



*Forging new
generations of
engineers*

Phone: 518-877-6491

Fax: 518-877-6260

747 Pierce Road

Clifton Park,

New York 12065

Email: mail@pltw.org

www.pltw.org

© 2006 Project Lead The Way

Pathway To Engineering Foundation Course

Introduction to Engineering Design

Students use a problem-solving model to improve existing products and invent new ones. They learn how to apply this model to solve problems in and out of the classroom. Using sophisticated three-dimensional modeling software, students communicate the details of the products. Emphasis is placed on analyzing potential solutions and communicating ideas to others.

■ Sample Activity

Objective: Demonstrate the ability to generate a three-dimensional model.

Activity: Using the computer and a parametric modeling program, students design and create a unique model of a toy castle while applying the following functions: extrude, revolve, pattern, shell, and others.

■ Sample Project

Objective: Demonstrate the ability to research the chronological development and accelerating rate of change that innovations in tools and materials have produced as related to a given consumer product.

Project: Two-person student design teams select, research, and trace the design changes of a product since its development. Each team evaluates the effect this product has had on the environment, society, and their own personal lives. Teams present their findings during a three- to five-minute class presentation.

■ Sample Problem

Objective: Experience the creative thinking process through the use of vertical and lateral thinking; identifying, categorizing, and selecting a solution to a problem; and communicating that solution in written and verbal formats.

Problem: Assuming the role of a design team for a leading packaging company, students design a package for the “Note”orious paper clip. The manufacturer’s marketing department requires a portfolio of the design team’s preliminary conceptual ideas before further work is completed.

This portfolio should include a record of brainstorming activities and a minimum of six preliminary sketches with color(s), including an annotated, detailed, and rendered sketch of the team’s favorite idea. In addition, the team must prepare a letter to the marketing department explaining how their solution meets the requirements of protecting and transporting the “Note”orious paper clip.

Pathway To Engineering

The PLTW Curriculum: How and Why it Works

All PLTW high school courses have several underlying content areas in common. As students progress through the sequence they will become proficient in:

- working as a contributing member of a team
- leading a team
- using appropriate written and/or visual mediums to communicate with a wide variety of audiences
- public speaking
- listening to the needs and ideas of others
- understanding the potential impact their ideas and products may have on society
- thinking
- problem solving
- managing time, resources and projects
- researching
- going beyond the classroom for answers
- data collection and analysis
- preparing for two-and four-year college programs.

PLTW's curriculum makes math and science relevant for students. By engaging in hands-on, real-world projects, students understand how the skills they are learning in the classroom can be applied in everyday life. This approach is called activities-based learning, project-based learning, and problem-based learning or APPB-learning. Research shows that schools practicing APPB-learning experience an increase in student motivation, an increase in cooperative learning skills and higher-order thinking, and an improvement in student achievement.

Activities are a method of instruction that involves directed teaching of a particular process or procedure. Activities engage students in learning skills that are later applied in more complex situations. Activities lead students to higher levels of learning.

Project-based learning is a comprehensive approach to instruction that presents a project or relevant activity that enables students to synthesize knowledge and to individually resolve problems in a curricular context.

Problem-based learning is both a curriculum organizer and an instructional strategy that presents a problem, which is relevant and related to the context where students are the stakeholders. Students synthesize and construct knowledge to help them actively grapple with the complexities of the problem and develop strategies to direct their own learning. When students experience a problem in context, they are more likely to make connections and thus see the value in what they are learning.



*Forging new
generations of
engineers*

Phone: 518-877-6491

Fax: 518-877-6260

747 Pierce Road

Clifton Park,

New York 12065

Email: mail@pltw.org

www.pltw.org

© 2006 Project Lead The Way

Pathway To Engineering Foundation Course

Principles of Engineering

This introductory course explores the wide variety of careers in engineering and technology and covers various technology systems and manufacturing processes. Using activities, projects, and problems, students learn first hand how engineers and technicians use math, science, and technology in an engineering problem-solving process to benefit people. The course also addresses concerns about social and political consequences of technological change.

■ Sample Activity

Objective: Students will learn key concepts of visual communication to design and create tables, charts, and graphs to illustrate data.

Activity: A table of numbers supplied by the teacher shows the results of a driver education experiment. The experiment measures the time between the appearance of a stimulus on a screen and a student's reaction of depressing the brake pedal. Use this data in Excel to create a Histogram.

■ Sample Project

Objective: Students will use knowledge of material properties and the effects of stress to build support structures. They will explain why their structure should withstand a given load and where weaknesses may occur.

Project: Using the skills students have developed through experiences of working with trusses and bridges, students will design and construct a bridge made from balsa wood. They will follow-up their first project by working in teams of two and will design and build a truss bridge to withstand the largest load while minimizing the bridge weight.

■ Sample Problem

Objectives: Students will apply concepts of mechanical, electrical, and control systems in a design problem.

Problem: Acting as engineers, student partners are asked to design an automated separation system that simulates the separation process used in an industrial recycling plant. The system the team designs must include the following sub-systems: Hopper System, Transport System, Sensing System, Bin System, and Computer Program.



*Forging new
generations of
engineers*

Pathway To Engineering Foundation Course

Digital Electronics

This course in applied logic encompasses the application of electronic circuits and devices. Students use computer simulation software to design and test digital circuitry prior to the actual construction of circuits and devices.

■ Sample Activity

Objective: Students will learn about the basic principles of the atom, how electrons flow, and how the various components work in an electrical circuit.

Activity: Using simulation software, students will build and run circuits based on a circuit diagram, and label the four major components.

■ Sample Activity

Objective: Students will learn and understand the relationship between a Karnaugh Map and a Boolean Expression.

Activity: Students will use Boolean rules and theorems to simplify a logic equation mathematically. They will simplify Boolean expressions and create a Karnaugh Map (K-Map).

■ Sample Activity

Objective: Students will program and use a Basic Stamp to create frequencies to output sound to an amplifier.

Activity: Students will be introduced to the concepts necessary to create music using the Basic Stamp and learn how this is used in the commercial development of musical greeting cards.

Phone: 518-877-6491

Fax: 518-877-6260

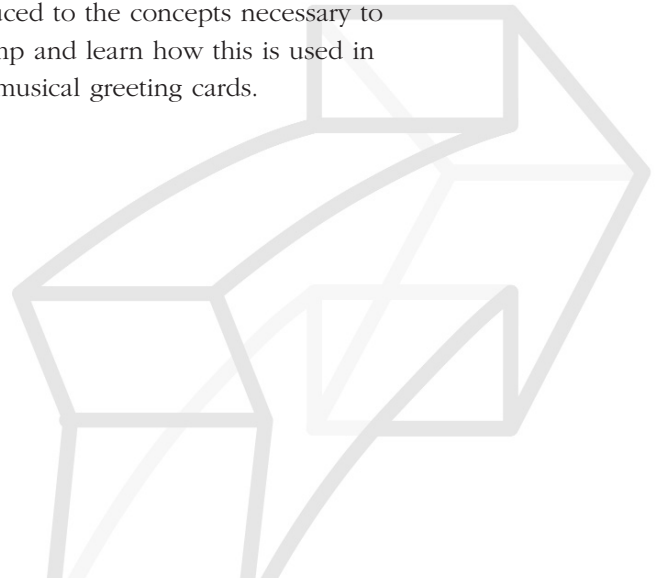
747 Pierce Road

Clifton Park,

New York 12065

Email: mail@pltw.org

www.pltw.org





*Forging new
generations of
engineers*

Phone: 518-877-6491

Fax: 518-877-6260

747 Pierce Road

Clifton Park,

New York 12065

Email: mail@pltw.org

www.pltw.org

© 2006 Project Lead The Way

Pathway To Engineering Specialization Course

Computer Integrated Manufacturing

Students take the three-dimension modeling software skills learned in Introduction to Engineering Design to a whole new level. Using a three-dimensional model, students use automation, control systems, sensing devices, computer programming and robotics to efficiently mass produce products. Trouble-shooting is emphasized throughout the course.

■ Sample Activity

Objective: Demonstrate a fundamental knowledge of programming and the importance of accuracy and repeatability using the Scorbot IV through a Pick-and-Place routine.

Activity: Use the Scorbot to perform the following steps:

- Program the Scorbot to select a hex nut from any one of the four initial starting locations labeled A, B, C, and D
- Move the hex nut in a vertical direction of sufficient distance to clear the pegs
- Move the hex nut in the X-Y plane to a location above the corresponding peg, labeled A1, B1, C1, and D1
- Lower the hex nut over the peg
- Open the gripper so that the hex nut rests flat on the base, centered on the peg.

■ Sample Project

Objective: Apply knowledge of the following concepts: mass properties, area, extrusion, cylinder, assembly constraints, cubic measurements, fillets and volume to mill a jewelry box.

Project: Teams of two students will design a jewelry box with a recessed lid. Each team is given the same size blank. The team is required to design an internal cavity of a specified size, which is a percentage of the total volume of the blank.

(Continued on Page 2)



*Forging new
generations of
engineers*

Phone: 518-877-6491
 Fax: 518-877-6260
 747 Pierce Road
 Clifton Park,
 New York 12065
 Email: mail@pltw.org
www.pltw.org

© 2006 Project Lead The Way

Pathway To Engineering Specialization Course

Page 2

Computer Integrated Manufacturing

■ Sample Problem

Objective 1: Students identify and study the relationship between a CNC milling machine interface and a jointed arm robot interface through communication handshaking processes. They explore the individual components used in selected Computer Integrated Manufacturing (CIM) systems and analyze and select components for a CIM system for a specific industrial application, along with the necessary safety precautions.

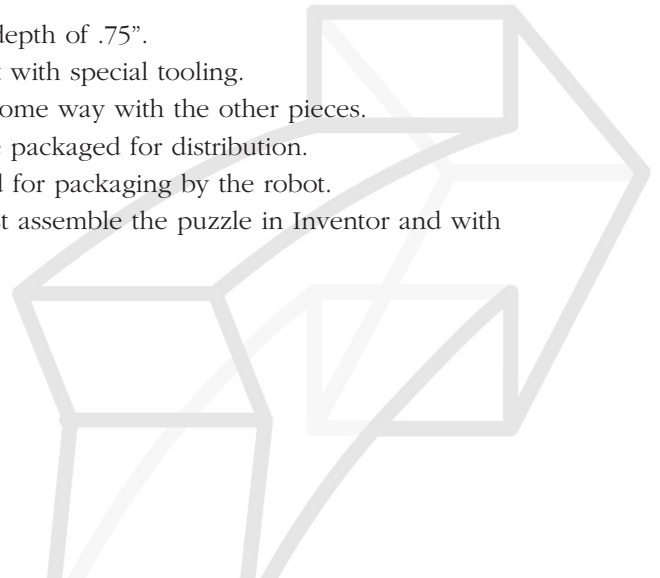
Objective 2: Students grasp the various applications of a Programmable Logic Controller as related to its use in a CIM system.

Objective 3: Students recognize and explain the significance of teamwork and communication. Each student assembles and tests his or her individual component designs by integrating them into a complete miniature FMS (flexible manufacturing system) built from the Fischertechnik models. The students then explain how their individual components work together to form a complete CIM system.

Problem: Students assume the role of project engineers who have been asked to work in a two-person team using the robot to design and produce a three-dimensional puzzle.

Each puzzle must meet the following requirements:

1. Each part must have a minimum of three levels of cutting.
2. One surface must be curved.
3. Tools can cut to a maximum depth of .75".
4. Certain angles can only be cut with special tooling.
5. Each piece must interlock in some way with the other pieces.
6. The pieces must be able to be packaged for distribution.
7. The pieces must be assembled for packaging by the robot.
8. Each person in the group must assemble the puzzle in Inventor and with the robot.





*Forging new
generations of
engineers*

Pathway To Engineering Specialization Course

Biotechnical Engineering

Curriculum Published in 2006

Students are exposed to the diverse fields of bio-technology including bio-medical engineering and genetics, bio-process engineering, agricultural and environmental engineering. Lessons engage students in engineering design problems that can be accomplished in a high school setting. Such problem will relate to biomechanics, cardiovascular engineering, genetic engineering, agricultural biotechnology, tissue engineering, biomedical devices, human interface, bioprocesses, forensics, and bio-ethics.

■ Sample Project

Objective: Through studying technological advances necessary for the identification and processing of DNA, students will learn how engineers play a vital role in supporting forensic professionals.

Project: In this project, students are Crime Scene Investigators (CSI). A crime has been committed, and as part of a CSI team, students must secure the crime scene, and collect evidence. Students will apply everything learned about DNA, forensics, technology, problem solving, and the use of the design process for engineering solutions in order to solve the murder mystery.

Phone: 518-877-6491

Fax: 518-877-6260

747 Pierce Road

Clifton Park,

New York 12065

Email: mail@pltw.org

www.pltw.org





*Forging new
generations of
engineers*

Pathway To Engineering Specialization Course

Aerospace Engineering

Curriculum Published in 2006

Students are introduced to the world of aeronautics, flight, and engineering through PLTW activity-based, project-based, and problem-based learning by exploring the world of aerospace engineering. Students should have experience in physics, mathematics, and engineering and technology education. Engineering and scientific concepts are used to find solutions to aerospace problems. The entire curriculum sequence will include experiences from the diverse fields of Aeronautics, Aerospace Engineering, and related areas of study. Students will be engaged in lessons about engineering design problems related to aerospace information systems, astronautics, rocketry, propulsion, space life sciences, principles of aeronautics, systems engineering, and more. The course of study includes history of flight, aerodynamics and aerodynamics testing, flight systems, astronautics, space life systems, aerospace materials, and systems engineering.

■ Sample Project

Objective: Demonstrate the ability to verify designs by the construction and testing of prototypes and models.

Project: Students will be introduced to wind tunnels, airfoils (a major component of airplanes, helping a plane to liftoff), and how both function based on their design. Airfoil designs vary by airplane, depending on the function of the plane, its size, and the distance and speed at which it is expected to maneuver. Students will be given the opportunity to design and test an airfoil, experiencing the work involved in aerospace engineering.

Phone: 518-877-6491

Fax: 518-877-6260

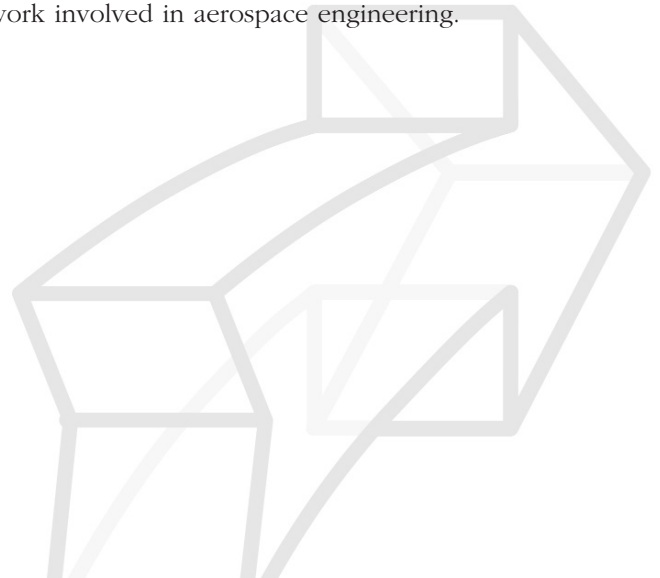
747 Pierce Road

Clifton Park,

New York 12065

Email: mail@pltw.org

www.pltw.org





*Forging new
generations of
engineers*

Phone: 518-877-6491

Fax: 518-877-6260

747 Pierce Road

Clifton Park,

New York 12065

Email: mail@pltw.org

www.pltw.org

© 2006 Project Lead The Way

Pathway To Engineering Specialization Course

Civil Engineering and Architecture

This overview of the fields of civil engineering and architecture emphasizes the inter-relationship and mutual dependence of both fields. Students use state-of-the-art software to solve real world problems and apply knowledge to hands-on projects and activities. By developing and implementing plans for a playground/park or vacation home for example, students experience firsthand the job responsibilities of architects and civil engineers. By the end of the course, students are able to give a complete presentation to the client including three-dimensional renderings of buildings and improvements, zoning and ordinance constraints, infrastructure requirements, and other essential project plans.

■ Sample Activity

Objective: Learn the design process an architect or civil engineer employs when designing a project for a client and use computer software to create and document the structure.

Activity: Design a small playhouse for a local day-care center. The inside of the playhouse can be no larger than 100 square feet and must feature an extruded roof and other design components, such as a column or railing. Wall height of the playhouse may be up to eight feet. Before starting the design on the computer, students must determine interior and exterior building materials (e.g. gypsum wallboard and siding) and create a detailed sketch of the floor plan, front elevation, and a side elevation including dimensions. Once the playhouse is designed using the three-dimensional modeling software, students are required to print a floor plan with permanent dimensions, two elevation views (front and side), and a rendered scene including the structure, plantings, and people.

■ Sample Project

Objective: Demonstrate knowledge of sound design elements and land use constraints to develop a land use project plan.

Project: Student teams research the various options for projects given the constraints of the site. For example, a team may decide to: develop a resort area; renovate an existing building and surrounding area; or develop a piece of property for green space with related buildings and access points, such as a parking lot. Teams investigate zoning regulations and any additional constraints on the property they want to develop.

(Continued on Page 2)



*Forging new
generations of
engineers*

Pathway To Engineering Specialization Course

Page 2

Civil Engineering and Architecture

■ Sample Problem

Objective: Communicate the current common practices utilized in civil engineering and architecture and apply them to develop a viable solution to the project. In addition, identify the criteria and constraints, and gather information to promote viable decisions regarding the development of the solution.

Problem: Two-person student teams design a vacation home for a client who has inherited a piece of lake front property. The property has the following restrictions created by the property owners association:

- No structure can be more than 400 square-feet.
- All structures must be at least 100 feet from the nearest water.
- Structures are limited to a single story.
- There must be a 10-foot egress from edge of road.
- There must be a 10-foot clearance from boundary lines.
- There must be off-street parking to accommodate two cars.

Team members alternately assume the role of architect and client for their partner. As architects, students review the existing lake property site plan and interview the client. The clients use a class-developed client survey to determine how they wish to use the structure. Students are required to record all meeting notes in journals. In addition, students must make a list of rooms and their potential sizes; use sketches to communicate with each other; and prepare a bubble diagram and review the use of space with the client, recording data on any changes in the journal. From the bubble diagram, students produce a modified plot plan, floor plan, elevations, and renderings in order to prepare for client presentations, which are made to the class. Any changes made throughout the process must be documented in the journal and signed by the client before the plans are revised.

Phone: 518-877-6491

Fax: 518-877-6260

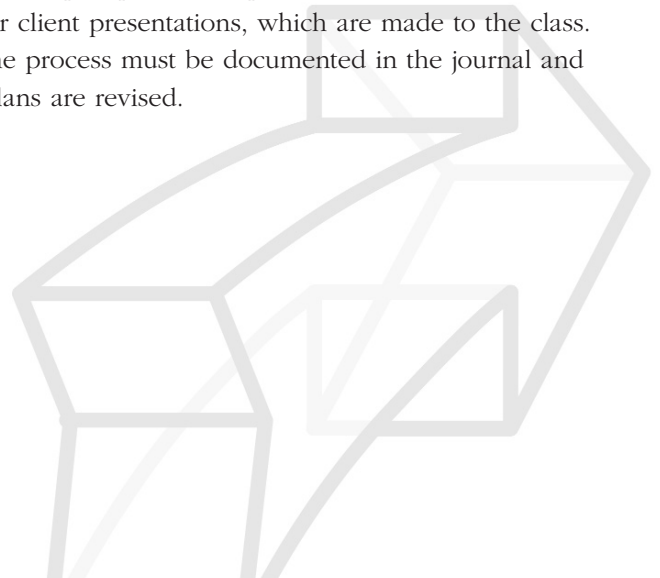
747 Pierce Road

Clifton Park,

New York 12065

Email: mail@pltw.org

www.pltw.org





*Forging new
generations of
engineers*

Pathway To Engineering Capstone Course

Engineering Design and Development

In this capstone course, teams of students spend the year solving problems of their own choosing. The teams apply principles developed in the four preceding PLTW core courses and are guided by a community mentor. They brainstorm possibilities, research current patents and regulations, construct a working model, test the model in real life situations (or simulation), document their designs, and present and defend the design to a panel of experts.

■ Sample Activity

Due to the nature of the capstone course, the use of activities is limited to those necessary to solve the problem the student or students have selected.

■ Sample Project

Projects are incorporated that enable students to apply prior knowledge in a new context or as needed in solving their chosen problem.

■ Sample Problem

The major focus of the course is the use of problem-based learning as experienced by engineers on a daily basis. Problems that have been investigated by students in the course include: a system which allows a person to adjust the height of a bicycle seat while riding the bike; a pool pump with an automatic backwash system; an open ended wrench that ratchets (for working in tight spaces); and a moisture sensing system programmed to close a window when it rains.

(Continued on Page 2)



Phone: 518-877-6491

Fax: 518-877-6260

747 Pierce Road

Clifton Park,

New York 12065

Email: mail@pltw.org

www.pltw.org



*Forging new
generations of
engineers*

Pathway To Engineering Capstone Course

Page 2

Engineering Design and Development

Here is an example of one problem students will encounter during the course:

Objective: Students will create and justify a process for testing their prototype design that will yield valid data concerning the design's attempt at solving their problem statement.

Problem: The students will design, develop and test a prototype of their solution using the Criteria for Engineering Design, Prototype Testing Guide Sheet, and Prototype Procedure worksheet. They will use their test results to revisit and optimize their design.

Result: Students who successfully complete the course will:

1. Create a working prototype of a product that solves a specific problem.
2. Write a product report outlining the work done on the pathway to developing the product.
3. Assemble a portfolio including the engineering journal, product report, drawings, data, meeting notes, etc.
4. Create and deliver a multimedia presentation and design defense to a live audience and panel of experts.

Benefits: College recruiters, scholarship committees, and industry professionals view a comprehensive and intensive student-driven project of this nature as a tremendous achievement, clearly demonstrating a student's capacity for demanding, college-level engineering coursework.

Phone: 518-877-6491

Fax: 518-877-6260

747 Pierce Road

Clifton Park,

New York 12065

Email: mail@pltw.org

www.pltw.org





*Forging new
generations of
engineers*

Middle School Program

Gateway To Technology

Gateway To Technology consists of five independent units that should be taught in conjunction with a rigorous academic curriculum. The units are designed to challenge and engage the exploratory minds of middle school students. Each nine-week unit contains performance objectives and suggested assessment methods. The five units are:

Design and Modeling

This unit uses solid modeling (a sophisticated mathematical technique for representing solid objects) to introduce students to the design process. Using this design approach, students understand how solid modeling has influenced their lives. Students also learn sketching techniques and use descriptive geometry as a component of design, measurement, and computer modeling. Using design briefs or abstracts, students create models and documentation to solve problems.

The Magic of Electrons

Through hands-on projects, students explore the science of electricity, the movement of atoms, circuit design, and sensing devices. Students acquire knowledge and skills in basic circuitry design and explore the impact of electricity on our lives.

The Science of Technology

This unit traces how science has affected technology throughout history. Students learn about the mechanics of motion, the conversion of energy, and the use of science to improve communication.

Automation and Robotics

Students trace the history and development of automation and robotics. They learn about structures, energy transfer, machine automation, and computer control systems. Students acquire knowledge and skills in engineering problem solving and explore requirements for careers in engineering.

Flight and Space

The purpose of this unit is to introduce the student to aeronautics, space, and the use of design used to help make aerospace engineering an important field. They learn about Newton's Laws of Motion, forces, rockets, propulsion, and what makes things fly. Students acquire and apply knowledge and skills in engineering problem solving and explore the many aspects of aerospace engineering.

Phone: 518-877-6491

Fax: 518-877-6260

747 Pierce Road

Clifton Park,

New York 12065

Email: mail@pltw.org

www.pltw.org

Gateway To Technology

The PLTW Curriculum: How and Why it Works

All PLTW middle school courses have several underlying content areas in common. As students progress through the sequence they will become proficient in:

- working as a contributing member of a team
- leading a team
- using appropriate written and/or visual mediums to communicate with a wide variety of audiences
- public speaking
- listening to the needs and ideas of others
- understanding the potential impact their ideas and products may have on society
- thinking
- problem solving
- managing time, resources and projects
- researching
- going beyond the classroom for answers
- data collection and analysis
- preparing for two-and four-year college programs.

PLTW's curriculum makes math and science relevant for students. By engaging in hands-on, real-world projects, students understand how the skills they are learning in the classroom can be applied in everyday life. This approach is called activities-based learning, project-based learning, and problem-based learning or APPB-learning. Research shows that schools practicing APPB-learning experience an increase in student motivation, an increase in cooperative learning skills and higher-order thinking, and an improvement in student achievement.

Activities are a method of instruction that involves directed teaching of a particular process or procedure. Activities engage students in learning skills that are later applied in more complex situations. Activities lead students to higher levels of learning.

Project-based learning is a comprehensive approach to instruction that presents a project or relevant activity that enables students to synthesize knowledge and to individually resolve problems in a curricular context.

Problem-based learning is both a curriculum organizer and an instructional strategy that presents a problem, which is relevant and related to the context where students are the stakeholders. Students synthesize and construct knowledge to help them actively grapple with the complexities of the problem and develop strategies to direct their own learning. When students experience a problem in context, they are more likely to make connections and thus see the value in what they are learning.