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Accessible Playground Design: A Community-Connected Elementary Engineering Unit Focused on Designing Accessible Playground Equipment

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Kristen Wendell is Associate Professor of Mechanical Engineering and Adjunct Associate Professor of Education at Tufts University. Her research efforts at at the Center for Engineering Education and Outreach focus on supporting discourse and design practices during K-12, teacher education, and college-level engineering learning experiences, and increasing access to engineering in the elementary school experience, especially in under-resourced schools. In 2016 she was a recipient of the U.S. Presidential Early Career Award for Scientists and Engineers (PECASE). https://engineering.tufts.edu/me/people/faculty/kristen-bethke-wendell

Dr. Chelsea Andrews, Tufts University

Chelsea Andrews is a post-doctoral researcher at Tufts University and University of Massachusetts-Boston in STEM education. She received a B.S. from Texas A&M University in ocean engineering, an S.M. from MIT in civil and environmental engineering, and a PhD from Tufts University in Engineering Education. Her current research includes investigating children's engagement in engineering design through in-depth case study analysis.

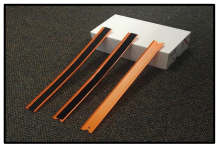
Nicole Alexandra Batrouny, Tufts University

Nicole Batrouny is a PhD candidate in Mechanical Engineering at Tufts University. Her engineering education research interests include upper elementary engineering education, integrated science and engineering, collaboration in engineering, and decision making in engineering. For her Master's thesis, she uncovered talk moves used by 4th grade students that fostered collaborative, disciplinary decision-making during an engineering design outreach program. For her dissertation, she intends to explore the ways in which team mental models function in teams of novice engineers and how novice engineers can be trained to collaborate more effectively on diverse teams.

Accessible Playground Design: A Community-Connected Elementary Engineering and Physical Science Unit

Grade band: 3-5. Specific focus: grade 3. Time: 10, one-hour lessons. Standards: NGSS 3-5 ETS and grade three physical sciences standards. The engineering design challenge could also be done as a standalone activity. See full documentation for standards.

In the ConnecTions in the Making project, researchers and school district partners work to develop and study community-connected, integrated science and engineering curriculum units that support diverse elementary students' science and engineering ideas, practices, and attitudes. Students investigate, prototype, share, and revise functional solutions to an engineering design challenge rooted in the students' local community while scientifically exploring the phenomena and mechanisms related to the challenge. This paper shares the "Accessible Playground Design" 3rd-grade unit in which students explore the scientific concepts of force, motion and magnetism based on the need to design a piece of accessible playground equipment. In this unit, the engineering task of designing a safe and wheelchair accessible playground equipment creates a need for students to study the underlying science concepts of force, motion and magnetism to inform their designs. The unit's focus question is: How can we design accessible playground equipment to ensure that ALL kids can play together?

Day 1. Unit Launch: Identify community connected engineering design challenge. *What is engineering? What does it mean to be "accessible" and "inclusive"?* Students view a video showing the difficulties that playground equipment and surfaces present to a child using a wheelchair. Following discussions, guide students to identify the need for inclusive playgrounds for ALL kids.	
Days 2 and 3. Inquiry: Forces and Motion *How can we get objects with wheels to move and to slow down?* Small groups of students rotate through multiple activity stations to investigate relationships between forces and motion, which are important to kids' experiences with playground equipment. Students work with ramps, rubber bands, toy cars and weights to study how and when forces cause changes in motion of objects. It takes two days for groups of 3-4 (~class of 25) to rotate through all stations.	 
Days 4 and 5. Inquiry: Magnetism *How do magnets influence the motion of other magnets and objects?* Small groups of students rotate through two stations to explore behavior and properties of magnets and how magnets affect motion. Stations include ring magnets on a pencil and gliding magnets in a bowl of water.	

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Project Link to full curriculum: https://bit.ly/connectionsengineering
The ConnecTions in the Making project is supported by the NSF, ITEST-1657218

Day 6: Design Challenge - Plan
What are important things to consider when solving a design challenge?
The class revisits the design task, constraints, and criteria. Students in small groups sketch and discuss initial ideas for a functional scale model of accessible playground equipment.

Day 7: Design Challenge - Build, Test, & Iterate
How do we know if our design works? How can we use failures to improve?
Student groups build their playground equipment models and test their designs with miniature wheelchairs. All initial designs have room for improvement; groups iterate and continue testing, trying to improve their designs.

Day 8: Design Challenge - Peer Feedback
How can we improve our designs by giving and receiving peer feedback?
Student groups self-evaluate their own design and design process, then pair up with other groups to offer feedback, help troubleshoot, and brainstorm solutions to common issues.

Day 9: Design Challenge - Final Test & Review
What can we learn by looking across all our design attempts?
Groups reflect on their design attempts, and the teacher facilitates a whole class discussion comparing across designs. Student groups complete their final tests and revisions.

Day 10: Design Challenge - Conference
How do engineers share their ideas through speaking and writing?
Groups prepare for and engage in a conference-style share-out, where they present their designs and design process with peers from other classes, school administration, and parents.

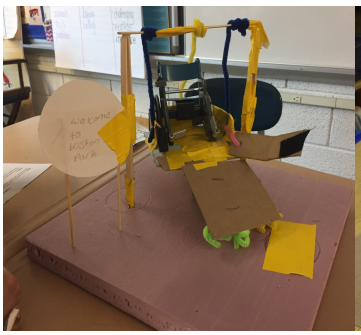
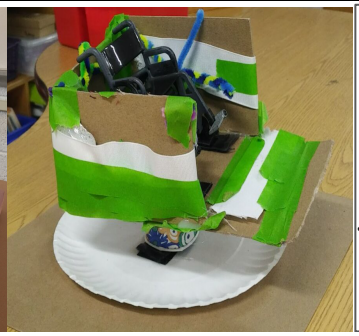
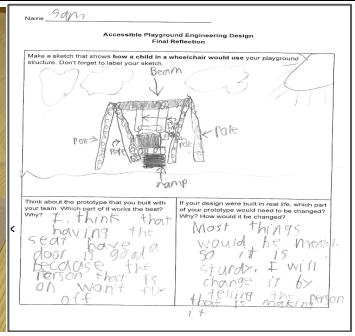
Design Brief

Design Task: You are working as engineers to design a playground structure that would be fun and safe for all children, including children who use wheelchairs.

Criteria: Playground equipment MUST be:
- Sized for wheelchair
- Stable
- Functional
- Fun
- Accessible

Constraints: The playground equipment,
- Must fit on the cardboard square given.
- Use only given materials.
- Should be built in limited time.

Materials: Skewers, Popsicle sticks, Play dough, Brads, Chipboard, Pipe Cleaners, Zip ties, Foil, String, Toothpicks, Straws, Small cups, Paper plates & clips, Rubber bands, Construction paper.

Example student solutions and student final design reflection

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