Driven by Innovation: Unleashing the Future of Autonomous Vehicles

Dive into the world of autonomous vehicles and their impact on transportation

Broad Based Technology Area: Transportation, Technological Design, Manufacturing, Communications, Construction

Project Overview

Welcome to an exciting unit where students will dive into the world of autonomous vehicles and their impact on transportation. Through a series of captivating lessons, students will uncover the fascinating realm of self-driving cars, exploring concepts such as form and function, simulation, coding, and engineering design. This unit not only provides valuable insights into autonomous vehicles but also connects to skilled trades and pathways, offering students a glimpse into potential career opportunities in the automotive industry.

Throughout this unit, students will not only gain a comprehensive understanding of autonomous vehicles but also develop critical thinking, problem-solving, collaboration, and presentation skills.

Each activity can be done in isolation or as an entire unit. Join us on this journey as we unlock the possibilities and shape the future of autonomous vehicles!

Connections to Grade 7 Form and Function and Autonomous Vehicles

Form: Students need to consider the physical structure, shape, and size of the vehicle, ensuring it meets the requirements for functionality, aerodynamics, and safety.

Function: Students explore how the vehicle's components (sensors, processors, actuators) work together to enable autonomous operation and perform specific functions such as obstacle detection, decision-making, and navigation.

Grade 7 Curriculum Connections

Science

A1. STEM Investigation and Communication Skills: use a scientific research process, a scientific experimentation process, and an engineering design process to conduct investigations, following appropriate health and safety procedures

- **A1.3** use an engineering design process and associated skills to design, build, and test devices, models, structures, and/or systems
- **A1.4** follow established health and safety procedures during science and technology investigations, including wearing appropriate protective equipment and clothing and safely using tools, instruments, and materials
- **A2.1** write and execute code in investigations and when modelling concepts, with a focus on planning and designing programs
- **A2.2** identify and describe impacts of coding and of emerging technologies, such as artificial intelligence systems, on everyday life, including skilled trades
- **A3.1** describe practical applications of science and technology concepts in various occupations, including skilled trades, and how these applications address real-world problems

Grade 7 Curriculum Connections - Continued

D1. Relating Science and Technology to Our Changing World: analyse personal, social, economic, and environmental factors that should be considered when designing and building structures

Form, Function, and Design of Structures

- **D1.1** evaluate environmental, social, and economic factors that should be considered when designing and building structures to meet specific needs for individuals and communities
- **D1.2** evaluate the impact of the ergonomic design of various tools, objects, and work spaces on a user's health, safety, and ability to work efficiently, and use this information to describe changes that could be made in their own spaces and activities

Grade 7 Curriculum Connections - Continued

D2. Exploring and Understanding Concepts: demonstrate an understanding of the relationship between structural forms and the forces acting on them

Form, Function, and Design of Structures

- **D2.4** describe the role of symmetry in structures, and identify instances of symmetry in various structures
- **D2.5** describe factors that can cause a structure to fail
- **D2.6** identify the factors that determine the suitability of materials for use in manufacturing a product or constructing a structure
- **D2.7** describe methods engineers and other professionals use to assess, improve, and maintain the safety of structures

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Lesson Instructions

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Activity 1

Autonomous Avenue: Unlocking the World of Self-Driving Cars

Activity 2

Form & Function Freeway: Unraveling the Impact on Autonomous Vehicles

Activity 3

K8 on Wheels: Navigating the Terrain with Autonomous Vehicle Simulation

Activity 4

Scratch the Surface: Coding Adventures in Autonomous Vehicle Simulation

Activity 5

Design Drive: Engineering the Ideal Autonomous Vehicle Model

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Activity 1

Autonomous Avenue: Unlocking the World of Self-Driving Cars

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Activity 1 Overview

In the lesson "Autonomous Avenue: Unlocking the World of Self-Driving Cars," students will be introduced to the concept of autonomous vehicles and their transformative potential. They will uncover the technological advancements, benefits, and challenges associated with this emerging field. By the end of this lesson, students will understand the significance of autonomous vehicles and how they can shape the future of transportation.

Materials

- Presentation slides or visual aids on autonomous vehicles
- Case Study
- Set of pictures of different autonomous vehicles
- Paper and pens for reflection activities
- Flipchart or whiteboard for group discussion

Minds On

Begin the lesson by engaging students with a thought-provoking question: "Can you imagine a world where cars can drive themselves?"

Facilitate a brief class discussion, allowing students to share their thoughts and prior knowledge about autonomous vehicles.

Introduce the learning goals and success criteria for the lesson.

Learning Goals

Understand the concept of autonomous vehicles and their potential impact on transportation.

Explore the form and function of autonomous vehicles and how they are designed.

Reflect on the benefits and challenges associated with autonomous vehicles.

Apply knowledge gained to propose innovative ideas for the future of autonomous vehicles.

Success Criteria

Students can define and explain the concept of autonomous vehicles accurately.

Students can identify and describe key features related to the form and function of autonomous vehicles.

Students can critically analyze the benefits and challenges of autonomous vehicles through class discussions and reflection activities.

Students can generate and present creative ideas for the future development and implementation of autonomous vehicles.

Participate

Introduce the concept of autonomous vehicles, their definition, and their potential impact on transportation.

Discuss the key features, technologies, and advancements related to autonomous vehicles.

Use this case study to demonstrate the practical applications and benefits of autonomous vehicles.

Participate

Divide the class into small groups or pairs.

Provide each group with a set of pictures of different autonomous vehicles.

Instruct students to examine the pictures and discuss the form and function of the vehicles.

Encourage students to identify and discuss the design features that contribute to the vehicles' autonomous capabilities.

Reflect- Benefits and Challenges

Have students individually reflect on the benefits and challenges of autonomous vehicles.

Provide guiding questions such as: "What are the potential advantages of autonomous vehicles in terms of safety, efficiency, and accessibility?" and "What are the concerns and challenges associated with the widespread adoption of autonomous vehicles?"

Students can write down their reflections or engage in a brief class discussion, sharing their thoughts and insights.

Apply- Future of Autonomous Vehicles

In small groups or pairs, instruct students to do a think tank and generate innovative ideas for the future of autonomous vehicles.

Encourage them to consider potential applications, advancements, and impacts on various aspects of society.

Each group presents their ideas to the class, explaining the reasoning behind their proposals.

Conclusion and Assessment

Summarize the key points covered in the lesson, emphasizing the learning goals and success criteria.

Assess student understanding and engagement through observation during group discussions and presentations.

Provide feedback and encourage further exploration of autonomous vehicles outside of the classroom.

Assessment can be conducted through observation of student participation and engagement during class discussions, group activities, and presentations.

Formative assessment can be embedded throughout the lesson, focusing on students' ability to define autonomous vehicles accurately, identify form and function

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Activity 2

Form & Function Freeway - Unraveling the Impact on Autonomous Vehicles

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Activity 2 Overview

Moving on to the "Form & Function Freeway: Unraveling the Impact on Autonomous Vehicles," students will explore the vital relationship between form and function in autonomous vehicles. They will examine how design choices influence safety, efficiency, and user experience. Through engaging activities, students will gain insights into the intricate balance between aesthetics and functionality in the world of autonomous vehicles.

Materials

- Presentation slides or visual aids on form, function, and autonomous vehicles
- Case study
- Paper and pens for reflection activities
- Design templates or drawing materials for design improvement exercise
- Rubric or checklist for design improvement assessment

Minds on

Begin the lesson by engaging students with a thought-provoking question: "What comes to your mind when you think about autonomous vehicles?"

Facilitate a brief class discussion, allowing students to share their thoughts and prior knowledge about autonomous vehicles.

Introduce the learning goals and success criteria for the lesson.

Learning Goals

Understand the importance of form and function in the design of autonomous vehicles.

Explore the relationship between form, function, and performance in autonomous vehicles.

Reflect on the impact of form and function on safety, efficiency, and user experience.

Apply knowledge gained to propose design improvements for autonomous vehicles.

Success Criteria

Students can define and explain the concepts of form and function in the context of autonomous vehicles.

Students can identify and describe key design elements that contribute to the form and function of autonomous vehicles.

Students can critically analyze the impact of form and function on the performance and user experience of autonomous vehicles.

Students can propose design improvements based on their understanding of form and function principles.

Participate- Form and Function

Present a slideshow or visual aids that explain the concepts of form and function in the context of autonomous vehicles.

Discuss the importance of form and function in achieving safety, efficiency, and user satisfaction.

Use examples and case study to demonstrate how design choices impact the form, function, and performance of autonomous vehicles.

Participate- Explore Design Elements

Divide the class into small groups or pairs.

Provide each group with images or diagrams of different autonomous vehicles.

Instruct students to examine the vehicles' design elements and discuss how each element contributes to form, function, and performance.

Encourage students to consider factors such as aerodynamics, sensor placement, interior layout, and user interfaces.

Reflect- Impact Reflection

Have students individually reflect on the impact of form and function on autonomous vehicles.

Provide guiding questions such as: "How does the design of an autonomous vehicle affect its safety and efficiency?" and "What role does user experience play in the success of autonomous vehicles?"

Students can write down their reflections or engage in a brief class discussion, sharing their thoughts and insights.

Apply- Design Improvement Exercise

Provide students with drawing materials (pencil, markers, paper OR virtual drawing tool like Google Draw or Tinkercad).

Instruct them to choose one aspect of autonomous vehicle design (e.g., exterior, interior, user interface) and propose design improvements based on form and function considerations. They could draw out what this would look like or create a list.

Encourage students to think creatively and consider the impact of their proposed improvements on safety, efficiency, and user experience.

Conclusion and Assessment

Summarize the key points covered in the lesson, emphasizing the learning goals and success criteria.

Encourage students to continue exploring the interplay between form, function, and autonomous vehicles in real-world contexts.

Provide opportunities for further research or design projects related to autonomous vehicle form and function.

Assess student understanding and engagement through observation during class discussions, group activities, and presentations.

Use the reflection activities and design improvement exercise to assess critical thinking and application of form and function principles.

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Activity 3

K8 on Wheels: Navigating the Terrain with Autonomous Vehicle Simulation

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Activity 3 Overview

In the lesson "K8 on Wheels: Navigating the Terrain with Autonomous Vehicle Simulation," students will have the opportunity to simulate autonomous vehicles using the K8 robot. They will delve into the world of robotics and programming, exploring how autonomous navigation can be achieved. By utilizing the K8 robot, students will navigate terrains, overcome obstacles, and learn about the challenges and considerations involved in programming autonomous functionalities.

If you do not have access to a K8 Robot, this lesson can be adapted using any other Robotics kit with a sensor. If no Robotics are available, more to activity 4.

Materials

- K8 robot kits (one per small group or pair)
- Micro:bit
- Laptops or devices with programming software compatible with the K8 robot
- Pen and paper for reflection activities
- Checklist for assessing programming and reflection activities
- Access to https://inksmith.teachable.com/ for tutorials and coding examples.

Minds on

Begin the lesson by engaging students with a thought-provoking question: "Can you imagine a vehicle that can drive itself without human control?"

Facilitate a brief class discussion, allowing students to share their thoughts and prior knowledge about autonomous vehicles.

Introduce the learning goals and success criteria for the lesson.

Learning Goals

Understand the concept of autonomous vehicles and their potential impact on transportation.

Explore the capabilities and functionalities of the K8 robot as a platform for simulating autonomous vehicles.

Reflect on the challenges and considerations in programming autonomous functionalities for the K8 robot.

Apply knowledge gained to program and simulate autonomous navigation using the K8 robot.

Success Criteria

Students can define and explain the concept of autonomous vehicles accurately.

Students can describe the functionalities and capabilities of the K8 robot in simulating autonomous vehicles.

Students can apply programming concepts to simulate autonomous navigation using the K8 robot.

Students can reflect on the challenges and considerations involved in programming autonomous functionalities for the K8 robot.

Participate- Autonomous Vehicles Overview

Introduce the concept of autonomous vehicles, their definition, and their potential impact on transportation.

Discuss the key features, technologies, and advancements related to autonomous vehicles.

Emphasize the importance of programming and simulation in developing and testing autonomous functionalities.

Participate- K8 Robot Introduction

Introduce the concept of autonomous vehicles, their definition, and their potential impact on transportation.

Discuss the key features, technologies, and advancements related to autonomous vehicles.

Use this case study to demonstrate the practical applications and benefits of autonomous vehicles.

Explain how the K8 robot can be programmed to simulate autonomous navigation and adapt to different terrains.

Reflect- Programming Challenges

Have students individually reflect on the challenges and considerations in programming autonomous functionalities for the K8 robot.

Provide guiding questions such as: "What programming concepts and skills do you think are necessary to simulate autonomous navigation?" and "What are some potential challenges in programming the K8 robot to adapt to different terrains?"

Students can write down their reflections or engage in a brief class discussion, sharing their thoughts and insights.

Apply- Autonomous Navigation Simulation

Divide the class into small groups or pairs, providing each group with a K8 robot kit and a laptop or device with compatible programming software.

Instruct students to program the K8 robot to simulate autonomous navigation in a designated simulated terrain (e.g., using line following or obstacle detection algorithms).

Encourage students to experiment and iterate on their programs, adjusting sensor readings, motor controls, and decision-making algorithms to enhance autonomous navigation.

Conclusion and Assessment

Have students reflect on their simulation experience, discussing the challenges they encountered and the effectiveness of their autonomous navigation programs.

Assess student understanding and engagement through observation during the simulation activity and reflection discussions.

Provide feedback and assess student programming and reflection activities based on the checklist.

Assess student understanding and engagement through observation during class discussions, group activities, and programming simulations.

Use the reflection activities and programming simulation to assess critical thinking, application of programming concepts, and understanding of autonomous navigation challenges.

Provide feedback on programming and reflection activities based on the success criteria and assessment rubric or checklist.

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Activity 4

Scratch the Surface: Coding Adventures in Autonomous Vehicle Simulation

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Activity 4 Overview

In "Scratch the Surface: Coding Adventures in Autonomous Vehicle Simulation," students will discover the power of coding as they use Scratch to simulate autonomous vehicle behaviors. Through hands-on activities, they will develop their coding skills, creating programs that simulate autonomous navigation, obstacle avoidance, and more. This lesson offers an exciting glimpse into the intersection of coding and autonomous vehicles.

Materials

- Computers or devices with Scratch software installed or accessible online (https://scratch.mit.edu/)
- Pen and paper for reflection activities
- Rubric or checklist for assessing coding and reflection activities
- Rubric

Minds On

Begin the lesson by engaging students with a thought-provoking question: "Can you imagine a vehicle that can navigate on its own without human control?"

Facilitate a brief class discussion, allowing students to share their thoughts and prior knowledge about autonomous vehicles.

Introduce the learning goals and success criteria for the lesson.

Learning Goals

Understand the concept of autonomous vehicles and their potential impact on transportation.

Explore the capabilities of Scratch coding in simulating autonomous vehicle behaviors.

Reflect on the challenges and considerations in programming autonomous functionalities using Scratch.

Apply coding skills to program and simulate autonomous vehicle behaviors in Scratch.

Success Criteria

Students can define and explain the concept of autonomous vehicles accurately.

Students can demonstrate an understanding of Scratch coding concepts and functionalities.

Students can apply Scratch coding skills to program and simulate autonomous vehicle behaviors.

Students can reflect on the challenges and considerations involved in programming autonomous functionalities using Scratch.

Participate- Autonomous Vehicles Overview

Introduce the concept of autonomous vehicles, their definition, and their potential impact on transportation.

Discuss the key features, technologies, and advancements related to autonomous vehicles.

Emphasize the importance of programming and simulation in developing and testing autonomous functionalities.

Participate- Scratch Introduction and Exploration

Introduce Scratch coding by demonstrating its interface and basic functionalities.

Guide students in exploring Scratch projects related to autonomous vehicles.

Encourage students to examine the code and behavior of these projects, discussing how Scratch can be used to simulate autonomous vehicle behaviors.

Design and Programming:

Provide students with access to Scratch, a block-based programming platform.

Guide them in designing and programming the sprite to simulate an autonomous vehicle.

Assist with implementing movement controls, collision detection, and sensor-like behavior using Scratch blocks.

Movement

Sprite Detection

Sensing Blocks

Virtual Terrains

Create multiple virtual terrains using different backdrops or sprites in Scratch.

Each terrain should present unique challenges such as hills, obstacles, or different friction levels.

Customize the behavior of the terrains to influence the movement of the autonomous vehicle sprite.

Reflect- Programming Challenges

Have students individually reflect on the challenges and considerations in programming autonomous functionalities using Scratch.

Provide guiding questions such as: "What coding concepts and skills do you think are necessary to simulate autonomous vehicle behaviors?" and "What are some potential challenges in programming autonomous functionalities using Scratch?"

Students can write down their reflections or engage in a brief class discussion, sharing their thoughts and insights.

Apply- Autonomous Vehicle Simulation in Scratch

Divide the class into small groups or pairs, providing each group with a computer or device with Scratch software.

Instruct students to design and program a Scratch project that simulates the behavior of an autonomous vehicle.

Encourage students to think creatively and apply coding concepts to program autonomous navigation, obstacle avoidance, or other relevant behaviors.

Conclusion and Assessment

Summarize the key points covered in the lesson, emphasizing the learning goals and success criteria.

Encourage students to continue exploring Scratch coding and autonomous vehicle simulation, applying their skills to real-world challenges.

Provide opportunities for further research or design projects related to Scratch coding and autonomous vehicle behaviors.

Have students reflect on their simulation experience, discussing the challenges they encountered and the effectiveness of their autonomous vehicle simulations.

Assess student understanding and engagement through observation during the coding activity and reflection discussions.

Provide feedback and assess student coding and reflection activities based on the rubric.

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Activity 5

Design Drive - Engineering the Ideal Autonomous Vehicle Model

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Activity 5 Overview

In "Design Drive: Engineering the Ideal Autonomous Vehicle Model," students will apply their knowledge and skills to the engineering design process. Working collaboratively in teams, they will embark on a design challenge to create a prototype of the ideal autonomous vehicle. Students will consider safety, efficiency, aesthetics, and urban adaptability as they strive to revolutionize transportation in urban environments.

Materials

- Research materials (books, articles, online resources) on autonomous vehicles and urban transportation
- Drawing materials (paper, pencils, markers)
- Design software or online tools (optional)
- Prototyping materials (e.g., cardboard, craft supplies, 3D printing, if available)
- Presentation materials (poster board, PowerPoint, or other presentation tools)
- Sample Assessment and Evaluation
- Sample Report Card Comments
- Sample Learning Skills Comments

Materials

Research materials (books, articles, online resources) on autonomous vehicles and urban transportation

Design software or online tools (optional)

Prototyping materials (e.g., cardboard, craft supplies, 3D printing, if available)

Presentation materials (poster board, PowerPoint, or other presentation tools)

The design challenge

Minds On

Begin the lesson with an engaging introduction, emphasizing the exciting world of engineering and the design challenge ahead.

Share the objective and expectations for the autonomous vehicle prototype design project.

Divide students into teams provide each team with a copy of the design challenge.

Provide time for each group to read the design challenge and receive clarification where necessary.

Introduce the learning goals and success criteria for the lesson.

Learning Goals

Understand the key considerations and features in designing an autonomous vehicle for urban environments.

Apply knowledge of autonomous vehicle concepts, urban transportation challenges, and design principles to the engineering design process.

Collaborate effectively in teams to design and create a prototype of an autonomous vehicle that addresses safety, efficiency, and aesthetics in urban transportation.

Reflect on the design choices and justifications, considering the impact of the autonomous vehicle prototype on revolutionizing urban transportation.

Success Criteria

Students can explain the key considerations and features involved in designing an autonomous vehicle for urban environments.

Students can actively engage in the engineering design process, including brainstorming, concept development, and prototype creation.

Students can collaborate effectively in teams, applying critical thinking and problem-solving skills to address design challenges.

Students can reflect on their design choices, justifying the selected features based on autonomous vehicle concepts, urban transportation challenges, and aesthetic considerations.

Students can present their autonomous vehicle prototype effectively, demonstrating their understanding of the design objectives and their ability to communicate their design choices.

Participate- The Engineering Design Process

The following slides will provide prompts for students to help guide them through the engineering design process when challenged to design their own autonomous vehicles.

The objective of this activity is for students to design a cutting-edge autonomous vehicle prototype that combines safety, efficiency, and aesthetics to revolutionize transportation in urban environments.

Define the Problem

Identify the key requirements and constraints for your autonomous vehicle. Consider factors such as size, speed, power source, communication systems, and the ability to detect and respond to obstacles.

Make sure students know the materials that are available to them and the constraints that they have to build their prototype.

Research

Explore existing autonomous vehicle technologies and research their form and function. Analyze how different components (sensors, processors, actuators, etc.) work together to enable autonomous operation.

Engage students in a brainstorming session to generate ideas for their autonomous vehicle prototype.

Encourage exploration of design aspects related to safety, efficiency, aesthetics, user experience, and urban adaptability.

Think Tank

Guide teams through brainstorming sessions to generate initial ideas and concepts for their autonomous vehicle prototype.

Encourage the use of sketching or design software to visualize their ideas.

Discuss and refine ideas as a team, considering the objective and key design considerations.

Design and Develop

Use your research and think tank outcomes to create detailed design drawings of your autonomous vehicle. Consider the form and function of the vehicle's structure, sensors, control systems, and any other components necessary for autonomous operation.

Have students sketch their initial design ideas, considering the overall structure, wheels, sensors, and other necessary components.

Guide them through the construction process, encouraging them to consider the form and function of each component and how they contribute to the vehicle's performance.

Build a Prototype

Allocate sufficient class periods for teams to develop their autonomous vehicle prototypes.

Provide necessary materials and resources based on the available options (e.g., prototyping materials, design software).

Encourage teams to collaborate, iterate, and refine their prototypes as they progress.

Test and Evaluate

Instruct each team to present their autonomous vehicle prototype to the class.

Require teams to explain their design choices, justifications, and how their prototype addresses the design challenge.

Evaluate the prototypes based on the objective, design considerations, functionality, aesthetics, and presentation quality.

Guide them in making necessary modifications to enhance the vehicle's form and function.

Encourage creative problem-solving and iteration to optimize the vehicle's autonomous capabilities.

Communicate and Reflect

Prepare a presentation or report to showcase your autonomous vehicle prototype. Explain the design choices you made, the challenges you faced, and how you addressed them.

Reflect on the form and function aspects that influenced your design decisions.

Engage in a reflective discussion about the challenges faced during the design process, the impact of form and function on the vehicle's performance, and the potential real-world applications of autonomous vehicles.

Assessment and Evaluation

Rubric

Note: The rubric aligns with the Grade 7 Ontario Science Curriculum by incorporating scientific concepts, the engineering design process, teamwork and collaboration, presentation and communication skills, and reflection and evaluation. It assesses the students' understanding, skills, and abilities related to these curriculum expectations in the context of the autonomous vehicle terrain challenge.

Sample Report Card Comments

Remember to tailor these sample comments to fit each student's individual performance and achievements in the Autonomous Vehicle Terrain Challenge, while aligning them with the specific rubric criteria and curriculum expectations.

Learning Skills

Please note that the sample comments provided above are intended as general examples and should be adapted to reflect the unique strengths, areas for growth, and individual progress of each student. These comments serve as a starting point to help guide the creation of personalized feedback and assessment for each student. As an educator, it is important to consider the specific context, observations, and evidence gathered throughout the unit to provide accurate and meaningful feedback that aligns with the Ontario Growing Success framework and the individual needs of the students.

Appendix A

Case study #1

Set of pictures

Form and function slides

Case study #2

K8 robot Checklist

Activity #4 Rubric

The design challenge

Assessment and Evaluation

Sample Report Card Comments

Learning Skills

References

Inksmith K8 robot

https://inksmith.teachable.com/

YouTube

Autonomous car / self-driving car - How it works! (Animation) - YouTube

Scratch

Scratch - Imagine, Program, Share (mit.edu)

https://en.scratch-wiki.info/wiki/Movement

https://en.scratch-wiki.info/wiki/Making_Sprites_Detect_and_Sense_Other_Sprites

https://en.scratch-wiki.info/wiki/Backdrop

https://en.scratch-wiki.info/wiki/Sensing_Blocks

https://en.scratch-wiki.info/wiki/Sprite

The Engineering Design Process

https://www.dcp.edu.gov.on.ca/en/curriculum/science-technology/context/processe