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Siemens Middle Grades Curriculum
Lower Secondary
Siemens Exploring the World of Engineering

Introduction

Siemens Exploring the World of Engineering is a project-based curriculum designed to engage middle school students in solving authentic, real-world STEM challenges. Through hands-on projects, collaborative problem-solving, and iterative design, students explore eight contemporary topics; ranging from aerospace and artificial intelligence to energy systems and biomedical engineering. Each course fosters critical thinking, creativity, and engineering and technical literacy while aligning with the *Siemens Pathway to Learning Engineering* (*PLE*) program of study. The courses use NX software as tools for design, and manufacturing as well as other teacher prescribed software to use for the projects. The objective is to apply these tools to address unique problems, enabling students to quickly create and analyze proposed solutions. Industry uses these tools, and understanding their application in problem-solving is critical to the growth of skills needed in the workplace.

The content is organized into eight non-sequential courses, each with three differentiated project options, ranging in length from 10 to 16 class periods (50 minutes a day) per project, enabling integration over the course of a school year. These timeframes are approximate and may vary based on classroom context, student needs, pacing, and instructional priorities.

Courses can be implemented in any order to suit a school's schedule, student interests, or instructional goals. Each includes a level 1, level 2, and level 3 project options. This support scaffolding, differentiation, and flexible pacing, with level 1 aligned to typical learners ages 11–12, level 2 to ages 12–13, and level 3 to ages 13–14. Project complexity increases across levels, allowing students to build knowledge and skills progressively through more sophisticated design challenges. Within a classroom of learners ages 11–12, teachers may select level 1, level 2, or level 3 projects to scaffold learning, differentiate instruction, and support authentic project-based learning experiences. It is recommended that the teacher choose projects based on students' age, grade level, or ability/knowledge of the focus of the overarching course.

Standards

Each of the projects has overarching standards that ensure that students move towards mastery. *Siemens Exploring the World of Engineering* is based on Career and Technical Standards, Standards for Technological and Engineering Literacy (STEL), Reading Standards for Literacy in History/Social Studies, and the Writing Standards for Literacy in History/Social Studies/Science/Technical Subjects.

The courses are based on the Next Generation Science Standards (NGSS) to engage students in the scientific and engineering practices taken from the National Research Council's Framework for K-12 Science Education, Practices, Crosscutting Concepts, and Core Ideas. This document is the basis of the NGSS, and these practices are used for two reasons: they parallel the design process used in each project, and 2) they serve as the foundation of the NGSS. The eight science and engineering practices are:

1. Asking questions and defining problems
2. Developing and using models
3. Planning and conducting investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations and designing solutions
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Student Assessment

There are two forms of student assessment: formative and summative.

The *Siemens Exploring the World of Engineering* uses formative assessment throughout the courses. The formative assessment criteria, usually through knowledge check questions or reflections, are a way to show student progression. The summative assessment criteria, usually through a rubric, is a way to show students in advance the expectations of each project. They both serve as a way for teachers to provide guidance and support throughout the learning process and to demonstrate end-of-project performance.

Project Badge Recognition

Upon completing the project by assessing students using the rubric, students who score level 3 or higher will be issued a badge. These badges progress as students go through multiple projects in the pathway.

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Course Descriptions

Each course in the *Siemens Exploring the World of Engineering* curriculum is built around project-based learning strategies that actively engage students in solving authentic, real-world problems. Through hands-on design challenges and collaborative inquiry, students develop meaningful solutions while building essential STEM skills and understanding core engineering concepts. Each course has level 1, level 2, and level 3 projects that will take between 10-16 class periods to complete.

1. Designing the Future

Students explore how engineers design solutions for real-world challenges by applying the engineering design process. They analyze existing designs, generate innovative ideas, and create models that address future needs using engineering principles, sustainability concepts, and systems thinking.

- Level 1: Design a future home using sketches and basic sustainability features.
- Level 2: Create a prototype of a smart product that solves a real-life problem.
- Level 3: Plan and present a model City of the Future integrating energy, housing, and mobility solutions.

2. Automation Technology

Students will investigate how automated systems improve efficiency and consistency by exploring sequencing, motion, and system control. They will compare manual and automated processes and analyze how components work together within a system.

- Level 1: Build a basic powered machine to explore motion and simple automation.
- Level 2: Design and test a motorized assembly line that completes a multi-step process.
- Level 3: Program and refine a robotic system to complete a sequenced task using logic and debugging strategies.

3. Autonomous Electric Vehicles

Students will explore, interpret, and design components of autonomous and electric vehicle systems. Through hands-on activities, they will differentiate between electric and gas-powered basic components and exemplify how they are controlled by computer systems.

- Level 1: Build and test a battery-powered vehicle to explore motion and energy flow.
- Level 2: Design a vehicle that uses sensors to navigate its environment.
- Level 3: Simulate an autonomous delivery challenge and justify system design decisions.

4. Aerospace Technology

Students will examine the principles of flight, aerodynamics, and stability through hands-on testing and iteration. They will collect and analyze data to improve performance and explain design outcomes.

- Level 1: Build and test a tethered balloon to observe basic flight concepts.
- Level 2: Design, test, and refine a glider to improve stability and distance.

- Level 3: Engineer, launch, and analyze a rocket using physics principles and flight data.

5. Energy Management
Students will investigate how energy is generated, transferred, and conserved within systems. They will design solutions that improve efficiency and promote sustainable energy use.

- Level 1: Build a simple solar-powered device to explore renewable energy conversion.
- Level 2: Design an energy-efficient model home using insulation, layout, and passive design strategies.
- Level 3: Develop a smart grid system that balances energy supply, demand, and storage.

6. Informatics
Students will explore how data is collected, organized, analyzed, and communicated to support decision-making. They will use data to identify patterns and explain real-world phenomena.

- Level 1: Decode and organize data using tables, categories, and basic visualizations.
- Level 2: Create a data-driven app interface that responds to user input.
- Level 3: Analyze and visualize a real-world data set to identify trends and communicate findings responsibly.

7. Biomedical Manufacturing and Engineering
Students will apply human-centered design and systems thinking to biomedical challenges. They will consider safety, usability, and quality in both product design and manufacturing processes.

- Level 1: Design a simple assistive device to support a specific human need.
- Level 2: Simulate a medical manufacturing process with defined roles, quality control, and documentation.
- Level 3: Engineer a biomedical innovation for a real-world need and justify design decisions using research and testing.

8. Artificial Intelligence
Students will explore how artificial intelligence systems make decisions using data, logic, and models. They will evaluate performance, consider ethical implications, and design responsible AI solutions.

- Level 1**:** Explore how AI makes decisions using inputs, rules, and decision trees.
- Level 2**:** Train and evaluate a machine learning model, examining accuracy and bias.
- Level 3: Design an AI solution for a real-world problem, addressing trade-offs, risk, and ethical considerations.

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Designing the Future

Project 1 – Level 1: Future Home Design – 10 class periods

Students will explore what homes of the future might look like by designing a sustainable living space that is efficient, comfortable, and environmentally responsible. This project introduces foundational engineering design thinking and encourages students to consider how choices such as layout, materials, and energy use can improve the way people live.

Project 2 – Level 2: Interactive or Sensor-Based Product Innovation – 15 class periods

Students will identify an everyday challenge and design a simple interactive or sensor-based product that helps solve the problem. The product may respond to user actions or environmental changes using basic system inputs and outputs. This project emphasizes user needs, iteration, and systems thinking as students design, prototype, and evaluate their ideas.

Project 3 – Level 3: City of the Future Design Challenge – 16 class periods

Students will apply knowledge and skills from earlier projects to design a conceptual "City of the Future." Working in teams, students will research urban challenges and develop a city design that integrates sustainable energy, transportation systems, housing, and infrastructure. The project emphasizes systems thinking, collaboration, and innovation as students design solutions for future communities.

Automation Technology

Project 1 – Level 1: Build a Basic Powered Machine – 16 class periods

Students construct a simple mechanical device, such as a crank-powered arm or conveyor, to explore how motion can be transferred through gears, pulleys, or levers. This project introduces foundational ideas of mechanical systems, automation, and the engineering design process.

Project 2 – Level 2: Build a Motorized Assembly Line – 16 class periods

Students will work in teams to design a small assembly line that uses motors and basic programming (such as block-based coding or timed switches) to complete 2–3 simple steps, such as moving an object, stopping it, or changing its direction. The project emphasizes sequencing, problem-solving, and comparing human vs. machine performance. Teams will iterate their design to improve accuracy and speed.

Project 3 – Level 3: Program a Robotic Task – 16 class periods

Students will use a programmable robotics platform such as micro:bit, Arduino, VEX IQ, LEGO, or Fischertechnik to code and complete an automated task such as sorting objects by color or navigating a path. Students will test, debug, and refine their programs based on system performance.

Autonomous Electric Vehicles

Project 1 – Level 1: Build a Basic Electric Vehicle - 16 class periods

Students will build a small battery-powered car using motors, wheels, and a chassis made from everyday materials. The focus is on understanding basic electricity, motion, and vehicle structure.

Project 2 – Level 2: Design a Vehicle with Sensor-Based Navigation - 16 class periods

Students will design a small robot or electric vehicle that navigates a track or obstacle course using sensors. They will adjust the sensitivity and placement of sensors to improve accuracy.

Project 3 – Level 3: Simulate an Autonomous Delivery Challenge - 16 class periods

Students will simulate a real-world scenario in which an autonomous electric vehicle must deliver a package, avoid obstacles, and reach a target zone. The project emphasizes sensor integration, logical sequencing, and autonomous decision-making.

Aerospace Technology

Project 1 – Level 1: Air Balloon Design - 16 class periods

Students will explore basic principles of lift and air pressure by designing and testing a tethered balloon model. The project introduces fundamental aerospace concepts in a hands-on and visual way.

Project 2 – Level 2: Glider Design and Test - 16 class periods

Students will design, build, and refine a hand-launched glider. Through testing and iteration, they will explore how glider performance is impacted by different design choices, simulating the work of aerospace engineers.

Project 3 – Level 3: Rocket Launch Engineering Challenge - 16 class periods

Students will build and launch a model rocket using air, water, or solid-fuel propulsion (depending on school guidelines). They will apply physics and engineering knowledge to optimize performance and analyze flight results.

Energy Management

Project 1 – Level 1: Build a Simple Solar-Powered Device - 16 class periods

Students will explore solar energy by constructing a basic solar-powered device. This hands-on activity helps students understand energy conversion and introduces renewable energy concepts in a tangible way.

Project 2 – Level 2: Design an Energy-Efficient Model Home - 16 class periods

Students will work in teams to design a model home that conserves energy. They will experiment with insulation, window placement, or lighting systems to simulate how homes can increase energy efficiency.

Project 3 – Level 3: Develop a Smart Grid - 16 class periods

Students will simulate a smart energy network system using solar panels, rechargeable batteries, or coding platforms. The project explores how smart grids manage energy flow and optimize renewable use.

Informatics

Project 1 – Level 1: Decode and Organize Data - 16 class periods

Students will explore how data is collected and used by conducting a basic survey or measurement activity (e.g., class snack preferences, temperatures). They will organize the data visually and learn how computers store and interpret information.

Project 2 – Level 2: Create a Data-Driven App Interface - 16 class periods

Students will create a simple interactive tool that uses input/output functions, such as a quiz app,

a habit tracker, or a digital form that collects and displays responses. This introduces informatics concepts including data input, processing, basic statistics, and interface design.

Project 3 – Level 3: Analyze and Visualize a Real-World Data Set - 16 class periods

Students will explore a data set on a topic of interest—such as weather, energy use, sports statistics, or school attendance—and use digital tools (e.g., Excel, Google Sheets, Python, or Tableau for kids) to organize and present their analysis in visual form.

Biomedical Manufacturing and Engineering

Project 1 – Level 1: Design a Simple Assistive Device - 16 class periods

Students will explore how biomedical engineers design tools that help people overcome physical limitations. They will research real-world needs and build a simple assistive device using basic materials.

Project 2 – Level 2: Simulate a Medical Manufacturing Process - 16 class periods

Students will simulate the manufacturing of a biomedical device in a mock work cell. They will focus on process efficiency, material selection, and quality control, emphasizing how biomedical tools must meet strict standards.

Project 3 – Level 3: Engineer a Biomedical Innovation for a Real-World Need - 16 class periods

Students will identify a biomedical need such as improving mobility, enhancing grip strength, or assisting recovery, and design a novel device or tool to address it. The focus is on human-centered design and innovation.

Artificial Intelligence

Project 1 – Level 1: Explore How AI Makes Decisions - 16 class periods

Students will explore basic AI logic by creating a decision tree that mimics how AI programs make choices—such as sorting animals by features or recommending music. They will use basic paper-based or digital tools to simulate how AI narrows decisions based on input.

Project 2 – Level 2: Train a Machine Learning Model - 16 class periods

Using a user-friendly platform like Google's Teachable Machine or another no code AI tool, students will train a machine to recognize images, sounds, or gestures. They will experiment with training data to see how changes affect accuracy.

Project 3 – Level 3: Design an AI Solution for a Real-World Problem - 16 class periods

Students will design an AI-driven solution to address a real-world issue, such as a study reminder bot, a sorting system for waste, or a mood-based music app. While they may not code the system fully, they will focus on how the AI would work and what data it needs to operate responsibly.
