Zooming into Physics: Building Motorized Lego Cars

Grade Level: 3rd to 5th Grade

Objective:

- Understand the basics of electric circuits and the roles of switches and batteries.
- Explore the conversion of electrical energy to mechanical energy using a motor and a fan.
- Apply principles of aerodynamics and design to enhance vehicle performance.

Standards:

- **NGSS 3-PS2-2:** Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.
- **NGSS 4-PS3-4:** Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.
- **NGSS 3-5-ETS1-1:** Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

Materials:

- Lego building sets suitable for constructing vehicle frames, including wheels and axles.
- Small electric motors.
- Fan blades that can be attached to motors.
- Battery packs with built-in switches, and wires.
- Tape for securing components.
- Various gears (if available in Lego sets).
- Additional crafting materials for customization (optional).

Mechanical Engineering Aspects:

- **Design and Construction:** Building the car and experimenting with changes to its physical design, such as altering wheel size or reducing weight, directly relate to mechanical engineering.
- **Energy Transfer and Conversion:** The motor converts electrical energy into mechanical energy to drive the car, a fundamental mechanical engineering concept.

Electrical Engineering Aspects:

- **Circuit Design:** Setting up a circuit that includes a motor and a switch involves key electrical engineering principles.
- **Understanding Electrical Control:** Using a switch to control the operation of the motor highlights concepts of electrical flow and control mechanisms.

Procedure:

1. **Introduction to Circuits and Energy Conversion (15 minutes):**
    - Discuss the components of a basic circuit, including the battery pack, motor, switch, and how attaching a fan to the motor converts electrical energy into motion.
2. **Building the Base Vehicle (25 minutes):**
    - Demonstrate how to construct a basic Lego car frame.
    - Show how to assemble a working circuit with the motor, battery pack, and securely attach the fan to the motor.
3. **Integrating Circuit into Vehicle Design (30 minutes):**
    - Students design their cars and figure out innovative ways to incorporate the motor and fan setup into their vehicles using tape for stability.
    - Discuss the importance of the fan's placement for effective propulsion.
4. **Initial Testing and Racing (20 minutes):**
    - Allow students to test their cars by racing them to observe the initial functionality and performance.
    - Encourage identification of design improvements based on the outcomes.
5. **Design Optimization (20 minutes):**
    - Students refine their cars to optimize speed, stability, or aesthetics based on initial tests.
    - Re-test cars to evaluate the impact of their modifications.
6. **Class Discussion and Reflection (20 minutes):**
    - Lead a discussion about various design strategies and their effectiveness.
    - Discuss the engineering challenges encountered and how they were resolved.

Guiding Questions:

- How does the addition of the fan affect your car’s propulsion and speed?

- What adjustments can you make to improve how your car uses the air pushed by the fan?
- How do changes in the car's design affect its overall performance?

Conclusions:

- Students should understand how the design and functionality of their cars are influenced by the mechanical setup of the fan and motor.
- They should appreciate the practical application of physics in designing vehicles that efficiently convert and use energy.

Assessment:

- **Performance Assessment:** Evaluate students on their ability to effectively integrate the motor-fan system into their car designs and the functionality of their final products.
- **Engineering Journal:** Have students keep a detailed journal documenting their design process, challenges, and reflections on their learning.

Extensions:

- **Advanced Modifications:** Challenge students to incorporate additional electronic components such as LEDs or sensors to add functionality to their cars.
- **Physics in Motion:** Extend the project to include quantitative measurements such as calculating the speed or distance traveled by the cars, linking the activity to math concepts.