



Our Future:
Built Better Together

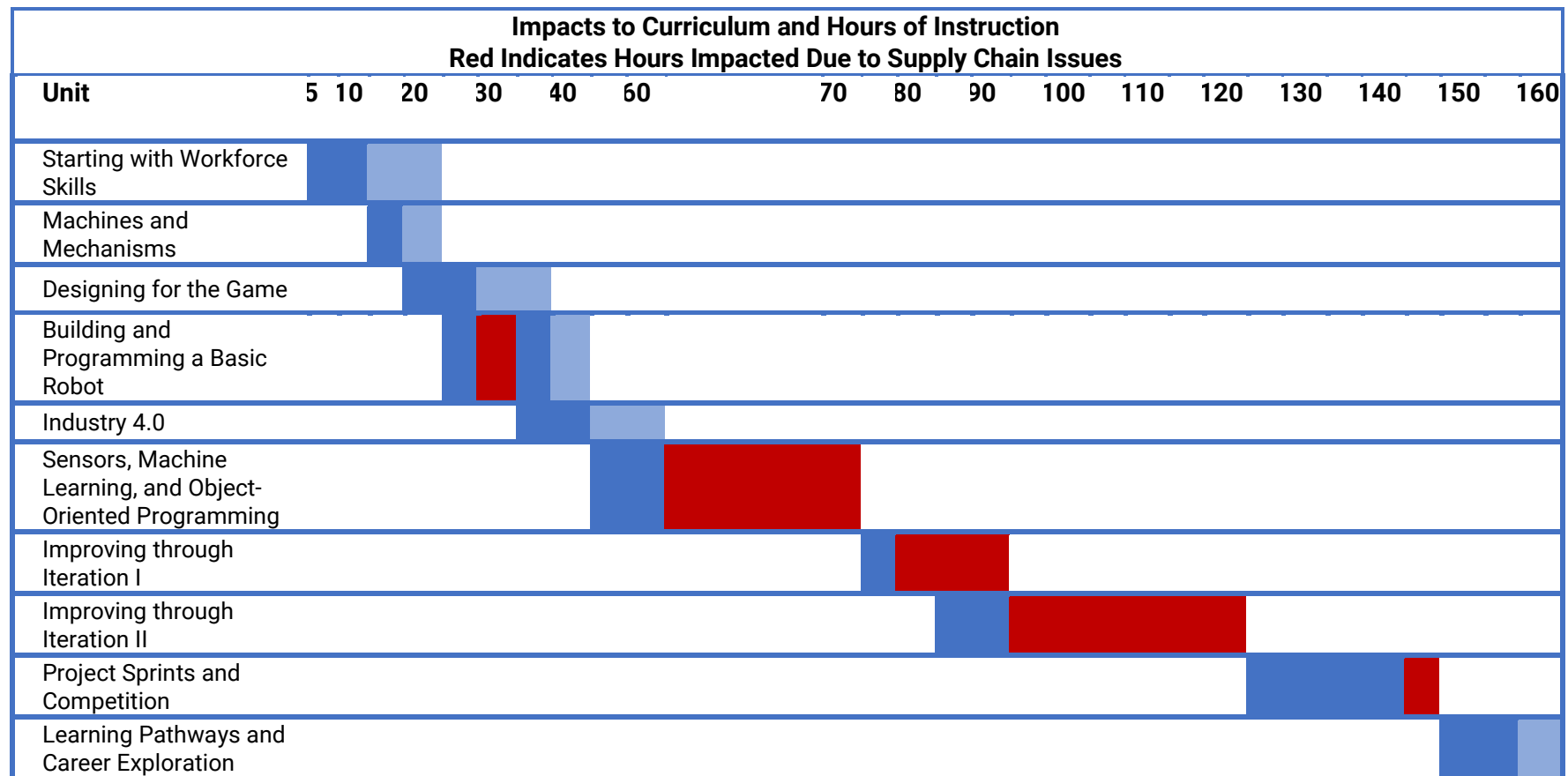


#firstinspires

Scope and Sequence Modifications to Address Supply Chain Issues

Given the current supply chain issues, modifications to the scope and sequence may be required to deliver the curriculum until the supply chain issues are resolved. This guide will enable a teacher to utilize the curriculum with the mechanical kit of parts without the Control Hub for 60 hours of instruction.

It does require the REV Servo Programmer which is included in the Expansion set but not in the Edubot kit. It will need to be purchased separately if the expansion set was not purchased.



Starting with Workforce Skills (10- 20 hours)

Lesson	Student Outcomes	Team Activity	Modification/ Hardware Need
Core Values Problem: How can you use <i>FIRST</i> ® philosophies to create a team purpose and achieve it through clear communications and expectations?	1) Demonstrate Core Values while participating in building activities. 2) Develop a team identity and use it for communicating expectations as a team using <i>FIRST</i> Core Values and <i>Gracious Professionalism</i> . 3) Develop a way to document communications with your team to explain your engineering and learning journey.	Brainstorming	None
		1. Innovating with Parts	Mechanical Kit of Parts w/out Control Hub
		2. Team Purpose	None
		3. Team Communication	None
Project Management Problem: How can you establish impactful goals and expectations for your team and execute these goals using project management?	1) Create goals for your team that include workforce skills, impactful learning, and incorporate Core Values. 2) Create a project management plan for how you will achieve goals and manage tasks for each member of your team and identify roadblocks to success. 3) Create a safety plan that addresses local and national safety expectations that are transferable to business and industry.	Brainstorming	None
		1. Goal Setting	None
		2. Project Management	None
		3. Safety Plan	None
Tools for Problem Solving Problem: How do we use the engineering design process and computational thinking to build a mechanical arm?	1) The arm will be built using materials and details supplied by your teacher. 2) Use computational thinking to gain a better understanding of the problem to modify engineering design goals. 3) Improve the design through iteration and testing. 4) Use Computer-Aided Design software to increase innovative capabilities in the engineering design process.	Brainstorming	None
		1. Can You Build It	Mechanical Kit of Parts w/out Control Hub
		2. Connecting Resources	Mechanical Kit of Parts w/out Control Hub
		3. Improving Testing	Mechanical Kit of Parts w/out Control Hub

		4. OnShape	Participants could spend up 4 Hours in OnShape Curriculum
Career Card Problem: How can our career skills help us pursue individual career goals while helping our team achieve its goal and purpose?	1) Use the Career Ready Skills Rubric to identify strengths and weaknesses and explore careers that might use these skills. 2) Develop a personal purpose, focus, how you will achieve the focus, and skills you add to the team and incorporate it into a career card that demonstrates who you are.	Brainstorming	None
		1. Career Skills	None
		2. Career Card	None

Machines to Mechanisms 10 -15 Hours

Teacher modification needed: Instead of students applying the analysis to their current robot game strategy, apply the content principles to the Can You Build it team activity from the previous module. Directions on how to use the servo programmer are located [here](#).

Lesson	Criteria and Constraints	Team Activity	Modification/ Hardware Need
Simple to Complex Machines Problem: How can we analyze the forces involved and know the essential calculations of the manipulator to achieve the desired output?	1) Improve a manipulator design by combining simple machines to make a more complex machine while considering the mechanical advantage. 2) Conduct tests using a simulator to understand and improve the magnitude of the scalar and vector forces.	Brainstorming	Mechanical Kit of Parts w/out Control Hub Servo Programmer Needed
		1. Simple to Complex Machines	Mechanical Kit of Parts w/out Control Hub Servo Programmer Needed
		2. Scalar, Vector, and Magnitude	Mechanical Kit of Parts w/out Control Hub Servo Programmer Needed
Levers, Cams, Linkages, and Linear Motion Problem: How can you increase the work your manipulators accomplish	1) Conduct a test with the Arm Physics Lab to understand how weight distribution affects the force needed for a fulcrum in a third-class lever. Apply knowledge of levers to improve the mechanical advantage of at least one lever on your robot.	Brainstorming	Mechanical Kit of Parts w/out Control Hub Servo Programmer Needed
		1. Lever Design	Mechanical Kit of Parts w/out Control Hub Servo Programmer Needed

<p>with levers, cams, linkages, and linear motion?</p>	<ol style="list-style-type: none"> 2) Analyze how the lifting force, the mass of the object, and the coefficient of friction affect the gripper’s ability to lift. 3) Design and prototype a linkage or cam mechanism that could improve the performance of one of your robot functions. 4) Conduct a design analysis to determine if linear motion could improve your robot performance. Design, develop, and test a linear motion prototype if it would help you meet your game strategy. 	<p>2. Gripper Forces</p>	<p>Mechanical Kit of Parts w/out Control Hub Servo Programmer Needed</p>
<p>Conveyors, Intakes, and Object Trajectory</p> <p>Problem: How can you design with more automation using the speed of motors to achieve intake, conveyance, or trajectory?</p>	<ol style="list-style-type: none"> 1) Discover how a robot might gather objects using an intake. Conduct a design analysis to determine if intakes could improve your robot performance. Design, develop, and test an intake prototype to manipulate a game object if it would help you meet your game strategy. 2) Discover how a robot might transfer objects using a conveyance system. Conduct a design analysis to determine if conveyance could improve your robot performance. Design, develop, and test a conveyance prototype to manipulate a game object if it would help you meet your game strategy. 3) Using the technical knowledge of trajectory, conduct a design analysis to determine if the trajectory of a game element is relevant to your game strategy. Design, develop, and test a shooting mechanism to manipulate a game object if it would help you meet your game strategy. 	<p>3. Linkages and Cams</p>	<p>Mechanical Kit of Parts w/out Control Hub Servo Programmer Needed</p>
		<p>4. Linear Motion</p>	<p>Come Back to in Designing for the Game Module</p>
		<p>Brainstorming</p>	<p>Optional</p>
		<p>1. Intake Design Analysis</p>	<p>Mechanical Kit of Parts w/out Control Hub Servo Programmer Needed</p>
		<p>2. Conveyance Design Analysis</p>	<p>Mechanical Kit of Parts w/out Control Hub Servo Programmer Needed</p>
		<p>3. Shooting and Trajectory Design Analysis</p>	<p>Skip</p>

Designing for the Game 10-20 hours

Lesson	Student Outcomes	Team Activity	Modification/ Hardware Need
Game Plan Problem: How do we use computational thinking to understand the game we will compete in with our robots?	1) Discover patterns in the game design by looking at the game flow and patterns of scoring. 2) Gain a deeper understanding of the engineering tasks by taking measurements of the game field, and game elements. 3) Develop a game strategy and robot algorithms for autonomous, teleop, and end-game.	Brainstorming	None
		1. Game Patterns	Mini- Game Field
		2. Engineering Tasks	Mini- Game Field
		3. Algorithm Development	Mini-Game Field
Robot Plan Problem: How do you design a robot using your game strategy?	1) Conduct a divergent brainstorming session to generate as many different robot design strategies. 2) Use the pros and cons of a design idea to narrow down the ideas and develop prototypes of the top three. 3) Use a decision matrix to determine a final design and develop orthographic drawings to support the design. 4) Test the design idea in the physics simulations to determine if it theoretically will work	Brainstorming	None
		1. Divergent Brainstorming	Mechanical Kit of Parts w/out Control Hub Servo Programmer Needed
		2. Convergent Brainstorming	Mechanical Kit of Parts w/out Control Hub Servo Programmer Needed
		3. Orthographic Drawing	Mechanical Kit of Parts w/out Control Hub Servo Programmer Needed
		4. Physics Lab Test	None
Robot Challenge by Unit	1) Students can use beginner, intermediate or advanced robot achievement goals to increase skill level with each unit. 2) The tasks are identified by unit and can be referred to throughout the course after the Game release.	1. Building and Programming a Basic Robot 2. Machines to Mechanisms 3. Sensors, Machine Learning and Java 4. Improving through Iteration I & II	FTC Sims

Building and Programming a Basic Robot 10-20 Hours

Lesson	Criteria and Constraints	Team Activity	Modification/ Hardware Need
Robots and the Workforce Problem: How can you develop design criteria for a FIRST® Tech Challenge robot built with your kit of parts?	1) Identify the essential components of a robot that are in your kit of parts. 2) Conduct an analysis of your kit of parts to determine those that constrain motion and those that transform motion. 3) Describe part distinctions and how they could relate to their performance. 4) Develop design criteria for your robot using the engineering design process.	Brainstorming	None
		1. Understanding Parts	Mechanical Kit of Parts w/out Control Hub
		2. Identifying Distinctions	Mechanical Kit of Parts w/out Control Hub
		3. Design Criteria	Mechanical Kit of Parts w/out Control Hub
Chassis and Drive System Problem: How can we design and build a chassis that considers center of gravity, speed, and torque and is rigid enough to hold the robot subsystems?	1) Discover different chassis designs and conduct a brainstorming session to choose an initial design that meets your design criteria and skill level. 2) Using the physics lab conduct an engineering analysis for the center of gravity for the chassis design you chose. 3) Using the physics lab, conduct an engineering analysis for friction, torque, and velocity for the chassis design you chose. 4) Develop a project management plan for your chassis build.	Brainstorming	None
		1. Chassis Brainstorming	Mechanical Kit of Parts w/out Control Hub
		2. Center of Gravity	Mechanical Kit of Parts w/out Control Hub
		3. Torque and Velocity	Mechanical Kit of Parts w/out Control Hub
		4. Chassis Project Management	Mechanical Kit of Parts w/out Control Hub
Electrical Wiring and Configuration Problem: How do you prevent communication errors with robot wiring and software	1) The robot should be wired using an understanding of electrical theory to prevent electrostatic discharge. 2) The team should have a wiring diagram created and placed in the <i>Engineering Notebook</i> . 3) The team should perform updates for the hardware and software and configure the hardware according to the wiring diagram.	Brainstorming	Required
		1. Wiring	Skip
		2. Electrical Diagram	Skip

management techniques?	4) Conduct research to understand the 5G wireless technology that the robot uses and its application in the future workforce.	3. Updates, Wi-Fi Connections, and Configuration	Skip
Programming Problem: How do you use the FIRST® Tech Challenge IDE and computational thinking to write the plans for the robot to act?	1) Algorithms should be developed using pseudocode and computational thinking. 2) Identify where abstraction occurs in the IDE and use the IDE to create a tank drive op mode. 3) Use conditionals to add a servo to your robot program. 4) Add an additional motor that could operate a manipulator. 5) Develop a basic algorithm for autonomous to drive and park.	4. Wireless Technology and Waves	None
		Brainstorming	Required
		1. Pseudocode Development	None Needed
		2. Tank Drive Op Mode	Skip
		3. Programming a Servo	FTC Sims
		4. Programming a Manipulator	FTC Sims
Manipulators Problem: How do you ensure your manipulator design is efficient and can perform the work you want it to do?	1) Design and build an end effector to manipulate an object. Record its design in your <i>Engineering Notebook</i> . 2) Gather data needed to perform calculations for the amount of torque needed to lift the game object with your manipulator. 3) Apply academic and technical skills including using physics simulations to determine the motor torque and efficiency when choosing an actuator that most suits your end effector. 4) Use gear ratios or gear trains to improve motor efficiency for your actuator.	5. Programming an Autonomous Mode	FTC Sims
		Brainstorming	
		1. End Effector	Mechanical Kit of Parts w/out Control Hub
		2. Motor Data Table	Mechanical Kit of Parts w/out Control Hub
		3. Using the Arm Physics Lab	Mechanical Kit of Parts w/out Control Hub
		4. Moment Calculations	Mechanical Kit of Parts w/out Control Hub
5. Gear Ratios	Mechanical Kit of Parts w/out Control Hub		

Industry 4.0 and Your Community 10-20 Hours

Lesson	Criteria and Constraints	Team Activity	Modification/ Hardware Need
Industry 4.0 and Your Robot Problem: How can building your robot increase your knowledge for an Industry 4.0 career?	1) Develop a presentation on your robot's utilization of Internet of Things technology. 2) Brainstorm ways the robot can use big data, augmented reality, and machine learning to better its automation and efficiency. 3) (Optional) Use industry tools such as augmented reality from PTC or collaboration tools.	Brainstorming	Suggested
		1. 5G Wireless Technology	None Needed
		2. Machine Learning and AI	None Needed
		3. Augmented Reality	None Needed
Industry 4.0 and Your Community Problem: How can you utilize Industry 4.0 in your community to impact others' understanding of STEM?	1) Create a Venn diagram poster that could be used to educate others about Industry 4.0 and the future. 2) Develop a plan to impact your community through a project, awareness, or education of Industry 4.0 and the future.	Brainstorming	None Needed
		1. Industry 4.0 and the Future	None Needed
		2. Community Impact Project	None Needed
Share with Your Community Problem: How can you share the impact with others through an event to benefit you and your community?	1) Brainstorm ways to implement a community event where you can share the knowledge you have learned. 2) Work with the rest of your class to determine how each team will help to contribute to the planning and even implementation of the event.	Brainstorming	None Needed
		1. Event Brainstorming and Planning	None Needed
		2. Event Project Management	None Needed

Sensors, Machine Learning, and Object-Oriented Programming 10-15 Hours

Lesson	Criteria and Constraints	Team Activity	Modification/ Hardware Need
Sensors and Feedback Problem: How can you increase feedback and control using sensors and improve program flow with Boolean data?	<ol style="list-style-type: none"> 1) Use a decision matrix to evaluate and choose sensors to improve robot feedback and performance. 2) Use a truth table and flow chart to evaluate the logic and program flow of your robot. 3) Choose one sensor to implement on your robot and use computational thinking to further develop your algorithm to reduce cumulative error. 	Brainstorming	None
		1. Sensor Choices	FTC Sims
		2. Truth Tables and Flow Charts	FTC Sims
		3. Algorithm Development	FTC Sims
Developing States and Functions Problem: How can you increase abstraction and robot control through functions and states?	<ol style="list-style-type: none"> 1) Use functions in your autonomous program to improve your autonomous program. 2) Improve your code using encoders for navigation, and if possible, use the IMU for turning navigation. 3) Use computational thinking to analyze your code for state machine development for your autonomous program. 	Brainstorming	FTC Sims
		1. Function Development	FTC Sims
		2. Using Encoders and the IMU	FTC Sims
		3. States	FTC Sims
Developing Robot Machine Learning Problem: How can you utilize your robot's ability to perform machine learning through vision processing?	<ol style="list-style-type: none"> 1) Develop a data table of how your robot might make decisions and classify objects. 2) Explore the tools available for using image processing via the Webcam. Utilize GitHub to test the webcam and its capability for Vuforia or TensorFlow. 	Brainstorming	Skip
		1. Machine Learning Pseudocode	Skip
		2. 2D and 3D Recognition	Skip
Object-Oriented Programming Problem: How is an abstraction used in Java to handle communicating with different components in a program?	<ol style="list-style-type: none"> 1) Decompose your Java program understanding syntax, methods, objects, and classes. 2) Use myBlocks to convert functions that you have created into myBlocks. 3) (Optional) Use an external source to learn more in-depth Java programming. 	Brainstorming	
		1. Decomposing Java	Skip
		2. myBlocks	Skip
		3. Learn Java	

Improving through Iteration I 5-10 Hours

Lesson	Criteria and Constraints	Team Activity	Modification/ Hardware Need
Iteration and Product Life Cycle Problem: How do you improve your robot using the Robot Technical Design Rubric while improving reliability and functionality to meet your design goals?	1) Improve your robot by making it simpler by analyzing the design for feasibility, optimality, and reliability. 2) Manage the product lifecycle to ensure growth continues through analyzing design weaknesses. Create a project management plan for improving those weaknesses. 3) (Optional) Use CAD to track versions and design changes on your robot.	Brainstorming	Skip
		1. Iteration I	Skip
		2. Iteration II	Skip
		3. OnShape CAD	Optional
Mechanism Improvement Problem: How can you improve the mechanisms on your robot by using industry machines for inspiration?	1) Brainstorm ways of improving your mechanisms using industry machines as inspiration for a design. 2) Prototype ideas for improving your mechanisms and use a decision matrix to determine the most effective one.	Brainstorming	Skip
		1. Industry Ideas	Skip
		2. Testing Ideas	Skip
Algorithm Improvement Problem: How do you improve the algorithms on your robot as you add functionality and hardware to it?	1) Use computational thinking to identify additional algorithms needed to control your robot or its actuators. Record information for understanding the problem in your <i>Engineering Notebook</i> . 2) Use components of flow control to increase functionality such as additional conditional logic, variables, or operators. Record code modifications and testing in the <i>Engineering Notebook</i> .	Brainstorming	FTC Sims
		1. Algorithm Improvement	FTC Sims
		2. Increase Flow Control	FTC Sims

Improving through Iteration II 5-10 Hours

Lesson	Criteria and Constraints	Team Activity	Modification/ Hardware Need
Mechanism Improvement Problem: How can you improve the mechanisms on your robot by improving the design idea and improving the execution of the design?	1) Use project management to improve your robot's reliability and functionality. 2) Brainstorm and analyze using the physics lab ways to improve a design with more speed and efficiency. 3) Use CAD or 3D Printing to improve your innovation and functionality on the robot while developing career skills.	Brainstorming	Skip
		1. Improving Reliability and Functionality	Skip
		2. Improving Design Ideas	Skip
		3. Design for 3D Printing	Skip
Algorithm Improvement Problem: How do you improve the algorithms on your robot as you add additional functionality and hardware to the robot?	1) Coordinate your hardware and software by adding additional hardware to your configuration file and identifying the data needed for the hardware. 2) Identify possible algorithms for using the hardware and record testing data. 3) Increase flow control through decreasing cumulative error and improved data processing	Brainstorming	Skip
		1. Configure Hardware	Skip
		2. Identify Possible Algorithms	FTC Sims
		3. Increase Flow Control	FTC Sims
Project Management Sprint Problem: How can you complete a project management sprint to address problems on the robot and prepare for the competition?	1) Complete a project sprint for tasks to be completed on the robot. 2) Complete a project sprint for your <i>Engineering Notebook</i> . 3) Complete an evaluation of our project management sprint to determine any roadblocks.	Brainstorming	Skip
		1. Robot Sprint	Skip
		2. Engineering Notebook Sprint	Skip
		3. Evaluate Sprints	Skip

Project Sprints and Competition 10 Hours

Lesson	Criteria and Constraints	Team Activity	Modification/ Hardware Need
Conducting a Project Management Sprint Problem: How can you complete a project management sprint to address problems on the robot and prepare for the competition?	1) Complete a project sprint for tasks to be completed on the robot. 2) Complete a project sprint for your Engineering Notebook. 3) Complete an evaluation of our project management sprint to determine any roadblocks.	Brainstorming	Suggested
		1. Robot Sprint	FTC Sims
		2. Engineering Notebook Sprint	FTC Sims
		3. Evaluate the Sprints	FTC Sims
Presentation and Competition Problem: How do you improve your communication skills by presenting and demonstrating your knowledge to others?	1) Create a team summary of your successes. 2) Develop a team presentation to articulate your team's purpose, goals, and accomplishments. 3) Compete with your team in a Mini-Game competition.	Brainstorming	Suggested
		1. Identifying Successes	FTC Sims
		2. Presentation Development	FTC Sims
		3. Mini-Game Competition	Required
Learning Portfolio Problem: How can you develop a portfolio that shows your skills to help you pursue your future goals and career?	1) Identify your strengths and weaknesses using the course rubrics. 2) Provide evidence of your strengths with references to the Engineering Notebook. 3) Make improvements to your portfolio based upon feedback from your team.	Brainstorming	None
		1. Identifying Strengths and Weaknesses	Focus on algorithms and programming
		2. Provide Evidence of Your Skills	Focus on algorithms and programming
		3. Improve through Feedback	Focus on algorithms and programming

Learning Pathways and Careers 10-20 Hours

Lesson	Criteria and Constraints	Team Activity	Modification/ Hardware Need
Competition and Learning Pathways Problem: How can I continue to learn about robotics on a competitive team and get access to scholarships and industry certifications?	1) Explore team roles on a <i>FIRST</i> ® competitive team and their correlation to jobs in different industries. Learn the benefits of being on a competitive team that can advance regionally and internationally. 2) Identify how career pathways on a competitive team can help you achieve scholarships, internships, and industry credentials. Create three goals for your future career path. 3) Explore careers and internship opportunities from <i>FIRST</i> Strategic Partners.	Brainstorming	None
		1. Team Role	None
		2. Goal Setting	None
		3. Career Exploration	None
Résumé Problem: How can you develop a résumé to share with potential scholarship providers, employers, or community members?	1) Understand the principles of writing a good résumé and the difference between an entry-level résumé and a professional résumé use it to build a résumé that demonstrates the impact you make with your workforce and technical skills. 2) Gain feedback and improve your résumé for potential scholarships, employers, or community members. 3) Apply for digital badges and take advantage of networking opportunities in Tallo.	Brainstorming	None
		1. Identifying Successes	None
		2. Presentation Development	None
		3. Mini-Game Competition	None
Learning Portfolio Problem: How can you develop a portfolio that shows your skills to help you pursue your future goals and career?	1) Identify your strengths and weaknesses using the course rubrics. 2) Provide evidence of your strengths with references to the Engineering Notebook. 3) Make improvements to your portfolio based upon feedback from your team.	Brainstorming	None
		1. Identifying Strengths and Weaknesses	None
		2. Provide Evidence of Your Skills	None
		3. Improve through Feedback	None

