UTICA CITY SCHOOL DISTRICT

Obstacle Course Challenge
Trade and Technology Module Project 3
8th Grade

Essential Question: How can we develop our mechanical intelligence with Lego? Or How do smaller parts work together to create movement?

Project Background

Mechanical skills are crucial in various trades and technical career fields, including engineering, automotive industries, manufacturing, robotics, and technology development. How do parts and pieces fit together to accomplish a task? How do you troubleshoot a complex machine? How can you iterate a design to optimize for a specific outcome? This project seeks to engage students to develop their mechanical intelligence.

As industries increasingly focus on automation and advanced technologies, the need for individuals who can design, analyze, and optimize mechanical systems is growing. Learning mechanical skills at a young age opens doors to high-demand careers in aerospace, automotive design, industrial mechanics, and even emerging fields like robotics and artificial intelligence.

Project Scenario

To be successful in a trade and technical career, you need to understand how smaller systems work together in a mechanical system to accomplish a task and troubleshoot when things go wrong. Legos provide a unique opportunity to practice these skills in a fun way.

You are challenged to develop your mechanical knowledge and skills through a series of Lego challenges your teacher will provide. After building these, your teacher will challenge each group to design a Lego car to navigate through a series of challenges. Your goal will be to design your vehicle to overcome each challenge in the least amount of time. Good luck!

As part of your design, you will need to keep good records of your design process. This includes research notes, brainstormed ideas, a plan of action, and creation and improvement notes from the building and testing process.

Deliverables include:

- Reflections from each Lego challenge
- Design process portfolio
- Final Lego vehicle
- Final Lego vehicle code

Preparation Notes

This project will use activities and problems from Lego Education and the Lego Spike Kits. Students will need to access the Lego Spike Education App at various times. You will need to work with your IT department to ensure it is downloaded on devices students can access.

This project is the last in the Technology and Trades module and maybe the last of all the career modules. It is an opportunity to assess students' use of the design process in a fun way. Students will be asked to work through and document their use of the design process. As students design and build their final Lego car, you may want them to take pictures of the process and use these as part of their design portfolio for this lesson.

Finally, you will need to design an obstacle course to challenge the students' final Lego Car design. This can be based on the challenges you chose for the students and customized depending on the student's comfort with the Legos. The course may include the following features:

- Navigating around blocks
- Going up and down a ramp
- Navigating a curvy black line (see options in Training Camp 3: Reacting to Sensors)
- Picking up blocks and putting them in a designated space

Content Standards

The 8th-grade Trade and Technical Module teaches students more about possible construction, electrical, and automotive engineering career pathways. As such, this module supports the NYSED CTE Theme Modules of Career and Community Opportunities in trade and technical careers. As students use the design process to solve problems, collaborate, and use various verbal and written communication forms throughout the project, we address standards in the NYSCE Middle-Level CTE Theme Modules of Communication and Interpersonal Relationships and Problem-Solving and Innovation.

This project will support addressing standards from the NYSED CTE Trade and Technology Education modules. Below is a list of the standards this project addresses.

- Exploring Trade and Technical Careers – using a mechanical and automotive lens
  - Trade and Technical Careers (b, d, g)
  - Essential Workplace Competencies (a, b, c)
  - Technical Skills (b, c, d, e)
  - Problem-solving (a, b, c, d, e)
- Measurement in Trade and Technical Fields

- Measuring Time (a, b, c, d)
- Measurement in Trade and Technical Career Pathways (a, b, c)

The unit overview below connects Utica's CTE Career Ready Practices and NYSE Computer Science and Digital Fluency Standards (CSDF). Throughout the unit of study, students will need their Power Skills to fully engage in the project; these have been indicated on the Map of Student Learning.

Unit Overview

Unit Phase	Career Ready Practices and Digital Fluency Standards (CSDF)	Skills/Topics	Assessments	Resources and Texts
Project Launch **2 Days**	**Career Ready Practices:** 1. Act as a responsible and contributing citizen and employee. 12. Work productively in teams while using cultural global competence.	Project Launch Good Morning Machine Lesson	Know/NTK chart Team Contract Obstacle Challenge Project Rubric	Obstacle Challenge Project Scenario
Skill Development **4 Days**	**Career Ready Practices:** 1. Act as a responsible and contributing citizen and employee. 2. Apply appropriate academic and technical skills. 12. Work productively in teams while using cultural global competence.	Optional Reading – Automotive Skills ● List skills that are needed to be successful in an automotive career. ● Reflect on what skills you already have and which you need to develop	Trades Skills reflection sheet	Articles ● Mechanic Sills: Top 7 Skills for Aspiring Auto Technicians ● 5 Qualities of a Successful Automotive Technician
	Career Ready Practices: 1. Act as a responsible and contributing citizen and employee.	Lego Challenges ● Develop your mechanical or	Skills Reflection Sheet Alternative Reflection Sheet	Lego Challenges: ● What is This? ● Going the Distance

Unit Phase	Career Ready Practices and Digital Fluency Standards (CSDF)	Skills/Topics	Assessments	Resources and Texts
	2. Apply appropriate academic and technical skills. 4. Communicate clearly and effectively and with reason. 6. Demonstrate creativity and innovation. 8. Utilize critical thinking to make sense of problems and persevere in solving them. 12. Work productively in teams while using cultural global competence. **NYCSDF** 7-8.CT.4 Write a program using functions or procedures whose names or other documentation convey their purpose within the larger task. 7-8.CT.6 Design, compare and refine algorithms for a specific task or within a program. 7-8.CT.8 Develop or remix a program that effectively combines one or more control structures for creative expression or to solve a problem 7-8.CT.9 Read and interpret code to predict the outcome of various programs that involve conditionals	professional skills through a series of Lego Challenges. • Write a reflective paragraph describing how you grew in your identified skills		• Broken • Super Cleanup • Training Camp 1: Moving around Obstacles • Training Camp 2: Moving around Obstacles • Training Camp 3: Reacting to Sensors

Unit Phase	Career Ready Practices and Digital Fluency Standards (CSDF)	Skills/Topics	Assessments	Resources and Texts
	and repetition for the purposes of debugging. 7-8.NSD.3 Identify and fix problems with computing devices and their components using a systematic troubleshooting method or guide 7-8.DL.5 Transfer knowledge of technology in order to explore new technologies.			
Lego Car Design **6 Days**	**Career Ready Practices:** 1. Act as a responsible and contributing citizen and employee. 2. Apply appropriate academic and technical skills. 6. Demonstrate creativity and innovation. 7. Employ valid and reliable research strategies 8. Utilize critical thinking to make sense of problems and persevere in solving them. 9. Model integrity, ethical leadership, and effective management. 12. Work productively in teams while using cultural global competence. **NYCSDF**	Brainstorming & Planning Vehicle ● Design a Lego vehicle to navigate an obstacle course. ● Document the use of the design process in the brainstorming (imagining) and planning stages.	Design Process Portfolio – (project rubric)	Project Management Task List

Unit Phase	Career Ready Practices and Digital Fluency Standards (CSDF)	Skills/Topics	Assessments	Resources and Texts
	7-8.NSD.2 Design a project that combines hardware and software components 7-8.CT.10 Document the iterative design process of developing a computational artifact that incorporates user feedback and preferences.			
	Career Ready Practices: 1. Act as a responsible and contributing citizen and employee. 2. Apply appropriate academic and technical skills. 6. Demonstrate creativity and innovation. 7. Employ valid and reliable research strategies 8. Utilize critical thinking to make sense of problems and persevere in solving them. 9. Model integrity, ethical leadership, and effective management. 12. Work productively in teams while using cultural global competence. **NYCSDF** 7-8.NSD.2 Design a project that combines hardware and software components	Car Creations & Initial Testing ● Build and test a Lego vehicle for an obstacle course. ● Document the use of the design process in the creation, testing, and improvement phases.	Car Testing Tracker Design Process Portfolio – (project rubric)	Project Management Task List

Unit Phase	Career Ready Practices and Digital Fluency Standards (CSDF)	Skills/Topics	Assessments	Resources and Texts
	7-8.NSD.3 Identify and fix problems with computing devices and their components using a systematic troubleshooting method or guide 7-8.CT.10 Document the iterative design process of developing a computational artifact that incorporates user feedback and preferences.			
	Career Ready Practices: 1. Act as a responsible and contributing citizen and employee. 4. Communicate clearly and effectively and with reason. 6. Demonstrate creativity and innovation. 11. Use technology to enhance productivity. 12. Work productively in teams while using cultural global competence. **NYCSDF** 7-8.CT.10 Document the iterative design process of developing a computational artifact that incorporates user feedback and preferences.	Competition Day & Final Documentation ● Compete in the obstacle course challenge. ● Document our use of the design process.	Obstacle Course Completion Obstacle Challenge Project Rubric	

Unit Phase	Career Ready Practices and Digital Fluency Standards (CSDF)	Skills/Topics	Assessments	Resources and Texts
	7-8.DL.4 Select and use digital tools to create, revise, and publish digital artifacts.			

Obstacle Course Challenge: Project Launch

Goal of Phase
Students will be introduced to the project by completing their first Lego Challenge, the Good Morning Machine. This will allow you to see how well they work together and assess their basic mechanical and coding skills with Legos. Students will start their Know/NTK document, choose roles, and develop a team contract.

Teacher Notes & Preparation
Key Concepts and Big Ideas ● N/A **Preparation Notes** ● Students will need to access the Lego Spike Education App and have a Lego Spike Education Kit for parts. This is a straightforward challenge to get students who may not be as familiar with the Lego Spike kits and the programming app for Lego to start building their familiarity with it.

Key Questions	Key Vocabulary
What skills will I need to develop to be better at building, coding, and troubleshooting mechanical systems?	N/A

Map of Student Learning

Day	Learning Goals	Student Learning Tasks	Teacher Supports
1 – 2	Learning Targets: ● Launching the Project Career Ready Practices: 1, 12 Power Skills Needed: ● Collaboration ● Initiative ● Self-Management	**Project Launch** ● Lead students through the Good Morning Machine Lesson. This guides students to create and test a program for a waving machine. The goal is to give students some experience with the Lego kit and app. ● Use the following discussion questions to help students make connections: o How did you work together to accomplish this task? o What did you notice about how the Legos fit together or how to use the app? ● Have students think, pair, and share the question, "What skills do you need to develop to be better at building programable Lego creations?" ● Introduce the project and explain that students will develop their mechanical intelligence, an essential part of many trades and technical career pathways. **Task Analysis & Team Contract** ● Divide students into their design teams of 2 – 4 students. Once in teams, have students complete the team contract. The following authentic career roles have been added to the team contract: o Automotive Engineer – responsible for ensuring the team uses and documents their design process. o Parts Technician – responsible for ensuring the team has what they need for each design and that no parts go missing. o Service Technician – responsible for helping the	This initial Lego activity is longer than a typical project launch but can serve as a review of the design process. Help students connect what they have done in previous projects to what they will do for this project. As students read through the project scenario, rotate and help students pull out the most important information. As students work through the K/NTK chart, help them pull out information from the project scenario they need to solve the problem and put this in their Know column. Help students bring in prior knowledge they may have about playhouses, construction, or measurement. Encourage students to be curious and ask questions as they fill out the NTK column. Students will revisit this chart several times throughout the project to track their learning and progress. It also helps to have a class Know/NTK chart on a wall or on a class Learning Management System (such as Google

Day	Learning Goals	Student Learning Tasks	Teacher Supports
		team troubleshoot when problems arise, maintaining the team's task list, and ensuring that each person has tasks to accomplish the project's overall goals. o All teammates are responsible for supporting each other during each project phase. ● Introduce the guiding question, "How can we develop our mechanical intelligence with Lego?" for this project and hand out the project scenario. ● Have them individually read the scenario and highlight key facts they will need for this project. ● Either give each student a copy of the Know/NTK chart or have them copy the chart into their design journals. Teams will complete the K-NTK charts as a team, but everyone should write their information individually on their chart. ● Student teams first complete the Know column, "What do you know that will help you solve this problem?" First start by sharing important facts from the project scenario, then add in their own personal background knowledge about the topic. ● You may want to pause and have each student group share one thing on their KNOW column that gets collected on a class K-NTK Chart ● Student teams then develop questions for their project, "What will you need to know to solve this problem?" ● Ask students to review their questions and select the top three that need to be answered immediately. ● Have each group share one question. If their top question is answered, they share their second most important question, and so on.	Classroom) that can be a class visual for their progress through the project. Use the NTK to see what questions students are asking and how future activities will help them to answer those questions.

Day	Learning Goals	Student Learning Tasks	Teacher Supports
		• After each group has shared one question, open the meeting to anyone with questions about the project. • Ask students to write any questions they didn't consider on their NTK chart. **Note on Rubrics:** A single-point rubric has been provided for this project. Some students like to see a rubric upfront; for others, providing it just as they need it for revising work may be more helpful. The rubric is designed so you can isolate sections at a time as needed. Use your best judgment of your students on how you wish to use the project rubric.	

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Obstacle Course Challenge: Skill Development Phase

Goal of Phase
Students will complete a series of Lego challenges from the Lego Spike Educational Resources. These are meant as skill-building exercises and offer students a way to reflect on how they are developing skills that can be helpful in the trades profession.
Teacher Notes & Preparation

Key Concepts and Big Ideas

- The Automotive and other Tech fields need professionals who embody skills and mindsets such as adaptability, troubleshooting, communication, problem-solving, and the ability to learn and use new forms of technology.
- It is also important for mechanics to understand how mechanical systems work together and how smaller systems interact to accomplish a task.
- Legos provide an opportunity to build our mechanical and coding systems skills while developing skills such as troubleshooting, adaptability and problem-solving.

Preparation Notes

- Students will need to access the Lego Spike Education App and have a Lego Spike Education Kit for parts. This is a straightforward challenge to get students who may not be as familiar with the Lego Spike kits and the programming app for Lego to start building their familiarity with it.
- Preview the challenges offered through the Lego Spike App and choose the ones you think your students will benefit the most, or you may have students choose their own based on the skills they want to develop. The ones recommended in the Map of Student Learning below are:
    - What is This? – Students create a predetermined Lego build and code. Students then need to brainstorm and determine a possible use for this thing. (Skills: Communication, detail-oriented, systems thinking) (45 minutes)
    - Going the Distance – Students build and code a “Rhino” to go 1 meter and stop as close to a brick without knocking it over (Skills: Detail-oriented, Troubleshooting, Integration with Technology) (45 minutes)
    - Broken – Students build a broken device that models a CNC machine and work to troubleshoot and fix it. (45 – 90 min)
    - Super Cleanup – Students test the efficiency of two different cleanup devices. (45 minutes)
    - Training Camp 1: Moving around Obstacles – (part of the Lego Competition Training Module) Students build a simple device to navigate around obstacles

- Training Camp 2: Moving around Obstacles – (part of the Lego Competition Training Modules) Students use sensors to control motors and interact with objects on the competition field. (45 minutes)
- Training Camp 3: Reacting to Sensors – (part of the Lego Competition Training Modules) Students write programs using the Color Sensor to make the Driving Base autonomous (45 minutes)

Key Questions	Key Vocabulary
What skills and aptitudes are essential in the fields of automotive and other technical trades? What skills do I already have? What skills do I need to develop?	**Adaptability** – the quality of being able to adjust to new conditions. **Mechanical Skills** – the ability to understand and work with machines and tools, including the principles that govern their construction and function. **Mechanical Reasoning** – The ability to apply mechanical concepts and principles to solve problems, such as analyzing mechanical systems, interpreting diagrams, and working with tools. **Troubleshooting** – trace and correct faults in a mechanical or electronic system **Problem-Solving** – the process of finding solutions to difficult or complex issues

Map of Student Learning

Day	Learning Goals	Student Learning Tasks	Teacher Supports
3 – 6	Learning Targets: ● List skills that are needed to be successful in an automotive career. ● Reflect on what skills you already have and	Lego Challenges ● Optional: Have students read one or both of the articles below. They detail essential skills for students wishing to pursue a career in automotive tech or other trades professionals. o Mechanic Sills: Top 7 Skills for Aspiring Auto Technicians	The skills in the skills reflection sheet are: ● Communication ● Troubleshooting ● Systems Thinking ● Integration with Technology

	which you need to develop. ● Develop your mechanical or professional skills through a series of Lego Challenges. ● Write a reflective paragraph describing how you grew in your identified skills. Career Ready Practices: 1, 2, 4, 6, 8, 12 Power Skills Needed: ● Perseverance ● Collaboration ● Professionalism ● Problem-Solving ● Initiative ● Communication ● Adaptability ● Self-awareness	o 5 Qualities of a Successful Automotive Technician o Give students a copy of the Automotive Trades Skills reflection sheet. o Have students complete the Venn Diagram comparing what each article says are the most essential skills. o Have students identify three skills they already do well and three they need to work on. Using the handout provided, they will reflect on the question, "Based on what you know about Legos, how might these help you develop these skills?" ● Introduce that the goal of these challenges is for participants to become familiar with Legos and Coding software and develop skills that may be helpful should they want to enter the automotive or other mechanical trades professions. ● Give students a copy of the Skills Reflection Sheet. After they complete a challenge, ask them to choose 2 – 3 skills to reflect on. ● Below are a series of challenges from the Lego Education Resources for the Spike App. Pick 3 – 4 for students to complete or have students pick the 3 – 4 they want to accomplish to deepen their skills. After completing each challenge, have students reflect on what skills they used and learned using the Skills Reflection Sheet. o What is This? – Students create a predetermined Lego build and code. Students then need to brainstorm and determine a possible use for this thing. (Skills: Communication, detail-oriented, systems thinking) (45 minutes)	● Detail-Oriented These were adapted from the following resources: ● Mechanic Sills: Top 7 Skills for Aspiring Auto Technicians ● 5 Qualities of a Successful Automotive Technician This is not an exhaustive list, so feel free to add or change skills you think your students need to focus on. Alternatively, you can give them this alternative reflection sheet. On it, they choose the top 3 – 4 skills from the articles they read and reflect on how they developed them through each challenge. The Lego challenges were chosen because they will use the Lego Prime Spike Kit and help students develop an awareness of how moving parts work and fit together. Feel free to add or change the challenges students complete.

		o Going the Distance – Students build and code a "Rhino" to go 1 meter and stop as close to a brick without knocking it over (Skills: Detail-oriented, Troubleshooting, Integration with Technology) (45 minutes) o Broken – Students build a broken device that models a CNC machine and work to troubleshoot and fix it. (45 – 90 min) o Super Cleanup – Students test the efficiency of two different cleanup devices. (45 minutes) o Training Camp 1: Moving around Obstacles – (part of the Lego Competition Training Module) Students build a simple device to navigate around obstacles o Training Camp 2: Moving around Obstacles – (part of the Lego Competition Training Modules) Students use sensors to control motors and interact with objects on the competition field. (45 minutes) o Training Camp 3: Reacting to Sensors – (part of the Lego Competition Training Modules) Students write programs using the Color Sensor to make the Driving Base autonomous (45 minutes) Skill Reflection ● Lead students in a whole-class discussion on what skills they developed more confidence with each challenge. ● Ask students to write a reflective paragraph on one or two skills they developed the most and how they might relate to a future career interest.	

Obstacle Course Race: Lego Car Design & Obstacle Course Challenge Phase

Students will design a vehicle to race in the obstacle challenge and compete in a teacher-created obstacle course. This can serve as an assessment of their independent use of the design process.

Teacher Notes & Preparation

Key Concepts and Big Ideas

- We can combine our knowledge from the prior tutorials to design a more complex mechanical system.
- Complex systems are made up of smaller interactive systems.

Preparation Notes

Design an obstacle course for your students to test their mechanical design skills and what they learned in the previous phase. You can design this for the students or have student teams develop an obstacle to be part of the course. Example obstacles include:

- Navigating around blocks
- Going up and down a ramp
- Navigating a curvy black line (see options in Training Camp 3: Reacting to Sensors)
- Picking up blocks and putting them in a designated space

This course can be a stepping stone for the national Lego League competition.

Key Questions	Key Vocabulary
How can we design a car to navigate an obstacle course?	N/A

Map of Student Learning

Day	Learning Goals	Student Learning Tasks	Teacher Supports
7	Learning Targets: ● Design a Lego vehicle to navigate an obstacle course.	Obstacle Course Introduction	It is assumed that students have had multiple experiences with the engineering design process and brainstorming prior to this

	• Document the use of the design process in the brainstorming (imagining) and planning stages. Career Ready Practices: 1, 2, 6, 8, 9, 12 Power Skills Needed: • Perseverance • Collaboration • Professionalism • Problem-solving • Self-management • Integrity • Initiative • Communication • Adaptability	• Show students the obstacle course they will need to complete. The goal is to build a device that overcomes each obstacle the fastest. • You can decide to set up and build your own obstacles or have student teams build and propose one of their own. Example obstacles include: o Navigating around blocks o Going up and down a ramp o Navigating a curvy black line (see options in Training Camp 3: Reacting to Sensors) o Picking up blocks and putting them in a designated space Team Brainstorming & Planning • Have students gather in their design teams and brainstorm ideas for their Lego creation that will navigate the obstacle course the fastest. Set a time limit of 10 minutes for students to brainstorm and get as many ideas on paper as possible. • Have teams narrow down their ideas to a workable solution. Have students start their project management task list and assign tasks to each team member. Remind them that this is a working document, and they will need to return to it daily to track their progress.	project. Scaffold as needed, but this can be a great culminating project to assess students' design process skills.
8 – 10	Learning Targets: • Build and test a Lego vehicle for an obstacle course. • Document the use of the design process in the creation, testing,	Car Creations & Initial Testing • Students work in teams to build and code their cars for the obstacle course. • Have the obstacle course set up in an area of the classrooms so they can test as needed. • The goal is to have the fastest time to complete the course. For each run-through, students need to track their run time through the track and take improvement notes. This can be done in their	You may want a sheet where students can sign up to test their vehicles on the obstacle course.

	and improvement phases. Career Ready Practices: 1, 2, 6, 8, 9, 12 Power Skills Needed: ● Perseverance ● Collaboration ● Professionalism ● Problem-solving ● Self-management ● Integrity ● Initiative ● Communication ● Adaptability	professional notebooks or using this Car Testing Tracker. ● Remind students to use their project management task list to set daily goals and ensure that each team member has a task to do.	
11 – 12	Learning Targets: ● Compete in the obstacle course challenge. ● Document our use of the design process. Career Ready Practices: 1, 4, 6, 11, 12 Power Skills Needed: ● Perseverance ● Collaboration	Competition Day ● Student teams take turns navigating their vehicles through the obstacle course. ● Keep track of the time it takes for students to navigate the obstacle course along with other observations on what the students do well. ● Celebrate each team's success and hard work. Final Discussion and Documentation ● Students gather evidence of their use of the design process and produce a portfolio detailing their design journey. Ideas for documenting include Google Docs, Canva, Google Slides, etc.	You may want to have a prize for the fastest time through the course along with other prizes that recognize other aspects of the design process: ● Best design documentation ● Best professional notebooks ● Best use of the obstacles ● Most innovative vehicle design ● Most efficient code

	• Professionalism • Self-management • Integrity • Communication	• Students turn this in for final grading. Use the Obstacle Course Challenge Rubric to provide students feedback on this project.	