Project Lead The Way [PLTW] Engineering Design and Development

PEIMS Code: N1303749

Abbreviation: EDD

Grade Level(s): 11-12

Award of Credit: 1.0

Approved Innovative Course

- Districts must have local board approval to implement innovative courses.
- In accordance with Texas Administrative Code (TAC) §74.27, school districts must provide instruction in all essential knowledge and skills identified in this innovative course.
- Innovative courses may only satisfy elective credit toward graduation requirements.
- Please refer to TAC §74.13 for guidance on endorsements.

Course Description:

Engineering Design and Development (EDD) is an open-ended engineering research course in which students work in teams to design and develop an original solution to a well-defined and justified open-ended problem by applying an engineering design process using the knowledge and skills they developed in previous courses. EDD is appropriate for 11th and 12th-grade students.

Students will perform research to select, define, and justify a problem. After carefully defining the design requirements and creating multiple solution approaches, teams of students select an approach, create, and test their solution prototype. Student teams will present and defend their original solution to an outside panel.

This course prepares students for college, a career, or the military by helping them become better problem-solvers. Students learn how to manage projects and further develop their transferable skills, such as communication and ethical reasoning.

Essential Knowledge and Skills:

(a) General Requirements. This course is recommended for students in 11th or 12th grade. Students shall be awarded one credit for successful completion of this course. Recommended Prerequisites: At least two courses in engineering with at least one being a Level 2 or higher course.

(b) Introduction.

(1) Engineering Design and Development is appropriate for 11th and 12th graders. Students design an original solution to a problem using the knowledge and skills they developed from prior courses.

(2) For the students' culminating project, students work with experts to define a problem, perform research, design multiple solutions, select the best approach, and create and test a prototype. Students then present and defend their solution to an outside panel.

(3) This course prepares students for college, a career, or the military by helping them become better problem-solvers. Students learn how to manage projects and further develop their transferrable skills, such as communication and ethical reasoning. They also develop professional skills, such as time management, organizational skills, and the ability to justify or defend their ideas.

(4) Students are encouraged to participate in extended learning experiences, such as career and technical student organizations and other leadership or extracurricular organizations.

(5) Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

(c) Knowledge and Skills.

(1) Critical and Creative Problem-Solving. The student demonstrates adaptability to change, independent thinking, and self-direction in pursuit of accomplishing a goal. The student is expected to:

(A) list and prioritize goals with tangible success criteria;

(B) demonstrate time management in pursuit of accomplishing a goal without direct oversight;

(C) explain how one can gain knowledge to accomplish a common goal or solution; and

(D) adapt to varied roles, job responsibilities, schedules, and contexts.

(2) Critical and Creative Problem-Solving. The student perseveres to solve a problem or achieve a goal. The student is expected to:

(A) describe why persistence is important when identifying a problem and pursuing solutions;

(B) explain what is learned from failure and how it can be applied to future problems; and

(C) explain how learning from past iterations or experiences can inform future progress.

(3) Critical and Creative Problem-Solving. The student explains and justifies an engineering design process. The student is expected to:

(A) explain why there are many versions of a design process that describe essentially the same process;

(B) identify and classify various steps in the design process;

(C) describe major steps of a design process and identify typical tasks involved in each step;

(D) explain how iterative processes inform engineering decisions, improve solutions, and inspire new ideas; and

(E) document a design process in an engineering notebook according to best practices.

(4) Critical and Creative Problem-Solving. The student collects, analyzes, and interprets information relevant to a problem or opportunity at hand to support engineering decisions. The student is expected to:

(A) explain the role of research in the process of design;

(B) identify relevant data in credible sources such as literature, databases, and policy documents;

(C) explain the role of stakeholders and subject matter experts in the design process; and

(D) describe criteria for determining the reliability and credibility of information.

(5) Critical and Creative Problem-Solving. The student synthesizes an ill-formed problem into a meaningful, well-defined problem. The student is expected to:

(A) explain the importance of defining a problem or opportunity, design criteria, and constraints to develop successful design solutions;

(B) identify and define visual, functional, and structural design requirements with realistic constraints against which solution alternatives can be evaluated; and

(C) list potential constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, technical feasibility, and sustainability that may impact the success of a design solution.

(6) Critical and Creative Problem-Solving. The student generates multiple potential solution concepts. The student is expected to:

(A) describe multiple techniques and appropriate guidelines used to generate ideas; and

(B) represent concepts using a variety of visual tools such as sketches, graphs, and charts to communicate details of an idea.

(7) Critical and Creative Problem-Solving. The student develops models to represent design alternatives and generates data to inform decision-making, test alternatives, and demonstrate solutions. The student is expected to:

(A) describe the use of a model to accurately represent the key aspects of a physical system, including the identification of constraints that may influence the selection of a model;

(B) define various types of models that can be used to represent products, processes, or designs such as physical prototypes, mathematical models, and virtual representations; and

(C) explain the purpose and appropriate use of students' selected models.

(8) Critical and Creative Problem-Solving. The student selects a solution path from many options to successfully address a problem or opportunity. The student is expected to:

(A) explain why there are often multiple viable solutions and no obvious best solution;

(B) consider and evaluate trade-offs throughout an engineering design process;

(C) develop and implement a justifiable scheme to compare and evaluate competing solutions; and

(D) apply a decision matrix to compare and evaluate competing solutions based on design criteria.

(9) Critical and Creative Problem-Solving. The student will identify deficiencies, limitations, and biases based on evidence and arguments are decisions. The student is expected to:

(A) explain how a conclusion is valid if the evidence supports the conclusion while acknowledging the limitations, opposing views, and biases;

(B) evaluate evidence and arguments to identify deficiencies, limitations, and biases; and

(C) evaluate appropriate next steps in the pursuit of a better solution.

(10) Collaboration. The student contributes individually to overall collaborative efforts and evaluates the work of others to provide helpful and effective feedback supporting an effective team environment. The student is expected to:

(A) evaluate and describe their personal contributions and collaboration effectiveness within a team;

(B) describe the purpose and positive outcomes of a peer review process;

(C) describe the characteristics of effective feedback; and

(D) describe the various individual roles and interdependencies of a collaborative team.

(11) Collaboration. The student manages project timelines and resources as part of an engineering design process. The student is expected to:

(A) explain the process of project management and the importance of elements such as timelines, schedules, task assignments, and identification and mitigation of potential risks in the effort to complete a project on time;

(B) develop a project plan using a project planning tool such as a Gantt chart; and

(C) select and use a system of collaborative tools such as cloud-based tools, document sharing, and video and text functions to successfully complete a project.

(12) Communication. The student communicates effectively with an audience based on audience characteristics. The student is expected to:

(A) describe established conventions of written, oral, and electronic communications, including grammar, spelling, usage, and mechanics;

(B) demonstrate acceptable formats through written and oral communication identified by the instructor for technical writing and professional presentations;

(C) describe how the size and characteristics of an audience will affect communication;

(D) modify the content, format, level of technical detail, and length of communications to meet the needs of the audience;

(E) cite references for all communication in an accepted format;

(F) label tables and figures with units and explain the information presented in context;

(G) describe characteristics important to successful oral delivery of information, including volume, tempo, eye contact, articulation, and energy; and

(H) explain the use of varied communication elements of delivery to convey and emphasize information and engage the audience.

(13) Engineering Tools and Technology. Using a variety of measuring devices, the student measures and reports quantities accurately and to a precision appropriate for the purpose. The student is expected to:

(A) explain how all measurements are an approximation of the true value of a quantity;

(B) explain and differentiate between the accuracy and precision of taking a measurement;

(C) explain the difference in accuracy with various measure devices; and

(D) use dimensional analysis and unit conversions to transform data to consistent units or to units appropriate for a particular purpose or model.

(14) Engineering Tools and Technology. The student interprets and analyzes data for a single count or measurement variable. The student is expected to:

(A) represent data for a single count or measurement with plots on the real number line, including dot plots, histograms, and box plots;

(B) use statistics appropriate to the shape of the data distribution to determine the center, including median, mean, spread, interquartile range, and standard deviation, of a data set to compare data sets;

(C) use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages; and

(D) identify data sets for which such procedures are not appropriate.

(15) Engineering Tools and Technology. The student applies mathematical models and interprets the output of models to test ideas or make predictions. The student is expected to:

(A) represent data for two quantitative variables on a scatter plot and describe how the variables are related;

(B) evaluate and solve linear, quadratic and exponential functions to test ideas or make predictions;

(C) interpret, in linear models, the rate of change and the intercept in the context of the data; and

(D) differentiate between sample statistics and population statistics and demonstrate appropriate applications of each.

Recommended Resources and Materials:

Ruggles, R., Phansey, A., & Linder, B. n.d. “Sustainable Design Guide.” http://www.solidworks.com/sustainability/sustainable-design-guide.htm.

Arnold, R. D., & Wade, J. P. 2015. “A Definition of Systems Thinking: A Systems Approach.” Procedia Computer Science, 44, 669–678. doi:10.1016/j.procs.2015.03.050.

Project Lead The Way Teacher and Student Resources. 2022. https://my.pltw.org/login.

Project Lead The Way Software and Technology Requirements. 2022. https://pltw.org/pltw-software.

Recommended Course Activities:

- Students will participate in an instant design challenge and outline how they approach problem solving from prior experience.
- Students will identify innovations and inventions and how the iterative process has brought current versions to the public. (i.e. shopping cart, phone, cup holder, etc.)
- Students will practice different brainstorming techniques to generate a multitude of ideas as a group in a short amount of time for given a problem statement.
- Students will create and use a Gantt chart using a sample problem statement and project outline.

- Students will create a testable prototype and an unbiased testing plan based on the defined design requirements to determine the effectiveness of the solution they created.

- Students will execute testing protocol on a prototype and reflect on the process and what conclusions can be drawn from their results or the process itself.

- Students will identify a real-world problem and complete the EDD engineering design process, documenting all steps and work of the journey. Students present their process for their created problem statement and defend their findings to a panel of experts and stakeholders.

Suggested methods for evaluating student outcomes:

PLTW supports a balanced approach to assessment for all programs. PLTW offers assessments that measure subject-matter knowledge as well as the in-demand, transportable skills that students need to succeed beyond high school.

A sample of theses assessment types are:

- Self-Assessments and Peer Assessments
- Discussions and Observations
- Project Rubrics
- Student Reflections
- Checklists
- Performance Checks (example: live presentation of design solution)
- Engineering Report and Final Defense

Teacher qualifications:

- Legacy Master Science Teacher.
- Mathematics/Physical Science/Engineering: Grades 6-12.
- Mathematics/Physical Science/Engineering: Grades 8-12.
- Physical Science: Grades 6-12.
- Physical Science: Grades 8-12.
- Physics/Mathematics: Grades 7-12.
- Physics/Mathematics: Grades 8-12.
- Science: Grades 7-12.
- Science: Grades 8-12.
- Science, Technology, Engineering, and Mathematics: Grades 6-12.
- Secondary Industrial Arts (Grades 6-12).
- Secondary Industrial Technology (Grades 6-12).
- Secondary Physics (Grades 6-12).
- Secondary Science (Grades 6-12).
- Secondary Science, Composite (Grades 6-12).
- Technology Education: Grades 6-12.
- Legacy Master Mathematics Teacher.
- Mathematics: Grades 7-12.
- Mathematics: Grades 8-12.
- Secondary Mathematics: Grades 6-12
- Secondary Physical Science (Grades 6-12)

- Technology Applications: Grades EC-12
- Technology Applications: Grades 8-12
- Trade and Industrial Education: Grades 6-12. This assignment requires appropriate work approval.
- Trade and Industrial Education: Grades 8-12. This assignment requires appropriate work approval.
- Vocational Trades and Industry. This assignment requires appropriate work approval.

Additional information:

Successful completion of the PLTW Core Training is required to offer this course.

PLTW's Core Training for Engineering Design and Development requires approximately 90 hours of instruction led by PLTW-approved Master Teachers (80 hours of class time plus 10 hours of prerequisite work). It is offered year-round with multiple options to allow teachers to select dates and pacing of their training sessions. Course mastery is demonstrated by the submission and approval of a course portfolio that meets PLTW's requirements. After successful completion of Core Training, teachers receive access to the National PLTW Engineering Professional Learning Community, course-specific student and classroom instructional resources, and Ongoing Training resources through the PLTW Content Management System.

Current details, such as pricing and listings for all PLTW professional development, can be found at https://www.pltw.org/our-programs/professional-development/core-training. At the time of this application submission, the course cost is *$2,400.

Note: Currently, PLTW offers a training guarantee to schools. The PLTW Training Guarantee protects a district's investment in PLTW programs by guaranteeing if a teacher leaves within four years of earning a PLTW credential, PLTW will provide a grant in the amount of the training fee for the district to train a teacher in the same course, replace the credential(s), and support continued student learning.

* PLTW Professional Development Fees are subject to change annually. Changes are communicated via email from PLTW Communications and on the PLTW website at least 90 days prior to the effective date for the upcoming school year. There are no changes for the 2023-24 school year.

Please contact Project Lead The Way directly for questions about these requirements:

Project Lead The Way

Solution Center

Toll Free: 877.335.PLTW (7589) solutioncenter@pltw.org