Case 3: Weightlifting Robot

Nezha Inventor's Kit V2 — STEAM Lesson Plan

TECHTELLIGENCE

Grade 6–8 | 45–90 Minutes | STEAM + Robotics | MakeCode | Circular & Reciprocating Motion

Lesson Overview

Subject	STEAM, Robotics, Computer Science
Grade Level	6–8
Time Required	1–2 periods (45–90 minutes)
Kit	Elecfreaks Nezha Inventor's Kit V2
Software	MakeCode (visual block programming)
Approach	5E Learning Model

Learning Objectives

01 Define circular motion and reciprocating motion
Students learn foundational physics concepts that explain how the weightlifting robot moves.

02 Explain how a weightlifting robot works
Students articulate the mechanical and electronic principles behind robotic weightlifting.

03 Build a weightlifting robot using the Nezha Inventor's Kit V2
Students apply engineering design principles to construct a functional robot.

04 Program the robot to lift weights
Students use MakeCode to control motor sequences and timing for the lifting motion.

05 Troubleshoot problems with their robot
Students develop iterative problem-solving skills by diagnosing and fixing robot issues.

Materials & Equipment

Required	Optional / Enhancement
• Elecfreaks Nezha Inventor's Kit V2	• Cardboard for custom builds
• Building blocks	• Craft sticks / fasteners
• Motors	• Student worksheet / engineering journal
• Micro:bit	• Observation / assessment checklist
• MakeCode software (web-based, free)	
• Computer with internet access	
• Weights (e.g., coins, washers)	

PHASE 1 — ENGAGE | 10 Minutes

Step	Activity	Key Focus
1	Introduce the concept of weightlifting and its benefits — discuss how athletes train and why strength matters.	Provide context and spark curiosity.
2	Show students a video of a weightlifting competition — highlight the mechanics of the lift and the force involved.	Engage students with a real-world example.
3	Facilitate a brainstorming session: 'How can we design a robot that lifts weights?' — encourage all ideas.	Encourage creative thinking and engineering imagination.

Teacher Tip: Connect to prior knowledge — ask if students have seen weightlifting machines or robotic arms in factories. Highlight that circular motion (from a motor) can be converted into lifting motion.

PHASE 2 — EXPLORE | 20 Minutes

Step	Activity	Key Focus
1	Divide students into small groups (2–3 per group) and provide each group with a Nezha Inventor's Kit V2 and materials.	Encourage teamwork and collaboration.
2	Challenge students to experiment with different ways to build a weightlifting robot — no single right answer.	Foster creativity and hands-on exploration.
3	Encourage students to think about how to convert circular motion into reciprocating (up-and-down) motion in their designs.	Apply engineering and problem-solving skills.
4	Guide students in using the MakeCode software to begin programming their robots to perform a lifting motion.	Integrate coding and robotics concepts.

Key Focus: Hands-on discovery — resist over-guiding. Let students struggle productively with the mechanical challenge of converting circular to reciprocating motion. Observe misconceptions to address in the Explain phase.

The Science: Circular & Reciprocating Motion

Circular Motion	Reciprocating Motion
• Produced by a rotating motor shaft	• Back-and-forth or up-and-down repeated motion
• Constant rotational speed in one direction	• Created by converting the motor's circular rotation
• Forms the power source of the weightlifting robot	• Key mechanism for simulating a lifting action
• Measured in RPM (revolutions per minute)	• Based on crank-slider mechanism principle
• Used in motors, wheels, gears, and crankshafts	• Examples: pistons, pumps, and robotic arms

PHASE 3 — EXPLAIN | 15 Minutes

Step	Activity	Key Focus
1	Have each group briefly present their robot designs and explain how they convert circular motion to lifting motion.	Develop communication and reflection skills.
2	Facilitate class discussion: compare the different mechanical methods used — gear trains, cranks, levers.	Build understanding of mechanical principles.
3	Discuss challenges faced during the design process and how students overcame them — focus on problem-solving strategies.	Encourage problem-solving and knowledge-sharing.

MakeCode Example — Motor Control Loop:

```
on start → Motor A run forward at speed 50 → pause 1000ms
→ Motor A run backward at speed 50 → pause 1000ms → repeat (forever loop)
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PHASE 4 — ELABORATE | 30–40 Minutes

BUILD	Groups design and assemble their weightlifting robots using Nezha Inventor's Kit V2 components — motors, building blocks, and structural pieces. Encourage different linkage configurations.
CODE	Students program robots in MakeCode — controlling motor direction, speed, and timing to achieve a smooth lifting motion. Key blocks: forever loop, motor run, pause, reverse.
REFINE	Groups iterate their designs: What works? What breaks? Why? Introduce sensors to make robots more interactive. Students also create a short video of their robot lifting weights.

MakeCode Step-by-Step Guide

Step 1	Open MakeCode at makecode.microbit.org or the Elecfreaks platform

Step 2	Create an 'on start' block — add motor initialization if needed
Step 3	Add motor run block — set Motor A forward at speed 50
Step 4	Add pause block — 1000ms to hold the lifted position
Step 5	Add motor run block — Motor A backward at speed 50 (lower weight)
Step 6	Add pause block — 1000ms to hold the lowered position
Step 7	Wrap steps 3–6 in a 'forever' block for continuous lifting
Tip	Test at slow speed (30–40) first, then increase for heavier loads

PHASE 5 — EVALUATE | 15 Minutes

Step	Activity	Key Focus
1	Set up a weightlifting challenge — each group demonstrates their robot. Record the maximum weight lifted by each team.	Assess design functionality and performance.
2	Students complete a written reflection on their learning experience — what worked, what they would change, and why.	Develop critical thinking and self-assessment skills.
3	Facilitate class presentations where students showcase their robots and share insights from the design process.	Foster communication and collaboration.

Reflection Questions: What type of motion does your motor produce? How did you convert it to a lifting motion? What mechanical change had the biggest impact on performance? What would you do differently if you rebuilt it?

Assessment

Criteria	Assessment Method
Participation and teamwork	Observe group discussions and collaborative efforts during all activity phases.
Robot design and programming	Evaluate functionality, creativity, and quality of MakeCode programming.
Written reflections	Review students' written reflections for depth of understanding and critical analysis.

Differentiation Strategies

Support for Struggling Students	Challenges for Advanced Students

• Provide additional scaffolding and step-by-step instructions • Allow students to choose simpler tasks focused on basic programming • Pair with a stronger engineering partner • Provide visual instruction card with build steps • Allow extra time on the build phase	• Challenge students to design robots capable of lifting heavier weights • Encourage exploration of advanced MakeCode coding features • Add sensors to make the robot more interactive • Program a weight-lifting counter using variables and display • Explore JavaScript mode in MakeCode for advanced control

Extension Activities

Research	Research the history of weightlifting robots and robotic arms in industry. Compare mechanisms to the class robot. Present findings to the class.
Competition Design	Design a robot specifically capable of competing in a weightlifting competition — optimise for maximum load. Document the engineering decisions made.
Multimedia Presentation	Create a presentation or video about the robot design and the engineering principles behind it. Focus on circular vs. reciprocating motion and the crank mechanism.

Teacher Notes

PREPARATION	Familiarise yourself with the Nezha Inventor's Kit V2 and MakeCode software before the lesson. Build a sample weightlifting robot to demonstrate to students at the start.
DEMONSTRATION	Prepare a sample weightlifting robot to showcase during the lesson. Show how circular motor rotation is converted to the lifting motion through mechanical linkages.
ENCOURAGEMENT	Emphasise the value of teamwork and creative problem-solving. Celebrate all attempts — a robot that fails is a learning opportunity, not a failure.
REAL-WORLD CONNECTION	Highlight the use of robotics in industries such as manufacturing, healthcare, and logistics. Examples: robotic arms in car factories, prosthetic limbs, warehouse automation.
SAFETY	Handle motors and electronic components carefully. Avoid water near electronics. Secure all loose wires. Supervise motor testing at all times.

Standards Alignment

Standard	Codes	Application

NGSS	MS-ETS1-1, MS-ETS1-2, MS-ETS1-3, MS-ETS1-4	Engineering Design — define problems, develop solutions, analyse and test
CSTA	1B-AP-10, 2-AP-11, 2-AP-12	Algorithms & Programming — loops, events, sequences, debugging
CCSS Math	7.G.A.1, 8.G.B	Geometry & Spatial Reasoning — circular motion, angles, rotation
Physical Science	MS-PS2-1, MS-PS2-2	Forces & Motion — applying force, mechanical advantage, Newton's Laws

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Empowering Students Through STEAM + Robotics

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