PLTW | Gateway

Introductory Lessons

2015-2016 Course Outline

PROJECT LEAD THE WAY

PLTW

PLTW Gateway
Introductory Lessons

1.2 million unfilled STEM jobs – PLTW Gateway embraces the challenge of engaging students in ways to solve this problem.

STEM is where jobs are today and where job growth will be in the future. Gateway exposes students to careers in science, engineering, biomedical sciences, computer sciences, and mathematics.

Is a STEM career in your future?

At the beginning of the Gateway experience, students should complete two introductory lessons: What Is Engineering? & Design Process. These lessons will take ten 45 minute class periods. In these lessons students will learn about STEM careers and how they impact the past, present, and future. Students will learn how to use an engineering notebook and develop a portfolio of their own work.

In all Gateway units, students will practice problem solving with structured activities and progress to open-ended projects and problems that require them to develop planning, documentation, communication, and other professional skills. Students with greater motivation, ability, or background knowledge will be challenged to work further.

The unit documents include a summary of each of the lessons of study that are included in the Gateway Program. Alignment with Next Generation Science Standards, Common Core State Standards, Technological Literacy Standards, and the National Healthcare Foundation Standards and Accountability Criteria will be available through the PLTW Alignment web-based tool. Activities, projects, and problems will be provided to the teacher in the form of student-ready handouts, teacher notes, and supplementary materials through the Learning Management System (LMS).

The Gateway units are planned for a rigorous pace and are likely to contain more material than a skilled teacher new to the course will be able to complete in the first iteration. Building enthusiasm for rigorous STEM applications is a primary goal of the Gateway program. Teachers are encouraged to emphasize content that will be fresh and exciting to students. The course is structured to facilitate local adaptation to a particular group of students' prior knowledge and experience.

Introductory Lesson Summary

Lesson 1: What Is Engineering?

What role will today's students play in the future of our global economy? The ability to use knowledge to create and process resources in new ways will take us to the stars, cure diseases, and create new problems for us to solve. Most career choices will involve the use of STEM. An understanding of engineering and technology and its impact is essential to today's students and our future society. The U.S. Department of Commerce estimates that jobs in science, technology, engineering, and math (STEM) will grow 17 percent by 2018—nearly double the growth for non-STEM fields. By 2018, the U.S. will have more than 1.2 million unfilled STEM jobs because there will not be enough qualified workers to fill them. STEM is where jobs are today and where job growth will be in the future. In this lesson students will learn about STEM careers and how they impact the past, present, and future.

Lesson 2: Design Process

The design process has evolved over centuries because the need to solve problems quickly forced people to refine the process. Each time a complex problem was solved, people studied the process along with the created solutions. The benefits of using a design process are more evident today than ever. The speed with which we can research solutions with today's design tools has increased exponentially. This lesson focuses on the tools that engineers use to solve problems. Students will study the Design Process and use it to guide their actions while solving problems.

Curriculum Framework – Gateway (2015-2016)
Design and Modeling – Lesson 1.1 What is Engineering?

<table>
<tr><th colspan="3">Desired Results (stage 1)</th></tr>
<tr><td rowspan="4">ESTABLISHED GOALS
It is expected that students will…

• G1 – Demonstrate an ability to identify, formulate, and solve engineering problems.
• G2 – Demonstrate an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
• G3 – Demonstrate an ability to design and conduct experiments, as well as to analyze and interpret data.
• G4 – Demonstrate an ability to apply knowledge of mathematics, science, and engineering.
• G5 – Demonstrate an ability</td><td colspan="2">Transfer</td></tr>
<tr><td colspan="2">TRANSFER: Students will be able to independently use their learning to …

• T1 – Understand the impact of engineering solutions in a global, economic, environmental, and societal context.
• T2 – Function on a multidisciplinary team.</td></tr>
<tr><td colspan="2">Meaning</td></tr>
<tr><td>UNDERSTANDINGS: Students will understand that …

• U1 – An engineering notebook is used to record original ideas or designs and to document the design process related to an invention or innovation.
• U2 – A portfolio is an organized collection of best works.
• U3 – Science is the study of the natural world, while technology is the study of how humans develop new products to meet needs and wants.
• U4 – Teams of people can accomplish more than one individual working alone.
• U5 – Technological change is seen through inventions, innovations, and the evolution of technological artifacts, processes, and systems.
• U6 – Technology can have positive and negative social, cultural, economic, political, and environmental consequences.
• U7 – Engineers, designers, and engineering technologists are needed in high demand for the development of future</td><td>ESSENTIAL QUESTIONS: Students will keep considering …

• Q1 –Why is it important for engineers to document their work?
• Q2 – How does each of the topics in STEM have an effect on the way you live?
• Q3 – Compare and contrast the difference between an invention and an innovation</td></tr>
</table>

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<table>
<tr>
<td rowspan="3">to use the techniques, skills, and modern engineering tools necessary for engineering practice.
• G6 – Pursue the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
• G7 – Demonstrate an understanding of professional and ethical responsibility.
• G8 – Demonstrate an ability to function on multidisciplinary teams.
• G9 – Demonstrate an ability to communicate effectively.
• G10 – Gain knowledge of contemporary issues.
• G11 – Recognize the need for, and develop an ability to engage in life-long learning.</td>
<td colspan="2">technology to meet societal needs and wants.</td>
</tr>
<tr>
<td colspan="2">Acquisition</td>
</tr>
<tr>
<td>KNOWLEDGE: Students will …

• K1 – Describe the relationship between science, technology, engineering, and math. U3
• K2 – Identify the differences between invention and innovation. U5
• K3 – Describe impacts that technology has had on society. U6</td>
<td>SKILLS: Students will …

• S1 – Utilize standard procedures to use and maintain an engineering notebook. U1
• S2 – Use guidelines for developing and maintaining an engineering notebook to evaluate and select pieces of one’s own work for inclusion in a portfolio. U2
• S3 – Operate as an effective member of a team to complete an investigation. U4
• S4 – Describe engineering and explain how engineers participate in or contribute to the invention and innovation of products. U5, U7</td>
</tr>
</table>

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Evidence *(stage 2)*		
Activities (A) Projects (P) Problems(B)	Assessment FOR Learning	Assessment OF Learning
A.1.1.1 Notebook Dividers	• Essential Questions • Gateway Notebook Grading Rubric	• Conclusion Questions • Gateway Notebook Grading Rubric
A.1.1.2 Introduction to Engineering	• Essential Questions • Activity Questions	• Conclusion Questions
P.1.1.3 STEM Investigation	• Investigating STEM Grading Rubric • Essential Questions	• Investigating STEM Grading Rubric • Project 1.1.3a Question Guide
A.1.1.4 What is Technology?	• Essential Questions	• Conclusion Questions and Chart
A.1.1.5 Engineering Careers	• Essential Questions	• Conclusion Questions

Learning Plan *(stage 3)*	
Activities (A) Projects (P) Problems(B)	Knowledge and Skills
A.1.1.1 GTT Notebook Dividers	S1, S2
A.1.1.2 Introduction to Engineering	K1, K2, S4
P.1.1.3 STEM Investigation	K1, K2, S3, S4
A.1.1.4 What is Technology?	K1, K3
A.1.1.5 Engineering Careers	S4

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Curriculum Framework – Gateway (2015-2016)
Design and Modeling – Lesson 1.2 Design Process

<table>
<tr><th colspan="3">Desired Results (stage 1)</th></tr>
<tr><td rowspan="4">ESTABLISHED GOALS
It is expected that students will…

• G1 – Demonstrate an ability to identify, formulate, and solve engineering problems.
• G2 – Demonstrate an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
• G3 – Demonstrate an ability to design and conduct experiments, as well as to analyze and interpret data.
• G4 – Demonstrate an ability to apply knowledge of mathematics, science, and engineering.
• G5 – Demonstrate an ability to use the techniques, skills, and</td><td colspan="2">Transfer</td></tr>
<tr><td colspan="2">TRANSFER: Students will be able to independently use their learning to …

• T1 – Apply the engineering design process to design a system, component, or process to meet desired needs within realistic constraints.
• T2 – Understand the role and impact of engineering and engineering solutions within a global, economic, environmental, and societal context.</td></tr>
<tr><td colspan="2">Meaning</td></tr>
<tr><td>UNDERSTANDINGS: Students will understand that …

• U1 – Many different design processes are used to guide people in developing solutions to problems.
• U2 – The design brief is a tool for defining the problem; it is an agreement between the engineer and client.
• U3 – Engineers use design briefs to explain the problem, identify solution expectations, and establish project constraints.
• U4 – Design teams use brainstorming techniques to generate large numbers of ideas in a short amount of time, striving for quantity, not quality.
• U5 – A decision matrix is a tool used to compare solution ideas to the criteria so that you can select the best solution.</td><td>ESSENTIAL QUESTIONS: Students will keep considering …

• Q1 – How do engineers use the design process to solve a problem?
• Q2 – Why is brainstorming important when modifying or improving a product?
• Q3 - Why do people work in teams when solving design problems?
• Q4 - Why are design elements considered when engineers and designers invent or innovate a product?</td></tr>
</table>

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	Acquisition	
modern engineering tools necessary for engineering practice. • G6 – Pursue the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context. • G7 – Demonstrate an understanding of professional and ethical responsibility. • G8 – Demonstrate an ability to function on multidisciplinary teams. • G9 – Demonstrate an ability to communicate effectively. • G10 – Gain knowledge of contemporary issues. • G11 – Recognize the need for, and develop an ability to engage in life-long learning.	*KNOWLEDGE: Students will …* • K1 – Describe the design process and how it is used to aid in problem solving. U1 • K2 – Describe the elements of design. U1 • K3 – Recognize design criteria and constraints. U2, U3 • K4 – Describe the purpose and importance of working in a team. U4	*SKILLS: Students will …* • S1 – Use the design process to solve a technical problem. U1 • S2 – Apply the elements of design to the design process. U1 • S3 – Explain a design brief and apply the concept when using the design process. U2, U3 • S4 – Operate effectively as a member of a team to complete a design project. U4 • S5 – Use a decision matrix to select the best solution to a design problem. U5

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Evidence *(stage 2)*		
Activities (A) Projects (P) Problems(B)	Assessment FOR Learning	Assessment OF Learning
A.1.2.1 Design Process	• Essential Questions	• Conclusion Questions
A.1.2.2 Design Elements	• Essential Questions	• Conclusion Questions
P.1.2.3 Furniture (Hobby Organizer) Design	• Essential Questions • Hobby Organizer Design Grading Rubric • Furniture Design Grading Rubric	• Conclusion Questions • Hobby Organizer Design Grading Rubric • Furniture Design Grading Rubric

Learning Plan *(stage 3)*	
Activities (A) Projects (P) Problems(B)	Knowledge and Skills
A.1.2.1 Design Process	K1, K3
A.1.2.2 Design Elements	K2
P.1.2.3 Furniture (Hobby Organizer) Design	K4, S1, S2, S3, S4, S5

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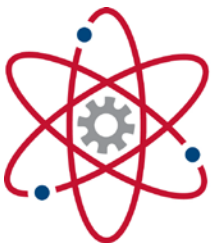
Automation and Robotics

2015-2016 Course Outline



PROJECT LEAD THE WAY

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PLTW Gateway
Automation and Robotics

Design, Build, and Program a Robot!

Students use tools such as the engineering design process, an engineering notebook, VEX Robotics®, and programming software to invent and innovate.

Learn how creative thinking and problem solving can change your world!

Automation and Robotics (AR) allows students to trace the history, development, and influence of automation and robotics as they learn about mechanical systems, energy transfer, machine automation, and computer control systems. Students use the VEX Robotics® platform to design, build, and program real-world objects such as traffic lights, toll booths, and robotic arms.

AR Lesson Summary

Lesson 1: What Is Automation and Robotics?

The field of automation and robotics includes computer-controlled machines used to make manufacturing more efficient, productive, and safe. Robots are also used as assistive tools for people with disabilities and as equipment in hospitals to help with surgery, to deliver food, or to dispense medications. Robots are becoming popular household helpers, performing chores like vacuuming and mowing lawns. Scientists say that future generation robots will be able to clean up, take out the trash, or even care for an elderly parent. In this unit students will learn how automation and robotics affect everyday life both positively and negatively, including safety, comfort, choices, and attitudes about a technology's development and use.

Lesson 2: Mechanical Systems

Think about a bicycle, an eggbeater, a sewing machine, a hand-cranked drill, and a workshop vice. What do they have in common? All of them have at least one mechanism that provides movement. If the devices were taken apart, you would find a series of gears that redirect the applied force so they can accomplish their tasks. The activities in this lesson will introduce the students to several mechanisms that are used to change speed, torque, force, type of movement, and direction of movement. These mechanisms have been developed over time to address the need for changes in machine tools, robots, automobiles, airplanes, etc.

Lesson 3: Automated Systems

Computer programs and sensing devices provide feedback to guide tools and machines in the manufacturing of parts. Automated systems can be used to pick up a part, move it to a certain location, wait for a process to be performed, pick it back up, and deliver it to an offloading location. Upon completion of this lesson, students will have a better understanding of the necessary components of a flexible manufacturing system and the programming necessary for communication between the sensors, motors and building components.

Curriculum Framework – Gateway (2015-2016)
Automation and Robotics – Lesson 2.1 What is Automation and Robotics?

<table>
<tr><th colspan="3">Desired Results (stage 1)</th></tr>
<tr><td rowspan="4">ESTABLISHED GOALS
It is expected that students will…

• G1 – Demonstrate an ability to identify, formulate, and solve engineering problems.
• G2 – Demonstrate an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
• G3 – Demonstrate an ability to design and conduct experiments, as well as to analyze and interpret data.
• G4 – Demonstrate an ability to apply knowledge of mathematics, science, and engineering.
• G5 – Demonstrate an ability to use the techniques, skills, and</td><td colspan="2">Transfer</td></tr>
<tr><td colspan="2">TRANSFER: Students will be able to independently use their learning to …

• T1 – Understand the impact of engineering solutions in a global, economic, environmental, and societal context.</td></tr>
<tr><td colspan="2">Meaning</td></tr>
<tr><td>UNDERSTANDINGS: Students will understand that …

• U1 – Automation is the use of technology to ease human labor or to extend the mental or physical capabilities of humans.
• U2 – Robotics is the specialized field of engineering and computer science that deals with the design, construction, and application of robots.
• U3 – The use of automation and robotics affects humans in various ways, both positively and negatively, including their safety, comfort, choices, and attitudes about a technology's development and use.
• U4 – Automation and robotics have had an influence on society in the past and present and will influence society in the future.
• U5 – Engineers, designers, and engineering technologists are in high demand for the development of future technology to meet societal needs and wants.</td><td>ESSENTIAL QUESTIONS: Students will keep considering …

• Q1 – What limitations do you think should be placed on the use of robots?
• Q2 - What type of robot do you think makes the most significant contribution to our lives today and why?
• Q3 - What is the greatest concern that should be considered before converting a factory from human workforce to robotic workforce?
• Q4 - What impact do you think robots will have on your life in 10 years and in 50 years?</td></tr>
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	Acquisition	
modern engineering tools necessary for engineering practice. • G6 – Pursue the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context. • G7 – Demonstrate an understanding of professional and ethical responsibility. • G8 – Demonstrate an ability to function on multidisciplinary teams. • G9 – Demonstrate an ability to communicate effectively. • G10 – Gain knowledge of contemporary issues. • G11 – Recognize the need for, and develop an ability to engage in life-long learning.	*KNOWLEDGE: Students will …* • K1 – Describe the purpose of automation and robotics and its effect on society. U1, U2, U3, U4 • K2 – Describe positive and negative effects of automation and robotics on humans in terms of safety and economics. U3, U4	*SKILLS: Students will …* • S1 – Summarize ways that robots are used in today's world and the impact of their use on society. U3, U4 • S2 – Provide examples of STEM careers and the need for these professionals in our society. U5

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Evidence *(stage 2)*		
Activities (A) Projects (P) Problems(B)	Assessment FOR Learning	Assessment OF Learning
A.2.1.1a Sandwich Algorithm or A.2.1.1b VEX build	• Essential Questions	• Conclusion Questions
A2.1.2a Understanding Robots	• Essential Questions	• Conclusion Questions
A2.1.2 What do we use Robots For?	• Essential Questions • What do we use Robots For Rubric	• Conclusion Questions • What do we use Robots For Rubric
A1.1.5 Engineering Careers	• Essential Questions	• Conclusion Questions

Learning Plan *(stage 3)*	
Activities (A) Projects (P) Problems(B)	Knowledge and Skills
A.2.1.1a Sandwich Algorithm or A.2.1.1b VEX build	K1, S1
A2.1.2a Understanding Robots	K1, K2, S1
A2.1.2 What do we use Robots For?	K1, K2, S1
A1.1.5 Engineering Careers	K1, K2, S1, S2

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Curriculum Framework – Gateway (2015-2016)
Automation and Robotics – Lesson 2.2 Mechanical Systems

<table>
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<tr><td rowspan="4">ESTABLISHED GOALS
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• G1 – Demonstrate an ability to identify, formulate, and solve engineering problems.
• G2 – Demonstrate an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
• G3 – Demonstrate an ability to design and conduct experiments, as well as to analyze and interpret data.
• G4 – Demonstrate an ability to apply knowledge of mathematics, science, and engineering.
• G5 – Demonstrate an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.</td><td colspan="2">Transfer</td></tr>
<tr><td colspan="2">TRANSFER: Students will be able to independently use their learning to …

• T1 – Apply knowledge of mathematics, science, and engineering to design and build mechanisms.
• T2 – Design a mechanical system that meets desired needs within realistic constraints.</td></tr>
<tr><td colspan="2">Meaning</td></tr>
<tr><td>UNDERSTANDINGS: Students will understand that …

• U1 – Energy is the capacity to do work; the use of mechanisms is necessary to transfer energy.
• U2 – Engineers and technologists design mechanisms to change energy by transferring direction, speed, type of movement, and force or torque.
• U3 – Mechanisms can be used individually, in pairs, or in systems.</td><td>ESSENTIAL QUESTIONS: Students will keep considering …

• Q1 – Why is it important for you to learn about mechanisms?
• Q2 - What is the purpose of being able to change speed, force, torque, direction and types of motion with a mechanism?
• Q3 – Describe where you see mechanisms used in three real-life applications, explain the purpose of using a mechanism for that application.</td></tr>
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	Acquisition	
• G6 – Pursue the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context. • G7 – Demonstrate an understanding of professional and ethical responsibility. • G8 – Demonstrate an ability to function on multidisciplinary teams. • G9 – Demonstrate an ability to communicate effectively. • G10 – Gain knowledge of contemporary issues. • G11 – Recognize the need for, and develop an ability to engage in life-long learning.	*KNOWLEDGE: Students will …* • K1 – Use ratios to solve mechanical advantage problems. U2, U3 • K2 – Use numerical and algebraic expressions and equations to solve real-life problems, such as gear ratios. U2, U3	*SKILLS: Students will …* • S1 – Use the characteristics of a specific mechanism to evaluate its purpose and applications. U1, U2, U3 • S2 – Apply knowledge of mechanisms to solve a unique problem for speed, torque, force, or type of motion. U1, U2, U3

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Evidence *(stage 2)*		
Activities (A) Projects (P) Problems(B)	Assessment FOR Learning	Assessment OF Learning
A.2.2.1 Observing Mechanisms	• Essential Questions	• Conclusion Questions
A.2.2.2 Mechanical Gears	• Student responses to presentation questions • Essential Questions	• Conclusion Questions
P.2.2.3 Windmill Construction	• Essential Questions	• Conclusion Questions
P.2.2.4 Pull Toy Construction	• Essential Questions • Pull Toy Construction Rubric	• Conclusion Questions • Pull Toy Construction Rubric
P.2.2.5 Survival Challenge	• Essential Questions	• Conclusion Questions

Learning Plan *(stage 3)*	
Activities (A) Projects (P) Problems(B)	Knowledge and Skills
A.2.2.1 Observing Mechanisms	K1, K2, S1
A.2.2.2 Mechanical Gears	K1, K2, S1
P.2.2.3 Windmill Construction	K1, K2, S1, S2
P.2.2.4 Pull Toy Construction	K1, K2, S1, S2
P.2.2.5 Survival Challenge	K1, K2, S1, S2

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Curriculum Framework – Gateway (2015-2016)
Automation and Robotics – Lesson 2.3 Automated Systems

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<tr><th colspan="3">Desired Results (stage 1)</th></tr>
<tr><td rowspan="3">ESTABLISHED GOALS
It is expected that students will…

• G1 – Demonstrate an ability to identify, formulate, and solve engineering problems.
• G2 – Demonstrate an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
• G3 – Demonstrate an ability to design and conduct experiments, as well as to analyze and interpret data.
• G4 – Demonstrate an ability to apply knowledge of mathematics, science, and engineering.
• G5 – Demonstrate an ability to use the techniques, skills, and</td><td colspan="2">Transfer</td></tr>
<tr><td colspan="2">TRANFER: Students will be able to independently use their learning to …

• T1 – Apply knowledge of mathematics, science, and engineering to design robotic systems that solve a problem.
• T2 – Use the techniques (design process), skills (mechanisms), and modern engineering tools (VEX and Programming Software) necessary for engineering practice.</td></tr>
<tr><td colspan="2">Meaning</td></tr>
<tr><td>UNDERSTANDINGS: Students will understand that …

• U1 – Automated systems require minimal human intervention.
• U2 – An open-loop system has no feedback path and requires human intervention, while a closed-loop system uses feedback.
• U3 – Troubleshooting is a problem-solving method used to identify the cause of a malfunction in a technological system.
• U4 – Comments do not change the way a robot behaves, but they do allow the programmer to remember the function that the code performs.
• U5 – Invention is a process of turning ideas and imagination into devices and systems.
• U6 – Some technological problems are best solved through experimentation.</td><td>ESSENTIAL QUESTIONS: Students will keep considering …

• Q1 - Why is it advantageous for some systems to be open loop and others to be closed loop? Explain using real-life applications.
• Q2 - How do you troubleshoot a malfunctioning system efficiently?
• Q3 – Why is it important for a computer and robotics engineer to understand how mechanisms work?
• Q4 - Why is good communication and teamwork important when solving technological problems?</td></tr>
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Evidence *(stage 2)*		
Activities (A) Projects (P) Problems(B)	Assessment FOR Learning	Assessment OF Learning
A 2.3.1 "Beef" Up Your Technological Resources Understanding	• Student responses to presentation questions • Essential Questions	• Conclusion Questions
A 2.3.2 Robot Behaviors and Writing Pseudocode	• Essential Questions	• Conclusion Questions
A 2.3.3 Using ROBOTC	• Essential Questions	• Conclusion Questions
P 2.3.4 Automation Through Programming	• Essential Questions	• Conclusion Questions
P 2.3.5 Simulated Factory Assembly Line	• Essential Questions	• Conclusion Questions • Project Evaluation Rubric

Learning Plan *(stage 3)*	
Activities (A) Projects (P) Problems(B)	Knowledge and Skills
A 2.3.1 "Beef" Up Your Technological Resources Understanding	K1
A 2.3.2 Robot Behaviors and Writing Pseudocode	K2
A 2.3.3 Using ROBOTC	K2, S1, S2
P 2.3.4 Automation Through Programming	K2, K3, K4, S1, S2, S3
P 2.3.5 Simulated Factory Assembly Line	K1, K2, K3, K4, S1, S2, S3

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