

Visible Elements in Photo



- A backhoe loader (construction vehicle with articulated arm and bucket) demonstrating extended and retracted positions
- Two people operating/standing near the equipment in an outdoor work setting
- A grapple/claw attachment on the extended arm holding materials
- A construction overhead gantry crane ("Construction King" sign visible) in the background
- Gravel driveway and grass yard with trees; metal shed structure in background

Reasonable Inferences

1. From the backhoe's extended/retracted arm positions: The machine must move its weight distribution and balance point as the arm extends outward, creating unbalanced forces that require counterweight or design strategy to prevent tipping.
2. From the grapple holding heavy materials: The load held at the end of a long arm creates leverage and moment forces—the farther the load extends, the greater the turning force on the machine's pivot point.
3. From two operators present: Real equipment operation requires understanding how to manage forces safely; this is a human-centered design problem about preventing failure.

Engineering Task

K-2 Challenge:

Design a "grabber arm" using a ruler, string, and tape that can pick up small objects (blocks, balls) from far away without your arm getting tired or the grabber falling over. Test which angle works best!

3-5 Challenge:

Design and build a stable lifting arm using craft sticks, straws, string, and a small bucket that can lift a 500g load horizontally 30 cm away from its base without tipping over. Your arm must remain stable when fully extended. Test two different counterweight positions and measure how heavy a load each design can hold before tipping.

EDP Phase Targeted

Ask / Define Problem

This phase fits best because the photo shows real equipment doing real work, but students must first identify what problem the backhoe solves (moving heavy things at a distance while staying stable). The visible forces and balance challenge are implicit—students need to ask "Why doesn't this tip over?" before they can imagine and test solutions.

Suggested Materials

- Craft sticks or wooden rulers (for arm structure)
- String or fishing line (for pivot joints and lifting mechanisms)
- Masking tape and duct tape (for assembly)
- Small bucket or cup (for load carrier)

- Weights: washers, rocks, or modeling clay (for testing load capacity and counterbalance)
- Blocks or small objects to "grab" (for function testing)

Estimated Time

K-2: 45-60 minutes (one session: 10 min intro, 20 min build, 15 min test and adjust)

3-5: Two 40-minute sessions (Session 1: 10 min challenge intro + 30 min design/build; Session 2: 40 min testing, measurement, and redesign with counterweight variations)

Why This Works for Teachers

This task directly addresses NGSS 3-5-ETS1-1 (define simple design problems reflecting a need or want) and K-2-ETS1-1 (ask questions, make observations about the world) by having students reverse-engineer the balance and leverage principles visible in working construction equipment, translating abstract forces into testable, hands-on prototypes.