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Engineering and Engineering Technology STEM Curriculum Courses (Resource Exchange)

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Siemens Engineering and Engineering Technology STEM Curriculum Courses (Resource Exchange)

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Siemens Engineering and Engineering Technology STEM Curriculum Courses (Resource Exchange)

Grade level: 9-12

Program Overview: This Siemens secondary school curriculum is an engineering project/problem-based learning curriculum which teaches the fundamentals of engineering design and manufacturing along with the enabling engineering technology, e.g., CAD, CAM, CAE, design collaboration, etc. Students utilize the iterative engineering design process to define, research, imagine, plan, create, test, improve, and communicate solutions. Each project allows student teams to develop distinct solutions to the same problem. The problem statement presents the student with an opportunity to plan, organize and conduct research. "Enabling Activities" provide students with the required knowledge and skills "just in time" so they may proceed to a viable solution. Teachers are trained on the curriculum, pedagogy and technology while receiving continuing education credits (40 CEUs/course). They serve multiple roles, from guide and facilitator of student work to provider of useful knowledge and demonstrator of useful skills.

Program Duration: The program is comprised of 3 year-long courses that build upon each other. Each course is divided into four quarters matching a schedule utilized by many school districts with 50-minute daily lessons. The four quarters build one upon each other. Additionally, courses can be used as a stand-alone, full-year course or taught in a semester double-period block schedule.

Standards & Guiding Principles:

- Next Generation Science Standards
- Career and Technical Standards
- National Research Council's Framework for K-12 Science Education, Practices, Crosscutting Concepts, and Core Ideas
- Common Core Math and English Language Arts Standards

Activities/Tutorials: Activities/tutorials are methods by which students are provided with the "just in time" knowledge, procedures and/or skills that are required to complete a project or problem. The concept of just in time means that the activity/tutorial is provided right when the student needs it; the optimal teaching and learning moment. An activity/tutorial is a means to an end, not an end in itself. Properly sequenced, the activities/tutorials lead to more complex contextual learning. Contextual learning occurs when students connect information to their own frames of reference. These frames of reference provide the contexts needed by students to make sense of what they are learning. Teachers are then expected to increase student motivation by helping their students apply more complex cognitive processes, such as analyzing, evaluating, and creating, to increase student achievement. These skills are found on the Webb's Depth of Knowledge (DOK) chart levels 3 and 4 exclusively.

The following are two examples from a project that requires students to design a pedestrian bridge:

Student teams conduct model analysis using Finite Element Analysis (FEA) and simulations to produce a detailed examination of the elements, structure, and behavior of a system under certain conditions. They create a report of the beam they design and how it is impacted by the forces placed upon it.

Conduct a systematic study of a structure by applying loads to determine the performance of the structure design, the structure members, and the structure materials as determined through the relationship between applied force and the corresponding deflection.

These activities/tutorials are designed to provide students with the knowledge and skills necessary to analyze their proposed design solutions to ensure that they can safely carry humans.

Projects: Projects are complex real-world learning experiences that have predictable outcomes. Often the design may differ, but the outcome is the same. The knowledge and skills learned in the activities/tutorials drive the new learning in the project producing greater depth of knowledge.

The following example is from a project on Playground Design:

A playground is a designated place specifically designed for children to play either indoors or outdoors. Playgrounds must be safe, easily accessible, sort activities by age, and have easy sightlines with minimum hiding spaces. Students will research the various aspects of playground design and develop an appropriate solution.

Problems: In contrast to projects, problems are typically open-ended with multiple solutions or plausible answers. Problems are the highest level of contextual learning producing the greatest depth of knowledge. They may evolve as an extension of a project or they can be original by design. They are truly real-world and often parallel the rigor found at the post-secondary level or a high wage job. Students learn that problems often produce new problems to solve and thus model the real world of creativity and innovation. Problems may last from 10-50 class days and can also be structured to last for an entire school year.

Here is an example of a problem from a project on Moving Large Amounts of Material from Place to Place:

Production systems often require moving substances from one place to another. A major grain grower has contacted your team about designing an efficient system for moving dry rice from storage silos into trucks for transport. The grower wants a system that will have high flow volume without causing damage to the product. The silos are in remote locations and can only be accessed by trucks. Additionally, to evaluate energy requirements, the grower requested power calculations from the proposed system.

Conclusion: CTE curriculum designed with a hierarchy of contextual learning produces students with the attributes necessary for the nation's new economy. The curriculum framework provides students with future-oriented, challenging, and meaningful learning experiences and establishes the attributes for lifelong learning. Pilot tested in 100 schools and by 150 teachers. Curriculum, teacher training and enabling software are offered at no cost.

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Curriculum Materials: https://solidedge.siemens.com/en/solutions/users/educators/#secondary-school-curriculum