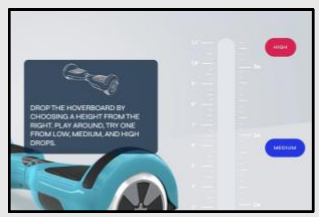
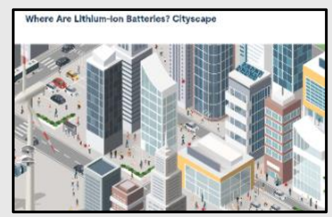
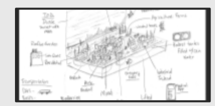
Xplorlabs Learning Experience: Sustainable Future City Design, Lithium-Ion Batteries, and the Science of Thermal Runaway

This learning experience provides opportunities for students to make sense of the science related to lithium-ion battery-powered devices and then consider real battery failure testing data to engineer solutions associated with the phenomenon of thermal runaway. Students analyze real-world data, participate in hands-on labs, and use engineering principles to design sustainable, resilient cities in response to climate change and public safety challenges.

Instructional phases	**Engage**	**Engage**	**Explore/Explain**	**Explore/Explain**	**Evaluate**
Pedagogies or Instructional Practices	Group Collaboration and Discussion: Students make connections to the youth-designed Turn It Around climate flashcards and explore initial ideas for the Future City challenge of adaptation to rising sea levels.	Student-Centered Inquiry: Use the QFocus and Question Formulation Technique (QFT) to activate prior knowledge and generate inquiry about thermal runaway.	Scientific Exploration: Conduct four digital battery safety labs: Overcharge, Drop Zone, Crush Test, Nail Test. Group Collaboration: Encourage discussion, design collaboration, and peer feedback. Community Connections: Engage with CommunityShare partners to deepen relevant knowledge.	Scientific Exploration: Explore where lithium-ion batteries are in a city, both independently and collaboratively. Group Collaboration: Encourage discussion, design collaboration, and peer feedback.	Engineering Design: Iterative prototype development using the Engineering Design Process (EDP). Apply knowledge to the Future City design challenge. Use peer feedback, gallery walks, and reflection. Group Collaboration: Encourage discussion, design collaboration, and peer feedback.
Visual storyline	 "I am an Agent for Change" (artwork by Quang, 15, Vietnam)	 	 	 	 
Standards	MS-ETS1 Engineering Design MS-PS3 Energy MS-PS1: Matter and Its Interactions				
Timing	1 class period	2 class periods	2-3 class periods	1-2 class periods	2-3 weeks

Overview	These flashcards, created by young artists and writers from around the world, are beautiful and thought-provoking. Their purpose is inspiring: According to Turn It Around, *"This deck of flashcards is designed by youth for education policymakers, politicians, and teachers to challenge them to think, see, and act in new ways"*. My middle schoolers used the digital version of these cards to launch discussions about climate change and sustainable city design. They were inspired that the flashcards were created by youth, just like them, to lead change. This is easily accessible for students who have digital devices.	Use a QFocus and the QFT process to activate prior knowledge. Investigate thermal runaway through collaborative video analysis and digital labs. The goal is to allow students to engage in scientific observation and questioning as they explore thermal runaway and the unintended consequences of lithium-ion batteries in self-driving vehicles. Play the video once with the sound off as students record their questions about the topic of thermal runaway. Then play the video with the sound on as students record additional questions. Post the video to Google Classroom so students can view it independently. As a group, students share observations and wonderings from the scooter video.	Work with a lab partner or partners to explore 4-labs (digital options) - Overcharge - The Drop Zone - Crush Test - Nail Test Students work with CommunityShare partners to deepen their knowledge and research on thermal runaway and urban transportation infrastructure design. Investigate battery applications in cities and explore the process of Extraction to E-waste. Begin ideations for city design.	Where are lithium-ion batteries in a city? Students explore the application and challenges of lithium-ion batteries in a modern city. How can cities mitigate thermal runaway and other challenges associated with lithium-ion batteries, like Extraction to E-waste. How will students apply their learning to a future city design?	Students apply their knowledge of climate science, battery safety, and engineering design to create future cities that adapt to climate change and sea level rise, mitigate risks like thermal runaway, and prioritize public health and safety. Engineering Design Challenge and Prototype Design.
Supporting Documents	• Turn it Around Cards and climate facts • Examples of student connections and selections	1. What is the QFT? 2. Scooter Video 3. Student Guide; adapt the guide to fit this lesson.	• Student Guide • Teacher Guide • Examples of student reflections on the Drop Zone • Communityshare.org	• Where are lithium-ion batteries • Examples of student reflections, noticing, wonderings, and application to future city designs • Extraction to E-waste	• Future City • Extraction to E-waste • Student Guide • Teacher Guide
Possible Extensions	1. Share student-designed cities with local policymakers. 2. Connect with elementary classrooms to teach about battery safety. 3. Partner with local STEM professionals for mentorship. 4. Share student-designed cities at school and local STEM nights.				

Advancing ULRI's three grand challenges	1. Building resilience for a sustainable future. Students will develop knowledge and insights about safety science as it relates to lithium-ion batteries, climate adaptation, and thermal runaway. They will apply this understanding in sustainability design projects, such as Kidstruction, Future City, SARSEF, Kidsbuild, and ArcGIS StoryMap, during the school year. These projects empower students to imagine and prototype more resilient, climate-ready cities. 2. Advancing individual and societal health in the 21st century. Students will explore how science and engineering principles contribute to public health and safety. They share their learning during regional engineering competitions, as well as with families, peers, and community members. By identifying real-world applications, students become active and stronger problem solvers in their communities. 3. Promoting safety at the human-digital interface. Through their 3d models and digital media, students communicate the importance of battery safety, sustainable design, and climate readiness. Students share their learning and promote safety through presentation of their projects on campus, with nearby elementary schools, at the regional science fair (SARSEF), and STEM nights.