INITIATE Lesson Plan: *Making AV Parking Safe*

Lesson plan at a glance...

Name: Auto Parking by AVs

Course: Geometry

Grade Level: 10

Prerequisites: Chapters 1 – 3 in geometry course

Time: 3 class periods

Preparation:
Instruction:

Standard(s): G.GPE4 – G.GPE7, A.REI.5 - A.REI.6, , G.MG.1, G.MG.3

In this lesson plan…

Lesson Overview

In this lesson, students will practice and review skills acquired in Chapters 1-3 of the geometry course to solve a real world problem. The skills are: using the midpoint and distance formulas, finding coordinates on a directed line segment, finding the intersection point of two lines, measuring segment length, determining angle measure, finding equations of parallel and perpendicular lines, using logic statements to program a GoPiGo car.

Driving Questions

Overarching Driving Question for INITIATE Wide Project:

- How safe are autonomous vehicles?

Lesson Specific Question:

- How can autonomous vehicles park safely in a parking lot?

Materials and Equipment

Chromebook, GoPiGo cars, Poster paper, markers, rulers/meter/yard sticks

Preparation Tasks

	None; inherent within the course and within other courses, such as robotics	

The Lesson

Warm-up Activity:	*15 min*
Activity 1: *Application*	*35 min*
Activity 2: *Design/Build/Program*	*50 min*
Activity 3: *Program*	*30 min*
Wrap-up Activity: *Share*	*20 min*

Warm-up Activity: Card Sort/AV Parking Video (15 min)

Activity Overview: In this activity, students will engage in an online card sort to review concepts needed to complete this

mini-project. Then, they will watch a video on autonomous vehicle parking to be the hook of the lesson. Finally, there will be a short sharing and discussion about the video before moving onto the next activity.

Activity: As students are entering the classroom, they will be directed to grab a chromebook and navigate to my Desmos class code. Direct students to complete slides 1 – 3 of the activity, including watching the video. If too many students do NOT have headphones, plan to watch the video together approximately 5 minutes after class begins. The first 3 slides should take 10-12 minutes to navigate through. Plan to discuss and share student results via the Desmos platform for 3-5 minutes.

Teacher Tip: Navigate to https://teacher.desmos.com/activitybuilder/custom/5d13b530a5916d120d896c5f to pull up the Desmos Activity – Click "Create Class Code" to start your own class session and dashboard.

Activity 1: Application (35 minutes)

Activity Overview: In this activity, students will apply the reviewed concepts in order to determine parameters of a small parking lot. Its scaled image will be overlaid onto a graph in Desmos.

Activity: Instruct students to go to slide 4 of the Desmos activity which asks them which information (potentially from the card sort) they would need to gather in order to determine how to 1) program an AV to park itself in one of the spaces shown when starting at the origin and 2) build a real size model of the parking diagram. Once all students have submitted a response, discuss as a whole group. (10 minutes) Instruct students to navigate through slides 5 - ?? to find the information required. Stop and start students in the activity as needed if common errors are evident on the dashboard. Use the dashboard feature to help individual students as necessary. Students who don't finish by the end of class time will be assigned to complete it for homework. (25 min)

Teaching Tips:

- *Go to teacher.desmos.com and search for the "AV Parking" activity by Lisa Foos. You can simply create a class code and use it with your students, or if you would like to copy and edit the activity to better accommodate your classroom, click the three dots in the upper right hand corner and select "Copy and Edit". OR* Navigate to https://teacher.desmos.com/activitybuilder/custom/5d13b530a5916d120d896c5f to pull up the Desmos Activity – Click "Create Class Code" to start your own class session and dashboard.

- *If you've never used Desmos activities before, I recommend that you enter and complete the activity as a student, using the class code you created, keeping your teacher view open. That way, you will be able to familiarize yourself with what you will see on the dashboard as a teacher before you actually roll it out in the classroom. Make sure to understand the Pause feature on the teacher dashboard.*

Activity 2: Design/Build/Program (50 min)

Activity Overview: Students will use the results from the previous day's activities to design and "build" the parking lot to fit the GoPiGo car. Once done, they will program their GoPiGo car in teams to park in various parking spaces, given prompts.

Activity: Begin the lesson by briefly reviewing the previous day's results, which can be done by pulling up the Desmos dashboard. Ask students for their input on what they learned, and then point out any errors which need mentioning based on student responses in Desmos. (5-7 min) Instruct students to navigate to the slide which asks them to

measure both the length and width of their GoPiGo car. They will then determine an appropriate length and width needed for a space to park their GoPiGo car. At this point, you will pause the Desmos screen and hold a large group discussion to come to a consensus as to what the dimensions of each individual parking space should be to hold the GoPiGo car. (10 min) Make a comparison to the agreed upon length and width to that on the Desmos graph to get a scale factor. Students will use the scale factor to determine the dimensions to be used for their GoPiGo cars. Students will work together to draw the parking lot on poster paper. (25-27 min) Students will work in teams to accommodate the number of GoPiGo cars in order to program their robot to do the following: 1) Park in the second spot. 2) Back out and go back to the origin. (6-10 min)

Teaching Tips:

- *Make sure to take your tablet with you as you walk around the classroom to help students. That way, you can keep an eye on the Dashboard and pause activities if needed.*

Activity 3: Program (50 min)

Activity Overview: In this activity, students will program their GoPiGo cars to park in a parking lot from a starting point, and then program them to back out and go back to the starting point.

Activity: At the beginning of class, recap the previous day's events with students and take any questions from students regarding programming. Remind students of yesterday's instructions: Students will work in teams to accommodate the number of GoPiGo cars in order to program their robot to do the following: 1) Park in the second spot. 2) Back out and go back to the origin. (30 min)

Teaching Tips:

- *For students needing remediation, limit the activity by only requiring the car to park, not back out of the space and go home.*
- *For advanced students who finish early, give additional, more challenging activities, such as programming a car to bypass a filled space and move to the next available space. You could also introduce advanced students to the line following*

Wrap-up Activity: Analysis and reflection (20 minutes)

Activity Overview: In this activity, students will share their group GoPiGo program and demonstrate it's route.

Activity:

1. In groups, students will share their group's program and demonstrate it using the poster paper route. They will also share at least one problem they encountered and how they fixed it.

Assessment: Students will be graded on the work they have done in Desmos, which is recorded on the dashboard. There will also be a grading rubric used to grade their group programming and demonstration.

Learning Objectives and Standards

Learning Objectives	Standards
Apply the midpoint and distance formula in a real world problem	G.GPE.4 Use coordinates to prove simple geometric theorems algebraically and to verify geometric relationships algebraically, including properties of special triangles, quadrilaterals, and circles. For example, determine if a figure defined by four given points in the coordinate plane is a rectangle; determine if a specific point lies on a given circle. G.GPE.7 Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula. G.MG.1 Use geometric shapes, their measures, and their properties to describe objects, e.g., modeling a tree trunk or a human torso as a cylinder
Solving a system of equations in a real world problem	A.REI.5 Verify that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions. A.REI.6 Solve systems of linear equations algebraically and graphically. a. Limit to pairs of linear equations in two variables. (A1, M1)
Identify parallel and perpendicular lines from slope; find equations of parallel and perpendicular lines	G, M2) G.GPE.5 Justify the slope criteria for parallel and perpendicular lines, and use them to solve geometric problems, e.g., find the equation of a line parallel or perpendicular to a given line that passes through a given point.
Find the location of a point on a directed line segment	G.GPE.6 Find the point on a directed line segment between two given points that partitions the segment in a given ratio.
Model a real world problem using geometric and algebraic concepts	G.MG.1 Use geometric shapes, their measures, and their properties to describe objects, e.g., modeling a tree trunk or a human torso as a cylinder. G.MG.3 Apply geometric methods to solve design problems, e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios.

Additional Information and Resources

Project-based Learning Features

Feature	Where does this occur in the lesson?
Driving Question	*In the Warm-Up Activity, students will watch a video after being asked the question "How can autonomous vehicles park safely in a parking lot?". In the Wrap-Up Activity, the driving question will be revisited.*
Investigation & Problem Solving	*In Activity 1, students will be required to investigate and problem solve to determine how to use what they've learned in the previous three chapters to find certain parameters of the parking lot. In Activity 2, Students will need to investigate what an appropriate dimension for a car parking space should be, i.e., they will need to answer questions such as, how much "cushion" should exist in a parking space. They will then need to look at the measurements they have taken of their GoPiGo car and problem solve to determine the best dimensions of an individual parking space.*
Making Sense of Data & Technology Integration	*Technology integration will occur in all activities as chromebooks will be used along with the Desmos activity builder program. In Activity 3, the GoPiGo car will be utilized along with the Bloxter coding program.*

Computational Thinking	*Decomposition – Activity 1 & 3; Abstraction – Activity 1 & 3; Pattern Recognition – Activity 3; Algorithm Design – Activity 3*
Collaborative Opportunities	*In all activities, there will be group discussion after individual effort. In Activity 3, students will work in groups to program and demonstrate parking their robot.*
Assessment Techniques	*In the Warm-Up Activity, students will be able to self-assess during the card sorting activity. In addition, group presentations and demonstrations during the Wrap-Up Activity will be assessed against a rubric that students will be given ahead of time.*

Computational Thinking Concepts

Concept	***Where does this occur in the lesson?***
Decomposition	*Activity 1 – Break down the diagram of the parking lot to answer the questions; Activity 2 – Break down the process of designing a parking space; Activity 3 – Break down the process of moving the robot car to move it into a parking space and then bringing it back home*
Abstraction	*Activity 1 – Uncover and develop the underlying math in parking a car in a parking lot, as well as in the design of the lot; Activity 3 – Uncover and develop the underlying math in programming a robot to park and then return home*
Pattern Recognition	*Activity 3 – note patterns in programming*
Algorithm Design	*Activity 3 – develop a set of steps to program the robot*

Administrative Details

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Sources: https://classroom.google.com/u/0/w/MzQ3NjQ5NjI4NDIa/t/all

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Template adapted from: https://edu.google.com/resources/programs/exploring-computational-thinking/