Department of Education | College, Career and Technical Education

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STEM III: STEM in Context

Primary Career Cluster:	Science, Technology, Engineering, and Mathematics (STEM)
Course Contact:	CTE.Standards@tn.gov
Course Code(s):	C21H17
Prerequisite(s):	*STEM II: Applications* (C21H16) and *Biology* (G03H03) or *Chemistry* (G03H12)
Credit:	1
Grade Level:	11
Focus Elective Graduation Requirement:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other *STEM* courses.
Program of Study (POS) Concentrator:	This course satisfies one out of two required courses that meet the Perkins V concentrator definition, when taken in sequence in the approved program of study.
Programs of Study and Sequence:	This is the third course in the *STEM Education* program of study.
Aligned Student Organization(s):	SkillsUSA: http://www.tnskillsusa.com 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/career-and-technical-education/work-based-learning.html.
Promoted Student Industry Credentials:	Credentials are aligned with post-secondary and employment opportunities and with the competencies and skills that students acquire through their selected program of study. For a listing of promoted student industry credentials, visit https://www.tn.gov/education/career-and-technical-education/student-industry-certification.html
Teacher Endorsement(s):	013, 014, 015, 016, 017, 018, 047, 070, 078, 081, 125, 126, 127, 128, 129, 157, 210, 211, 212, 213, 214, 230, 232, 233, 413, 414, 415, 416, 417, 418, 449, 470, 477, 519, 531, 595, 596, 700, 740, 760, 982
Required Teacher Certifications/Training:	Teachers who have never taught this course must attend the training provided by the Department of Education.
Teacher Resources:	https://www.tn.gov/education/career-and-technical-education/career-clusters/cte-cluster-stem.html Best for All Central: https://bestforall.tnedu.gov/

Approved April 10, 2015; Amended January 25, 2018; Amended Nov. 2021

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 Tennessee SkillsUSA at http://www.tnskillsusa.com and Technology Student Association (TSA): http://www.tntsa.org

Using Work-based Learning 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 1.1-1.2**| Invite an industry representative to discuss occupational safety hazards.
- **Standards 2.1-2.3**| Invite a research specialist to discuss essential components of research.
- **Standards 3.1** | Do a project that is useful to a local employer.
- **Standards 4.1-5.3** | Invite an educational psychologist to discuss team development and communication.
- **Standards 6.1-8.1** | Integrated project evaluated by industry professionals.

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

Course Description

STEM III: STEM in Context is an applied course in the STEM career cluster which allows students to work in groups to solve a problem or answer a scientific question drawn from real-world scenarios within their schools or communities. This course builds on *STEM I: Foundation* and *STEM II: Applications* by applying scientific and engineering knowledge and skills to a team project. Upon completion of this course, proficient students will be able to effectively use skills such as project management, team communication, leadership, and decision making. They will also be able to effectively transfer the teamwork skills from the classroom to a work setting.

Note: Mastery of the following standards should be attained while completing a STEM project that follows the scientific inquiry or engineering design process. This course prepares students for the STEM IV: STEM Practicum course.

Program of Study Application

This is the third course in the *STEM Education* program of study. For more information on the benefits and requirements of implementing this program in full, visit the STEM website at https://www.tn.gov/education/career-and-technical-education/career-clusters/cte-cluster-stem.html.

Course Standards

1. Safety

1.1 Safety Rules: Accurately **read 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.

1.2 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.

2. Essential Components of STEM Research

2.1 Formation of Research Teams: Explore **how research teams are formed in order to answer scientific questions or design solutions to engineering problems**. Using a scholarly database such as the Education Resources Information Center (ERIC), or searching on the websites of universities and other research institutions, investigate a well-known team of scientists or engineers (for example, the most recent Nobel Prize-winning teams in the sciences) and report to the class on how they collaborated to produce new scientific knowledge or solve an engineering problem.

2.2 Ethical Requirements: Research the **ethical requirements for conducting scientific research or testing a prototype** that will involve the public. For example, investigate the process for obtaining Institutional Review Board (IRB) approval when proposing a biomedical

or human behavioral research study. Describe the concept of risk-benefit analysis in the production of new scientific knowledge; detail the rights and responsibilities of researchers—and, if applicable, their subjects—as they relate to conducting research in STEM fields.

2.3 Funding Obtainment: Examine **how scientists, engineers, and other STEM professionals obtain funding, seek sponsorship, and/or gain approval to conduct their research**. Explore websites such as the National Science Foundation or the National Institutes of Health to identify common processes around submitting proposals for research studies and procuring the necessary funds. Explain specific terminology such as request for proposals (RFP), competitive grants versus formula grants, and seed funding.

3. Research & Project Definition

3.1 Research and project defining: Survey and observe people in your school and/or community. Analyze the results to **determine potential STEM problems that need investigating or solving.** Use these ideas to conduct research to determine and define a team project. Using supporting evidence from the research, write and present a STEM project proposal defining the project's purpose and goals. Include an outline of how the team intends to follow the scientific inquiry or engineering design process.

4. Team Development

4.1 Team Norms: Define the **team norms**, or the **set of team values, that are understood and approved** by all team members. The norms should include the team's mission and guidelines for how team members will treat each other. Create a team handbook and include the documented team norms.

4.2 Professional Attributes: As a team, determine the **professional attributes that must be embodied by team members** in order to successfully complete the proposed project. Collaboratively develop a professionalism rubric with performance indicators for each attribute agreed upon. Include the rubric in the team handbook. Attributes may include the following:

a. Effective communication
b. Respect for fellow team members
c. Ethical use of intellectual property and other project resources (including ethical treatment of test subjects, if applicable)
d. Timely achievement of project deadlines and goals
e. Collaborative and equitable distribution of work among all team members

4.3 Team strengths and weakness: Identify the **strengths and weaknesses of team members** and organize the results into a graphic representation. Use the graphic representation to define the **roles of each team member** and create an organizational chart for the team handbook. For example, the strengths and weaknesses document will help identify the leader of the project team.

4.4 Tuckman's Stages of group development: Research **Tuckman's stage model for team development** (i.e., forming, storming, norming, performing, and adjourning). Prior to starting the STEM project, understand and explain each stage. After completing the project, write a brief evaluation of the team's growth at each stage.

5. Communication

5.1 Team Communication: Develop **a process for official team communication**. Define and document **format guidelines for various modes of communication** such as written, verbal, and email. For example, distinguish between communication appropriate to use with a team member versus communication appropriate to use with a supervisor (teacher). Document the communication guidelines in the team handbook.

5.2 Types of Communication: Practice **effective verbal, nonverbal, written, and electronic communication skills** for working with team members while demonstrating the ability to: listen attentively, speak courteously and respectfully, discuss each member's ideas, resolve conflict, and reach a consensus for team progress.

5.3 Decision-making methods: Research various **decision-making methods for teams**, such as consensus, majority, minority, averaging, and expert. Practice using these various methods when team disagreements arise, determine which are most effective for the project team, and explain the reasoning.

6. Project Management

6.1 Principles of Project Management: Perform an Internet search, interview local professionals, or consult industry journals to **identify common principles of successful project management.** Based on templates retrieved online or approved by the instructor, estimate a detailed project plan for the course-long project. The project plan should include at minimum the following: a schedule or Gantt chart outlining deliverables, complete with job assignments based on team member strengths and weaknesses; a tracker for progress toward goals; a time management component to log hours worked for each team member; and supporting diagrams, datasheets, and flowcharts illustrating essential stages in the process.

6.2 Projected Costs and Budget: Based on the project proposal and project plan, **identify projected costs and estimate a hypothetical budget**. The projected costs may include but are not limited to materials, labor, equipment, and travel. Create a method to track the actual costs. For example, spreadsheets can be used to analyze and track project expenses.

7. Project Completion and Presentation

7.1 Using Scientific Inquiry and Engineering Design Process: Apply all steps of the scientific inquiry or the engineering design process (depending on the nature of the project) to successfully **generate a hypothesis or prototype, collect the relevant data, perform the**

necessary tests, interpret the results, make modifications to models or prototypes, and communicate results over the course of the project's duration. Produce a technical report documenting the findings of the project and justifying the team's final conclusions based on evidence obtained.

7.2 Presentation Design: As a team, **design a presentation to communicate the results of the project to both a technical and a non-technical audience**. The presentation should be delivered orally but supported by relevant graphic illustrations, such as diagrams and models of project findings, and/or physical artifacts that represent the outcome of the project (i.e., a robotic prototype or a 3-D model). Prepare the presentation in a format that could be submitted to a competition such as a local Maker Faire or CTSO competitive event.

8. Evaluation of Project Outcome

8.1 Project Evaluation: Using tools that were developed during the course (i.e., professionalism rubric, project plan, organizational chart, team development evaluation), write a reflection paper to **evaluate the project team's performance**. Present the STEM project and team evaluation to the class. The paper should address, but is not limited to the following:

a. Did the team accomplish the project goal?
b. How well did the team (collectively and individually) meet the performance indicators?
c. How did the team develop throughout the duration of the project?
d. How well did the team resolve disagreements?
e. Was the team leadership effective?
f. Was the project completed within budget?

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.