# Lesson Three: Simulation Driving Day

**Grade level:** 6-8
**Expected length of lesson:** Two days, approximately 90 minutes

## Overview:

On the third day, groups should finalize their driving plan before driving the simulator to replicate the graphs given to them the prior day. Afterwards, NADS generated graphs are compared to the homework graphs. An assessment will follow the NADS simulation and graph comparison.

## Standards and/or benchmarks:

## NGSS:

Disciplinary Core Idea:
Forces and Motion

- MS-PS2-2:
  - All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared.

Cross-Cutting Concepts:

- MS-PS3-1, MS-PS3-4:
  - Proportional relationships (e.g. speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes.

Science and Engineering Practices:
Planning and Carrying Out Investigations

- MS-PS2-2:
  - Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim.
- MS-PS2-5:
  - Conduct an investigation and evaluate the experimental design to produce data to serve as the basis for evidence that can meet the goals of the investigation.

## Iowa Core:

- S.6–8.PS.3
  - Essential Concept and/or Skill: *Understand and apply knowledge of motions and forces.*
    - The motion of an object can be described by its position, direction of motion, and speed. That motion can be measured and represented on a graph.

## Learning Goals:
Students will understand:

- How position vs time, speed vs time, acceleration vs time and steering (or direction) vs time are related
- Multiple graphs are necessary to know the whole story of complex motions.

## Learning Performances:
Students will be able to:

- Generate a driving plan from the 4 graphs provided.
- Compare simulation graphs to activity graphs.
- Compare simulation graphs between groups.
- Decide the criteria to pick a winner of the driving contest.

## Materials:

- Activity graphs
- NADS simulator
- Describing Motion and Position Using Graphs (Assessment Activity)
- Assessment Key and Rubrics

## Safety:
Make sure students with a history of motion sickness do not drive the simulator.

## Critical Thinking Question:
What story are the graphs are telling us?

## Student Ideas:
Students will devise a method to translate a graphical representation of motion into a real-world complex motion using the simulator.

## Main Lesson:
At the end of the second lesson plan, students were given the four activity graphs to analyze to create a list of motion segments from information on the graphs. Roles for each group member were also assigned (timer, driver, manager, coach).

1. Students will gather in assigned groups of 3-4, with member roles already assigned.
    a. Students should compare the trips they wrote from the graphs.
    b. An example of the trip that may be used to check the work of the students:

| Action | Details | Total Time (seconds) |
|---|---|---|
| Accelerate | Go from 0 km/h to 40 km/h in 5 seconds | 5 |
| Constant speed | Continue at 40 km/h for 15 seconds | 20 |
| Accelerate | Go from 40 km/h to 80 km/h in 10 seconds | 30 |
| Decelerate | Go from 80 km/h to 0 km/h in 10 seconds | 40 |
| Full stop | Stop for 10 seconds | 50 |
| Accelerate | Go from 0 km/h to 60 km/h in 10 seconds | 60 (1:00) |

| | | |
|---|---|---|
| Constant speed | Continue at 60 km/h for 20 seconds | 80 (1:20) |
| Decelerate | Go from 60 km/h to 20 km/h in 10 seconds | 90 (1:30) |
| Constant speed | Continue at 20 km/h for 10 seconds | 100 (1:40) |
| Turn | Turn left | 105 (1:45) |

   c. The manager should determine the final trip for the group.
      1. This will be the instructions the group uses to drive on the simulator.
2. When the trips are finalized, have the class decide the criteria that will determine the winner.
   a. Examples of criteria include: accelerating at the right times, accelerating at the correct rate, maintaining correct speeds, turning the correct direction, etc.
3. Explain that each group will have one attempt to drive the simulation to generate graphs as close to the given activity graphs as possible.
   a. If time permits, groups may have the ability to drive more than once.
4. Choose how to decide the order of groups.
   a. Groups should not be allowed to watch others drive the simulator.
5. Graphs will be generated by the simulation program after all groups have finished their simulation.
   a. The ideal graphs (from the homework) will be the black line on the graph.
   b. Each graph will contain all of the trials from the groups in different colors.
   c. Groups will not know what color they are until after the winner is decided.
   d. Winners will be given prizes brought by NADS (pencils, highlighters, etc.).
6. Based on the criteria chosen above (in step 2), the class chooses which color is the winner.
   a. Each group's color will then be revealed.
7. A whole class discussion will facilitate a comparison of the graphs between groups and given activity graphs.
   a. Discuss what they could have done differently to create graphs closer to the graphs given to them.
   b. Discuss why their graphs are not identical to the graphs given to them.

## Differentiation:

- ELL: Put them in groups with stronger students who will assist them in understanding.
- TAG: Have them create their own scenario and their own graph for the Describing Motion and Position Using Graphs Worksheet.
- Special Education: Provide the labels on graphs axes for the Describing Motion and Position Using Graphs Worksheet.

## Assessment:

Use the *Describing Motion and Position Using Graphs* assessment worksheet to check for understanding at the end of the progression:

- Graph axes may be filled in for students with special needs.
- ELL students may be allowed to use verbal descriptions to answer the questions.