NEW YORK STATE EDUCATION DEPARTMENT
MIDDLE LEVEL CAREER AND TECHNICAL EDUCATION

PROBLEM SOLVING AND INNOVATION THEME MODULE

UPDATED JUNE 2023

MODULE DESCRIPTION

This module introduces students to problem-solving methods and research. Problem solving can be proactive through design or reactive through troubleshooting. This module will relate invention and innovation to problem solving processes. Students will learn to acquire, critically evaluate, and apply the products of research to make informed problem-solving decisions. Problem-solving skills are essential for all students to develop; they can use formal, iterative, and systemic approaches to solve real-world problems. Current issues related to problem-solving processes, research processes, information access, and information literacy will be examined. Students will have the opportunity to explore the wide variety of career options related to technological invention, innovation, and research and identify the knowledge, skills, education, and training necessary for success within these fields.

GUIDING QUESTION

What knowledge and skills are necessary to demonstrate introductory understanding of the application of problem-solving processes and the acquisition, evaluation, and application of the products of research for informed decision making?

MODULE CONTENT

1. PROBLEM SOLVING

Students will:

a. Describe the scientific method of inquiry as it relates to real-world problem solving
b. Define technological problem solving in the context of design and troubleshooting
c. Define invention as new designs for technologies and systems
d. Define innovation as new applications for existing technologies and systems
e. Demonstrate personal development of problem-solving skills through practice of these skills in a variety of classroom applications

2. DESIGN PROCESS (PROACTIVE)

Students will:

a.   Implement a formal design process to solve a given problem by:
     1. Defining the problem being addressed
     2. Defining criteria that must be met through the finished design
     3. Defining constraints that must be adhered to
     4. Brainstorming and examining possible solutions
     5. Selecting the best solution for evaluation
     6. Developing and constructing a prototype or model of the selected design

7. Testing and evaluating the prototype and model against the design criteria and constraints
8. Optimizing the solution for best form and function
9. Evaluating their use of the design process and how it impacted their final solutions
10. Demonstrate personal development of design skills through practice of these skills in a variety of classroom applications

3. TROUBLESHOOTING PROCESS (REACTIVE)

Students will:

a.   Implement a formal troubleshooting process to solve a given problem by
1. Defining the problem being addressed
2. Identifying criteria and specifications for the desired outcomes or operation
3. Testing and evaluating to isolate the problem
4. Correcting the problem by implementing changes or repairs
5. Validating that the corrective action produced desired outcomes or operation
6. Identifying strategies to prevent future problems
b.   Demonstrate personal development of troubleshooting skills through practice of these skills in a variety of classroom applications

4. RESEARCH APPLICATIONS IN CTE

Students will:

a.   Locate and gather information about a problem by:
1. defining the problem being researched
2. Utilizing search tools to locate information, data, or reference materials
3. Implementing search-refinement tools (such as Boolean functions and keywords to narrow results)
4. Saving, archiving, or bookmarking information sources for future retrieval
b.   Evaluate information sources for value and applicability toward a problem, by:
1. Identifying the source of the information, data, and reference material
2. Evaluating the source to determine if the author(s) or publisher can be considered an authoritative source for the desired content
3. Evaluating the value of the of research sources toward a given problem
c.   Apply the products of research for informed decisions by
1. Locating and retrieving information, data, or reference materials to be applied to a given problem
2. Applying the research sources for decision making when solving a given problem
3. Rationalizing the selection of sources used in problem solving when differing or conflicting sources are found
4. Crediting information sources when documenting the results of a problem-solving effort
d. Demonstrate personal development of research application skills through practice of these skills in a variety of classroom applications

5. CAREERS IN PROBLEM SOLVING, INVENTION, AND INNOVATION

Students will:

a.   Investigate knowledge, skills, and practices needed for a career utilizing problem solving, invention, and innovation skills
b.   Analyze career paths requiring skills for problem solving, invention, and innovation
c.   Evaluate personal skills, abilities, and interests for employment opportunities utilizing skills for problem solving, invention, and innovation

ILLUSTRATIVE ACTIVITIES BY CTE CONTENT AREA

AGRICULTURAL EDUCATION

FAULTY SYSTEM

Students identify a system that is not functioning properly. Students observe, identify and document the individual system components, how they operate, and how they interact. Students locate the system component that is not functioning, implement a change or repair, and evaluate the system to ensure that it is functioning properly. Students document the repair and propose preventive maintenance solutions.

BUSINESS AND MARKETING EDUCATION

COMMON COMPUTER PROBLEMS

Prepare a list of the most common computer and technology problems students encounter in class daily. Divide the class into small teams. Pass out copies of the common problems. Have each team complete a troubleshooting process and prepare a write-up showing how to solve one of the common problems. Have a different team apply the solution to determine whether the corrective action solved the problem and led to the desired outcome.

COMPUTER SCIENCE AND INFORMATION TECHNOLOGY

INQUIRY BASED DATA INVESTIGATION

Students will engage in the problem-solving process by collecting and analyzing data to develop an informed solution to be demonstrated through an artifact such as a flowchart or coding.

FAMILY AND CONSUMER SCIENCES EDUCATION

REWORKING SPACES

Students work with the school leaders to identify areas in their school that are not functioning well due to space issues. Examples might be slow-moving cafeteria lines, overcrowded storage areas for sports,

or music equipment, lack of classroom space for group work, etc. Students apply the design process to create plans to rework the spaces to improve functioning. Students present their interior design plans to school leaders for consideration and possible implementation.

HEALTH SCIENCE EDUCATION

MEDICAL INVENTIONS

Students identify medical inventions that have had an impact on human life. Students research information on how the invention was developed and what desirable and undesirable impacts it created. Students create a report and/or presentation that includes multiple information sources.

TECHNOLOGY EDUCATION

DEVELOPING PROTOTYPES

Students identify a problem that requires a designed solution such as a new product that can be made from recycled materials. Students develop a problem statement, constraints and parameters, and proposed solutions. Students develop a model or prototype for testing and optimization, record the process, and present results. Examples of design problems could include a structure, a household item, a planting container, or others.

TRADE AND TECHNICAL EDUCATION

BRAND LOGOS

Students define the term "branding" and examine the role of the graphic designer in the development of brand logos. Students will trace the design changes in a company's logo over time and research company innovations that led to these design changes.

STANDARDS ADDRESSED

NEW YORK STATE CAREER DEVELOPMENT AND OCCUPATIONAL STUDIES (CDOS) STANDARDS

Intermediate Level

Standard 1: Career Development

Students will be knowledgeable about the world of work, explore career options, and relate personal skills, aptitudes, and abilities to future career decisions

Standard 2: Integrated Learning

Students will demonstrate how academic knowledge and skills are applied in the workplace and other settings

Standard 3a: Universal Foundation Skills

Students will demonstrate mastery of the foundation skills and competencies essential for success in the workplace

COMMON CAREER TECHNICAL CORE STANDARDS

Career Ready Practices

1.   Act as a responsible and contributing citizen and employee
2.   Apply appropriate and academic and technical skills
4.   Communicate clearly and effectively and with reason
5.   Consider environmental, social, and economic impacts of decisions
6.   Demonstrate creativity and innovation
7.   Employ valid and reliable research strategies
8.   Utilize critical thinking to make sense of problems and persevere in solving them
11.   Use technology to enhance productivity
12.   Work productively in teams while using cultural global competence

CONTENT AREA STANDARDS

NATIONAL AGRICULTURAL EDUCATION STANDARDS

https://thecouncil.ffa.org/afnr/

PST.01 Apply physical science principles and engineering applications to solve problems and improve performance AFNR power, structural, and technical systems
CRP.02 Apply appropriate academic and technical skills
CRP.06 Demonstrate creativity and innovation
CRP.07 Employ valid and reliable research strategies
CRP.08 Utilize critical thinking to make sense of problems and persevere in solving them
CRP.11 Use technology to enhance productivity
Note: National Agricultural Education Standards CRP .01-.12 coincide with Common Core Technical Core Standards

NATIONAL BUSINESS EDUCATION STANDARDS

https://nbea.org/general/custom.asp?page=BusinessEdStandards
Computation
      I. Mathematical Foundations Achievement Standard
            Apply basic mathematical operations to solve problems
      II. Number Relationships and Operations Achievement Standard
            Solve problems involving whole numbers, decimals, fractions, percents, ratios, averages, and proportions
      III. Patterns, Functions, and Algebra
            Use algebraic operations to solve problems
      V. Measurements Achievement Standard
            Use common international standards of measurement when solving problems
      V. Statistics and Probability Achievement Standard
            Analyze and interpret data using common statistical procedures
      VI. Problem-Solving Applications Achievement Standard

Use mathematical procedures to analyze and solve business problems

NATIONAL FAMILY AND CONSUMER SCIENCES STANDARDS

3.0 Consumer Services

Integrate knowledge, skills, and practices needed for a career in consumer services

3.5   Demonstrate skills needed for product development, testing, and presentation

3.5.1   Conduct market research to determine consumer trends and product development needs

3.5.2   Design or analyze a consumer product

3.5.3   Analyze features, prices, product information, styles, and performance of consumer goods for potential global impact and trade-offs among the components

11.0 Housing and Interior Design

Integrate knowledge, skills, and practices needed for a career in housing and interior design

11.3   Apply residential and commercial interior design knowledge, skills and processes to meet specific design needs

11.3.6   Demonstrate design processes such as determining the scope of the project, programming, research, concept development, schematic design, design drawing, and design development and presentation

11.5   Analyze design and development of architecture, interiors, and furnishings through the ages

11.5.5   Predict future design and development trends in architecture, interiors, and furnishings

16.0 Textiles, Fashion, and Apparel

Integrate knowledge, skills, and practices needed for a career in textiles, fashion, and apparel

16.3   Demonstrate textiles, fashion, and apparel design skills

16.3.4   Demonstrate design concepts using fiber, fabric, or digital means, employing draping and/or flat pattern making techniques

16.3.7   Demonstrate ability to use technology for fashion, apparel, and textile design

NATIONAL CONSORTIUM FOR HEALTH SCIENCE EDUCATION

Foundation Standard 11: Information Technology Applications

Utilize and understand information technology applications common across health professions

11.3   Basic Computer Skills

11.31   Apply basic computer concepts and terminology necessary to use computers and other mobile devices

11.32   Demonstrate basic computer troubleshooting procedures

11.33   Demonstrate use of file organization and information storage

11.34   Identify uses of basic word processing, spreadsheet, and database applications

11.35   Evaluate validity of web-based resources

ITEEA STANDARDS

Design

8.   Students will develop an understanding of the attributes of design

E. Design is a creative planning process that leads to useful products and systems
F. There is no perfect design
G. Requirements for a design are made up of criteria and constraints

9. Students will develop an understanding of engineering design
F. Design involves a set of steps which can be performed in different sequences and repeated as needed
G. Brainstorming is a group problem-solving design process in which each person in the group presents his or her ideas in an open forum
H. Modeling, testing, evaluating, and modifying are used to transform ideas into practical solutions

10. Students will develop an understanding of the role of troubleshooting, research and development, invention, innovation, and experimentation in problem solving
F. Troubleshooting is a problem-solving method used to identify the cause of a malfunction in a technological system
G. Invention is a process of turning ideas and imagination into devices and systems. Innovation is the process of modifying an existing product or system to improve it
H. Some technological problems are best solved through experimentation

Abilities for a Technological World
11. Students will develop abilities to apply the design process
H. Apply a design process to solve problems in and beyond the laboratory-classroom
I. Specify criteria and constraints for the design
J. Make two-dimensional and three-dimensional representations of the designed solution
K. Test and evaluate the design in relation to pre-established requirements, such as criteria and constraints, and refine as needed
L. Make a product or system and document the solution

USDOE EMPLOYABILITY SKILLS

http://cte.ed.gov/employability skills/

Applied Knowledge: Applied Academic Skills, Critical Thinking Skills
The thoughtful integration of academic knowledge and technical skills put to practical use

Effective Relationships: Interpersonal Skills, Personal Qualities
The skills that enable individuals to interact effectively with clients, coworkers, and supervisors

Workplace Skills: Resource Management, Information Use, Communication Skills, Systems Thinking, Technology Use
The skills employees need to successfully perform work tasks

RESOURCES

UNITED STATES DEPARTMENT OF EDUCATION GREEN STRIDES: ENVIRONMENT, HEALTH, AND FACILITIES AT ED
STEM PROGRAMS AT ED

https://www2.ed.gov/about/inits/ed/green-strides/stem.html

Federal resources are helping to assist educators in implementing effective approaches for improving STEM teaching and learning; facilitating the dissemination and adoption of effective STEM instructional practices nationwide; and promoting STEM education experiences that prioritize hands-on learning to increase student engagement and achievement.

BROOKINGS INSTITUTE TEACHING PROBLEM SOLVING: LET STUDENTS GET 'STUCK' AND 'UNSTUCK'

https://www.brookings.edu/blog/education-plus-development/2017/10/31/teaching-problem-solving-let-students-get-stuck-and-unstuck/

This is a resource describing ways to create a classroom culture of problem solvers.

TED ED

https://ed.ted.com/lessons?category=problem-solving

TEDEd has an extensive website section dedicated to problem solving skills including videos and interactive tasks. Teachers can use these free materials as resources to build lessons for their individual CTE classrooms.

THE HENRY FORD

https://www.thehenryford.org/education/teaching-innovation/innovation-101/

Online education modules that combine lesson plans and active teaching and learning resources, including oral history interviews, to ignite the imagination of future innovators.

CAREER AND TECHNICAL EDUCATION TECHNICAL ASSISTANCE CENTER OF NEW YORK (CTE TAC)

http://nyctecenter.org/

The Career and Technical Education Technical Assistance Center (CTE TAC) operates under a state contract to assist the New York State Education Department (NYSED) in carrying out its mission of improving the quality, access, and delivery of career and technical education through research-based methods and strategies resulting in broader CTE opportunities for all students.