Performance Objective
Upon completion of this lesson, each student will apply concepts of critical thinking and problem solving using the mathematical modeling concept to solve a Mathematical Modeling Real-World Problem.

Specific Objectives
- Demonstrate the use of critical-thinking and problem-solving skills.
- Conduct technical research.
- Analyze information for problem-solving tasks.
- Evaluate alternatives using problem-solving and critical-thinking skills.
- Develop a creative and innovative solution.

Terms
- **2-Credit Course**
  - 90-minute (or two 45-minute) lab-based class (training plan *should* be on file if students leave campus).
  - OR
  - At least 45 minutes of daily instruction time and 10 hours per week average work required (like a career preparation class with a paid or unpaid training plan on file for the work portion).
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  - OR
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- **Alternatives** – two or more available possibilities to a problem.
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- **Innovative** – a person introducing new ideas; original and creative thinking.
- **Mathematical Modeling** – mathematical concept used to solve real-world problems.
• **Practicum** – designed to be a capstone experience, providing supervised practical application of knowledge and skills following a coherent sequence of courses.

• **Problem solving** – the process of working through details of a problem to reach a solution; it may include mathematical or systematic operations.

• **Solution** – a means of solving a problem or dealing with a difficult situation.

• **STEM** – stands for a cluster of careers in the fields of Science, Technology, Engineering, and Mathematics.

• **Technical research** – aimed at developing tools, testing equipment and procedures, and providing solutions to specific technical problems.

**Time**
This four-week lesson should take 540-900 minutes. Teachers may choose to compact the lesson into 540 minutes (three 45-minute classes; 135 minutes/week).

- Week 1: Introduction and Overview of the Mathematical Modeling Process, 135-225 minutes
- Week 2: Research and construct *Mathematical Modeling Real-World Problem*, 135-225 minutes
- Week 3: Validate *Mathematical Modeling Real-World Problem*, 135-225 minutes
- Week 4: Implementation and presentation of *Mathematical Modeling Real-World Problem* 135-225 minutes

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### Preparation

**TEKS Correlations**
This lesson, as published, correlates to the following TEKS. Any changes/alterations to the activities may result in the elimination of any or all of the TEKS listed.

**Practicum in Science, Technology, Engineering, and Mathematics**

- **130.374 (c)**
  - (1) The student demonstrates professional standards as required by business and industry. The student is expected to:
    - (A) adhere to policies and procedures;
    - (B) demonstrate positive work behaviors and attitudes, including punctuality, time management, initiative, and cooperation;
    - (C) accept constructive criticism;
    - (D) apply ethical reasoning to a variety of situations in order to make ethical decisions;
    - (E) complete tasks with the highest standards to ensure quality products and services; and
    - (G) comply with practicum setting safety rules and regulations to maintain safe and healthful working conditions and environments.

- **130.374 (c)**
The student applies concepts of critical thinking and problem solving. The student is expected to:

(A) analyze elements of a problem to develop creative and innovative solutions;
(B) critically analyze information to determine value to the problem-solving task;
(C) compare and contrast alternatives using a variety of problem-solving and critical-thinking skills; and
(D) conduct technical research to gather information necessary for decision making.

130.374 (c)

The student demonstrates leadership and teamwork skills in collaborating with others to accomplish goals and objectives. The student is expected to:

(A) analyze leadership in relation to trust, positive attitude, integrity, and willingness to accept key responsibilities in a work situation;
(B) demonstrate teamwork skills through working cooperatively with others to achieve tasks;
(C) demonstrate teamwork processes that promote team building, consensus, continuous improvement, respect for the opinions of others, cooperation, adaptability, and conflict resolution;
(D) demonstrate responsibility for shared group and individual work tasks; and
(E) establish and maintain effective working relationships in order to accomplish objectives and tasks.

Interdisciplinary Correlations

English Language Arts and Reading, English I

110.31 (b)

Reading/Vocabulary Development. Students understand new vocabulary and use it when reading and writing. Students are expected to:

(G) use a dictionary, a glossary, or a thesaurus (printed or electronic) to determine or confirm the meanings of words and phrases, including their connotations and denotations, and their etymology.

Public Speaking I, II, III

110.57 (b)

Organization. The student organizes speeches. The student is expected to:

(A) apply knowledge of speech form to organize and design speeches;
(B) organize speeches effectively for specific topics, purposes, audiences, and occasions;
(C) choose logical patterns of organization for bodies of speech; and
Accommodations for Learning Differences
It is important that lessons accommodate the needs of every learner. These lessons may be modified to accommodate your students with learning differences by referring to the files found on the Special Populations page of this website (cte.unt.edu).

Preparation
- Review and become familiar with the terminology, website links, and the slide presentation.
- Have materials, slide presentation, and websites ready prior to the start of the lesson.
- Provide a *Mathematical Modeling Real-World Problem* to assign to the students.
- Allow the industry STEM practicum partner to identify a *Mathematical Modeling Real-World Problem* to assign the students.
- Teacher should search the Internet and select videos on the following topics: *Mathematical Modeling*, *Tradeoffs in Mathematical Modeling*, and *Error Analysis*.

References

Instructional Aids
- *Mathematical Modeling* slide presentation and notes
- *Notes Taking* form
- *Mathematical Modeling* videos

Materials Needed
- *Note Taking* form
- *Mathematical Modeling TEAM TASKS Guide*
- Pencils and Pens
- *STEM Practicum Terms and Definitions* handout for each student

Equipment Needed
- Computer for teacher
- Projector (for digital presentation)

Introduction
The main purpose of this lesson is to give students an opportunity to apply the concepts of *Mathematical Modeling* during the capstone experience.

- **Say**
  - During this lesson you will learn how to understand the problem-solving process; learn how to identify a problem; construct or select a mathematical model;
determine what data needs to be collected; test the validity of the selected model; and calculate solutions and implement the model. (Slide 7)

- **Say**
  - As you recall, the STEM Practicum is designed to be a capstone experience providing supervised practical application of knowledge and skills in Science, Technology, Engineering, and Mathematics.

- **Ask**
  - Why do you think Mathematical Modeling is necessary in the capstone experience?

- **Say**
  - You will understand the purpose of in the STEM Practicum and develop a solution for a real-world STEM problem by applying the concepts of Mathematical Modeling.

- **Show**
  - Mathematical Modeling slide presentation
<table>
<thead>
<tr>
<th>OUTLINE</th>
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</table>
| **I.** Introduce STEM Practicum  
  A. What is STEM?  
  B. What is a practicum?  
  C. STEM Practicum as a 2-credit course  
  D. STEM Practicum as a 3-credit course |
| **II.** STEM Practicum Course Objective  
  A. STEM Practicum lesson  
  B. Week 1  
  C. Week 2  
  D. Week 3  
  E. Week 4 |
| **III.** Week 1  
  A. Day 1 - Overview of the Mathematical Modeling Process and Mathematical Modeling videos  
  B. Day 2 - Overview of Problem-Solving Process and the Engineering Design Process  
  C. Day 3 - Establish Mathematical Modeling Teams  
  D. Day 3 and 4 - Select and begin researching a Mathematical Modeling Real-World Problem  
  E. Day 5 - Research and construct Mathematical Modeling Real-World Problem |
| **IV.** Week 2  
  A. Day 6 - Research and construct Mathematical Modeling Real-World Problem |

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<tr>
<th>NOTES TO TEACHER</th>
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<tbody>
<tr>
<td>Begin the Mathematical Modeling slide presentations. Students will use Notes Taking handout to record notes during slide presentation. (Slide 2)</td>
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<tr>
<td>Students will read all handouts. Students will complete assigned activities. Students will participate in group discussions and class activities.</td>
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<tr>
<td>Teacher selects videos from the Internet on Mathematical Modeling to show as an overview of the process. (Video topics: Introduction to Mathematical Modeling, Tradeoffs in Mathematical Modeling, and Error Analysis)</td>
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<tr>
<td>Week 1 can be covered in 135-225 minutes.</td>
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<tr>
<td>Students use the Mathematical Modeling TEAM TASKS Guide to document the name of the real problem, team members, tasks, who is responsible, and status of completion of the tasks.</td>
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<td>Week 2 can be covered in 135-225 minutes.</td>
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OUTLINE

IV. Week 2 (continued)
   B. Day 7 - Research and construct Mathematical Modeling Real-World Problem
   C. Day 8 - Research and construct Mathematical Modeling Real-World Problem
   D. Day 9 - Research and construct Mathematical Modeling Real-World Problem
   E. Day 10 - Validate Mathematical Modeling Real-World Problem

V. Week 3
   A. Day 11 - Validate Mathematical Modeling Real-World Problem
   B. Day 12 - Validate Mathematical Modeling Real-World Problem
   C. Day 13 - Validate Mathematical Modeling Real-World Problem
   D. Day 14 - Implement Mathematical Modeling Real-World Problem
   E. Day 15 - Implement Mathematical Modeling Real-World Problem

VI. Week 4
   Day 16 - Implement Mathematical Modeling Real-World Problem
   Day 17 - Implement Mathematical Modeling Real-World Problem
   Day 18 - Prepare for STEM Practicum Presentation
   Day 19 - Prepare for STEM Practicum Presentation
   Day 20 - STEM Practicum Team Presentations

NOTES TO TEACHER

Week 3 can be covered in 135-225 minutes.

Week 4 can be covered in 135-225 minutes.
Multiple Intelligences Guide

Guided Practice
- The teacher will present the Mathematical Modeling slide presentation and lead the class discussion.
- The teacher will identify a Mathematical Modeling Real-World Problem from the Internet or other source for students to consider for the assignment.
- The STEM Practicum industry partner will identify a Mathematical Modeling Real-World Problem from the Internet or other source for students to consider for the assignment.
- The teacher will allow the student teams to choose a Mathematical Modeling Real-World Problem.
- After the student teams have selected a Mathematical Modeling Real-World Problem, they will begin to working on daily activities. The activities are broken up so that they are all completed within the time frame of the lesson.
- The teacher will distribute all handouts and the class will discuss them.

Independent Practice
- Student teams will research, construct, collect data, validate, implement, and present their Mathematical Modeling Real-World Problem solution. The activities are broken up so that they are all completed within the time frame of the lesson.
- The STEM Practicum presentation activities and final presentation will be stored in the students’ folders.

Summary

Review
There are various real-world problems that may be used in Mathematical Modeling. Student teams were able to demonstrate the processes required to solve the real-world problem and explain their solutions.

Evaluation

Informal Assessment
- The teacher monitors during activities to check for understanding.
Formal Assessment

- Daily grade on activities

Enrichment

- Classroom guest speaker presentation from a college professor who studies Applied Mathematics may be used as enrichment to discuss real-world problems in Mathematical Modeling.
STEM Practicum Terms and Definitions

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Mathematical Modeling TEAM TASKS Guide

Real-World Problem

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<td>Who Is Responsible</td>
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Team Members:

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