions and Defining Problems
- Planning and Carrying Out Investigations
- Developing and Using Models
- Constructing Explanation and Designing Solutions
- Engaging in Argument from Evidence
- Obtaining, Evaluating, and Communicating Information

**Crosscutting Concept Elements:**
- Patterns
- Systems and System Models

**Disciplinary Core Idea:**
- S-IC - Make inferences and justify conclusions
- ETS2 - Links Among Engineering, Technology, Science, and Society

**Component Idea:**
- S-IC.B.3 - Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.
- ETS2.B - Influence of Engineering, Technology, and Science on Society and the Natural World

**Target Grade Level:** 9-12

**Learning Performance:**
Students will recognize the purpose of observational studies by finding, researching, and defending a local intersection to use for gap time data collection and analysis.

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**Lesson Summary**

Few things annoy people more than having to wait in line, especially when they are in a hurry. It seems like there is a line everywhere you go. Want that new bobble head or jersey at the sports game? Be prepared to show up hours in advance and bring a lawn chair to make the wait more comfortable. Want to buy that 55" TV on Black Friday? Make sure to add an extra hour to your time just for the checkout. Want to drive to the mall to check out all the sales? Leave yourself time to wait at all the stoplights along your route.

How much time is spent waiting in lines? Richard Larson, a professor at MIT who studies queuing theory, estimates that some people spend a year or two of their lives waiting in line (The Washington Post). People dislike waiting so much that some companies have come up with solutions to shorten lines and wait time - priority boarding, carrots-to-go, and special lines for VIP customers. However, nothing will eliminate lines and waiting completely. What does this mean for our shopping sprees or morning commute?

How much time is really spent waiting for traffic at the stop sign? What feels like an eternity might not be as long as you think. During my research experience with the Iowa State InTrans department, the longest wait at a stop sign that I observed was 45 seconds, with the average time being significantly less than that. Do we wait as long as we think at intersections? Is waiting for traffic at an intersection really going to affect our commute time? Can we blame traffic for being late to an event?

This lesson is the first lesson of a unit that focuses on gap time at local intersections and how that gap might change the longer vehicles have to wait at the stop sign. The goal of this lesson is to choose two intersections in town to collect data about gap time as drivers approach and wait at a stop sign. It is driven by the question: What intersections would provide the best data for gap time analysis?

A member of the Iowa Department of Transportation or Iowa State University InTrans Department will present to the students a list of criteria for good intersections for data collection. (Local police officers could also work in this scenario.) From this information, students will work in groups to find and research different intersections around town to determine the best intersection to use for data collection. To limit the amount of video that has to be reduced, student groups will also determine a three hour time frame for which video will be reduced. During this research time, the teacher and expert will guide and question students about their research. Students may have to be supervised as they travel to different intersections to add real-time data about the traffic level at different intersections.

Once the groups determine which intersection and time frame they would like to use, they have to create a presentation to defend their choice. They will have to include information about any real-time data they collected at the intersection and how that connects to the research and information provided by the expert. All groups will present their choice to the Transportation Expert. The expert will choose two of the intersections based on the group presentation and set up video cameras at those intersections. Data from these videos will be collected for a total of five days.
Lesson Context

This lesson is the first lesson in a unit designed to help students explore questions about gap time. What is the accepted gap time at stop signs, and how does that change the longer you wait? As students are waiting for the collection period (as defined in this lesson) to be completed, they will partake in a series of additional lessons and activities to learn and review the mathematics concepts they will need for analyzing their reduction data. Students will learn about graphing one and two variable data to determine trends and correlation. They will also learn about measures of central tendency, measures of spread, normal distribution, writing equations from data, and types of regression models. Students will also have to agree on what data they will collect and create a spreadsheet to organize their information.

After the five days of data collection are complete, students will have to reduce the video based on the time frame presented in the first lesson. Groups of students should be assigned different videos to watch, to save time and sanity. Students will use the spreadsheets they made to organize the information they are reducing from their videos. After all videos have been reduced for both intersections, students will combine their data into one class spreadsheet. Students will then analyze the data, as determined in lesson two, in their initial groups. If possible, the expert and teacher will be available to help guide and facilitate student work and discussion.

The final portion of the unit is for students to write up a final report of their findings and prepare a short presentation for the expert. Students should include information about the data collection process, including the reasoning behind the intersections and time intervals used. The reports should also discuss the process of their analysis as a group and the results their group came up with. Students should be able to answer the driving question and provide proof for their answer. Connections to safety and what the expert could do with their results must also be included in the report.

Phenomena

To Introduce this unit, show a video of a crash, near crash, or long wait time at an intersection. Videos can be found at the YouTube Car Crashes Time Channel at https://www.youtube.com/user/CarCrashesTime or by contacting the Iowa Department of Transportation for use of their traffic cameras.

Other Resources

http://www.iowadot.gov/travel.html#/Safety
http://511ia.org/
http://lb.511ia.org/ialb/cameras/routeSelect.jsf;jsessionid=4DD46F969941EC4A38D215ADA38CE36?view=state&text=m&textOnly=false

Science Partners

The ISU InTrans Department and Iowa Department of Transportation will be valuable partners for this lesson. Local police departments could also act as the experts.

Unit Plan

http://bit.ly/2a4TeCF