Department of Education | College, Career and Technical Education

May 2023

STEM Explorers

Primary Career Cluster:	Science, Technology, Engineering, and Mathematics (STEM)
Course Contact:	CTE.Standards@tn.gov
Course Code(s):	C25600
Prerequisite(s):	None
Credit:	N/A
Grade Level:	6
Graduation Requirement:	N/A
Coursework and Sequence:	This is the first course in the *Middle School STEM* sequence of coursework.
Aligned Student Organization(s):	Technology Student Association (TSA): http://www.tntsa.org
Coordinating Work-Based Learning:	Teachers are encouraged to use embedded WBL activities such as informational interviewing, job shadowing, and career mentoring. For information, visit https://www.tn.gov/education/educators/career-and-technical-education/work-based-learning.html.
Promoted Student Industry Credentials:	N/A
Teacher Endorsement(s):	001, 013, 014, 015, 016, 017, 018, 047, 070, 078, 081, 101, 121, 122, 123, 124, 125, 126, 127, 128, 129, 157, 210, 211, 212, 213, 214, 230, 232, 233, 400, 401, 402, 413, 414, 415, 416, 417, 418, 440, 449, 470, 477, 499, 982
Required Teacher Certifications/Training:	Teachers who have never taught this course must attend training provided by the Department of Education.
Teacher Resources:	https://www.tn.gov/education/educators/career-and-technical-education/career-clusters/cte-cluster-stem.html Best for All Central: https://bestforall.tnedu.gov/

Course at a Glance

There is no one way to create meaningful learning experiences for students. There are best practices available that data and students say impact long-term student learning. One of those best practices is to put student learning in context with their experiences.

Career and Technical Student Organizations (CTSOs) provide an opportunity for students to display their learning in the classroom and through regional, state, and/or national competition. Work-based Learning (WBL) consists of sustained and coordinated work-based activities that relate to the course content. These activities should occur at every level through a program of study. Below is a listing of possible CTSO connections and WBL activities for this course. This listing is intended to be an idea starter and not a comprehensive listing.

Using a Career and Technical Student Organization (CTSO) in Your Classroom

Putting the classroom learning into real life experiences is often what creates a meaningful learning experience for students, one that lasts beyond the exam and course. CTSOs are a great resource to create this type of learning for your students. They are also a great resource to showcase your students learning through regional, state, and national competitions. Possible connections for this course include the following. This is not an exhaustive list.

- Participate in CTSO Fall Leadership Conference to engage with peers by demonstrating logical thought processes and developing industry specific skills that involve teamwork and project management.
- Participate in contests that highlight job skill demonstration, interviewing skills, community service activities, extemporaneous speaking, and job interview.
- Participate in leadership activities such as National Leadership and Skills Conference, National Week of Service, 21st Century Skills.

For more ideas and information, visit Technology Student Association (TSA): http://www.tntsa.org

Using Work-Based Learning (WBL) in Your Classroom

Sustained and coordinated activities that relate to the course content are the key to successful work-based learning. Possible activities for this course include the following. This is not an exhaustive list.

- **Standards 1.1-11.1** | Career Fair that exposes students to all aspects of STEM and Manufacturing with a multi-industry discussion panel.

For more ideas and information, visit https://www.tn.gov/education/educators/career-and-technical-education/work-based-learning.html.

Course Description

STEM Explorers is a fundamental course for middle school students to search for answers to *"What is STEM?"* A student proficient in this course will understand science, technology, engineering, and mathematics (STEM) as a collection of interrelated disciplines, rather than a series of isolated fields. Students will come away from this course with a thorough understanding of how the STEM disciplines work together to investigate the world, define problems, and create optimal solutions to benefit society. In this course, students will explore the history of engineering and technology; they will be introduced to the practices of science and engineering; and they will explore various STEM fields to empower them to make an informed decision when selecting a career pathway in high school.

Course Standards

1. STEM Overview

1.1 STEM Influence: Drawing on multiple sources (such as the Internet, textbooks, videos, and journals), **investigate historical figures and milestones in science, technology, engineering, and mathematics**. Create a report over a selected STEM figure or milestone. Explain how this figure or milestone had a lasting influence on at least two of the four STEM fields.

1.2 Benefits of Technology: Drawing on multiple sources (such as the internet, textbooks, videos, and journals), **research technologies that have benefited society**. Create a presentation illustrating society's role in the creation of a chosen technology. Discuss the societal needs that led to the creation of this technology, as well as the benefits resulting from it. Provide examples to support the claim that this technology has been beneficial to society. Relate the specific areas of science, technology, engineering, and math that contributed to the development of this technology.

2. Science & Engineering Practices

2.1 Scientific Questions: Explain **how asking scientific questions can help to define an engineering problem to be solved**. Choose a specific question(s) and problem that a scientist or engineer would encounter, then develop a model to illustrate the problem. Provide textual evidence from science and engineering books and websites to justify why the model illustrates the problem.

3. Safety

3.1 Safety Rules: Accurately r**ead and interpret safety rules**, including but not limited to rules published by the National Science Teachers Association (NSTA), rules pertaining to electrical safety, Occupational Safety and Health Administration (OSHA) guidelines, and state and national code requirements. Be able to **distinguish between the rules** and explain why certain rules apply.

3.2 Safety Equipment: Identify and explain the **intended use of safety equipment** available in the classroom. For example, demonstrate how to properly inspect, use, and maintain safe

operating procedures with tools and equipment. Incorporate safety procedures and complete safety test with 100 percent accuracy.

4. STEM Fields Exploration

4.1 STEM Career Clusters: **Investigate the following six STEM-intensive career clusters**: Manufacturing; STEM; Health Sciences; Information Technology; Architecture and Construction; Agriculture, Food and Natural Resources; and Transportation, Distribution and Logistics. **Identify companies and organizations in the state, region, and the school's local community related to each of these clusters.** Create an informative poster or presentation that identifies companies in each cluster, the products they produce, and the services they offer.

4.2 STEM Occupations: **Research various occupations in each of the six STEM-intensive career clusters**: Manufacturing; STEM; Health Sciences; Information Technology; Architecture and Construction; Agriculture, Food and Natural Resources; and Transportation, Distribution and Logistics. Compose an informative table or chart highlighting at least one occupation in each cluster, to include the following: work activities typically performed; tools and technology used; nature of the work environment; and the knowledge and skills needed for success.

5. Manufacturing Cluster

5.1 Manufacturing: Investigate the field of **manufacturing and manufacturing processes**. Drawing on technical texts and exemplar designs retrieved from manufacturing websites, **design and create a model of a manufacturing process**. Demonstrate how the model would be used by a manufacturer to conduct a specific manufacturing process. Write a persuasive essay that argues for the quality and efficiency of the model and the process it simulates/demonstrates. Then, evaluate the model and discuss how it and/or the process can be improved.

6. STEM Cluster

6.1 Engineering Design Process: Research engineering and scientific texts to **understand the engineering design and scientific inquiry processes**. Design and create a product that meets specific constraints and criteria using an engineering process that includes the following: identifying the problem; identifying criteria and specifying constraints; brainstorming for possible solutions; researching and generating ideas; exploring alternative solutions; selecting an approach; writing a design proposal, developing a model or prototype; testing and evaluating; refining and improving; creating or making a product; and communicating results. Evaluate and report whether the solution met the original criteria and constraints, as well as what improvements could be made to the solution, including a summary of data. *For example, students design and build a paper airplane that will stay aloft for the longest time. Students record their plane design before building and testing it. Students build and test their plane three times, recording the time aloft in each test. Students make a modification to their plane design. Students should be encouraged to only modify a single variable. Students build and test their modified plane three times as with their original plane. This*

process may be repeated multiple times. Students should create and present a report of the design, test results, results and conclusions. Teachers may wish to have students use their phones to take pictures of their plane designs and test results.

7. Health Sciences Cluster

7.1 Health Science Field: **Research areas of the health sciences field**. Collect, graph, and analyze personal health or forensic-related information. Write a brief explanation that categorizes the data collected and then describes the significance of the data. *For example, students may collect personal health-related information, such as heart rate (resting, vs. standing vs. active), their BMI, flexibility, or their lung capacity, and compare these against government recommendations. Alternatively, students may collect and analyze forensic information, such as hair or fingerprint samples. Students may then analyze and classify the samples. In either of these examples, the class or individuals' data should be graphed using bar or box-and-whisker graphs.*

8. Information Technology Cluster

8.1 Information Technology Field: **Research the field of information technology** (IT) and define a **problem that could be solved by an IT professional**. Create a presentation that defines the problem and presents a possible solution including some form of information technology. Create a model (could be 3-D, a diagram, website, etc.) to illustrate the problem, the solution, or both. Include an informative evaluation of the model that explains the features and limitations of the model. *For example, students design a webpage that educates the community about an issue, concept, or program. The webpage may include audio, video, graphics, and text. After completing the webpage, have students check the size of the webpage, calculate download time under various download speeds, and determine changes that could be made to improve download time.*

9. Architecture & Construction Cluster

9.1 Architecture & Design: Research a well-known building, such as the Empire State Building. Incorporate information obtained from the **research to inform an original design for a structure meant to serve a specific purpose**. Create a scaled drawing of the design as well as a 3-D model, attending to appropriate dimensions and scale. Provide evidence supporting why the design will work to meet the specific purpose. *For example, students design and build a model of a bridge that spans a specific space. Present the size of the bridge across a life-sized ravine and specify the material from which the students may build their model (i.e., balsa wood, bass wood, tooth picks, or soda straws). Test the load capacity of the bridge.*

10. Agriculture, Food & Natural Resources

10.1 Agriculture Field: Research **a problem related to agriculture, food, and natural resources that could be solved using science, engineering, technology, and/or math**. Design and conduct an experiment with a single independent variable that models the selected problem. Collect and analyze the data from the experiment. Create a report on the experiment that includes:

a. introduction explaining the principle tested and the methodology used in the test;

b. data in graphs and/or tables;
c. explanation of the data analysis; and
d. findings and conclusion from the experiment, as well as a justification to support the conclusion.

For example, students design a water filtration experiment. The students test the ability of various materials, such as activated charcoal, a coffee filter, rocks, dirt, or a combination of materials, to clean water via a filtration process. Students should measure the volume, mass, and density; judge color; measure spectroscopy; and/or test the pH of water samples before and after filtration.

11. Transportation, Distribution & Logistics

11.1 Transportation, Distribution & Logistics Field: Research **a problem relating to transportation, distribution, and logistics that could be solved using science, engineering, technology, and/or math**. Design a model of a transportation technology based on specific criteria and constraints. Test the model's performance. Modify single aspects of the model's design and retest the model. Graph and analyze data from the test. Write an explanation based on the data analysis describing how the model could be further modified to optimize the design. Include any reasons why the test may have produced data that does not reflect the actual impact of the change in the test variable. *For example, have students design and build a water bottle rocket. Divide the class into groups and have the various groups each test a different variable such as ballast, nose cone design, fin size, fin shape, water-to-air mixture, and bottle size. After each group presents their findings, assign the students to construct a rocket that will reach the maximum altitude.*

Standards Alignment Notes

*References to other standards include:

- P21: Partnership for 21st Century Skills Framework for 21st Century Learning
    - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.