TN Department of Education | College, Career and Technical Education

May 2023

STEM Innovators

Primary Career Cluster:	Science, Technology, Engineering, and Mathematics (STEM)
Course Contact:	CTE.Standards@tn.gov
Course Code(s):	C25701
Prerequisite(s):	None
Credit:	N/A
Grade Level:	7
Graduation Requirement:	N/A
Coursework and Sequence:	This is the second 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, 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-middle-school-cte-coursework.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 1.1-1.2** | Invite an OSHA industry representative to discuss occupational hazards.
- **Standards 2.1-2.4** | Invite a Scientist, Engineer and Mathematician to discuss the evolution of STEM.
- **Standards 3.1-3.5** | Do a virtual tour of a Tech Lab.
- **Standards 4.1-5.1** | Visit a university and their computer aided drafting facility to showcase equipment and demonstrate usage.
- **Standards 6.1-6.2** | Partner with an industry rep to do an integrated project.

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

Course Description

STEM Innovators is a fundamental course for middle school students to understand the relationship between STEM and innovation, as well as explore the possibilities of *"What could be?"* Upon completion of this course, proficient students will understand why innovation is important and how it benefits society. Students will learn how innovation requires creativity and leads to new discoveries and technologies that make life better for humans. In this course, students will identify past innovations and what inspired their creation. Students will continue learning the practices of science and engineering. This course will reinforce the specific practices of developing and using models; planning and carrying out investigations; and analyzing and interpreting data.

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. Introduction to Innovation

2.1 Innovators: Research **great innovators**. Create a presentation about selected innovators and their occupations. Discuss **what inspired them, how their innovations have affected society, their education and background** (Were they engineers or scientists?), and how they used science, technology, engineering, and mathematics to innovate. Examples of great innovators include Alexander Graham Bell (the telephone), Thomas Edison (electricity), Albert Einstein (theory of relativity), Henry Ford (assembly line), Grace Hopper (developed the first compiler for a programming language), Martin Cooper (wireless communications), Bill Gates (Microsoft), Steve Jobs (Apple), Mark Zuckerberg (Facebook), Jack Dorsey (Twitter).

2.2 Innovator Skills: Research and **identify skill sets that are important to innovators**. Given a specific product, criteria and constraints, apply the innovation skills identified in the research to suggest improvements to the product. Working collaboratively with peers, implement the suggested improvements and defend choices in a presentation to the class. In the presentation, highlight the skill sets that were applied in the process and discuss why they were helpful in improving the product. *For example, students build a wind turbine from a kit and measure the amount of electricity it produces from the wind created by a fan. Students then redesign the size, shape, or number of turbine fins to increase the electrical output by at least 20 percent.*

2.3 STEM Career Cluster Technological Development: Select one of the **STEM-intensive career clusters** and create a timeline of **technological developments that helped advance industries associated with that cluster**. (The STEM-intensive career clusters are considered to be: Manufacturing; STEM; Health Sciences; Information Technology; Architecture and Construction; Agriculture, Food & Natural Resources; and Transportation, Distribution & Logistics.) Present this timeline as a 3-D model, PowerPoint, Prezi, poster, etc. Include in the presentation how society's needs have affected this technological development.

2.4 Patents and Trademarks: Research **how a specific product became trademarked or patented**, and write a brief blog post citing historical documents and other narratives to tell the story. Detail the process involved as this innovator or group of innovators secured intellectual property rights for the product, discussing any legal, political, or cultural obstacles faced. For example, research the development of the first smartphone and describe the experience with the trademark and/or patenting process.

3. Innovation Process

3.1 Innovation in Technology: Select and research a **personally-used technology that was an improvement over an existing technology**. Identify the reasons for the innovation, the approximate date of the innovation, and the process that resulted in the innovation. Compare and contrast the existing technology with the technology it replaced. Present the findings to the class.

3.2 Divergent and Convergent Thinking: Articulate the **concepts of divergent and convergent thinking** to classmates. Create a table comparing and contrasting divergent (creativity) thinking and convergent (usually used in engineering) thinking. Research and present an example illustrating the convergent and/or divergent thinking processes involved in a specific innovation.

3.3 Technology Used to Solve Societal Problem: Research an existing **technology whose purpose is to solve a societal problem**, and follow a general innovation process to determine if the technology can be improved upon. The process should include, but is not limited to:

a. Researching the advantages and disadvantages, including costs and benefits, of an existing technology whose purpose is to solve a societal problem;
b. Presenting the advantages and disadvantages and proposing alternatives and solutions to the disadvantages;
c. Analyzing and comparing advantages and disadvantages of a proposed solution

Consider any environmental, health, and economic impacts of the proposed solution. Prepare a chart illustrating the trade-offs and impacts of the proposed solution and include it in the presentation.

3.4 Science and Engineering in Innovation: Illustrate **how the practices of science and engineering relate to the innovation process**. This illustration could be in the form of a skit, a PowerPoint, a poster, or other graphic illustration. Science and engineering practices include: Asking questions (for science) and defining problems (for engineering); developing and using models; planning and carrying out investigations; analyzing and interpreting data; using mathematics and computational thinking; constructing explanations (for science) and designing solutions (for engineering); engaging in argument from evidence; obtaining, evaluating and communicating information. *For example, students create questions that could have led to the development of the iPad.*

3.5 Science and Engineering Practices Used for Improvement: Given a specific product, apply science and engineering practices *(as listed above)* to **improve the product in a measurable manner**. Design, produce, test, and analyze an improved product that meets specific constraints and criteria. Compose a report that summarizes the test data, evaluates whether the solution meets the original criteria and constraints, discusses and justifies what improvements were made to the original product, and explains what improvements could be made to the solution. *For example, students are shown a model catapult and a demonstration of its launching power. Students then design a new catapult that outperforms the catapults demonstrated in distance or accuracy. Students create a design that specifically shows what feature is modified to improve performance. Students conduct tests of their design, modify their design, and produce a final product.*

4. Fundamental Sketching

4.1 Design and Sketch Principles: Identify **basic design and sketching principles used in the design stage of the innovation process**, including orthographic projection, object lines, hidden lines, dimensioning, and scale. Create a scaled and dimensioned, single or multi-view sketch of a product. *(Note: There are multiple versions of the design process. This standard will address one version.)*

5. 3-Dimensional Models & Prototypes

5.1 3-D Models and Prototyping: Research **how 3-D printing and rapid prototyping have revolutionized the innovation process**, consulting popular news media, engineering journals, and relevant industry magazines. Design a 3-D model of a chosen product using computer-aided drafting or modeling software such as SolidWorks or Google SketchUp, then create a 3-D model of the design. Explain how 3-D printing can simplify the process of making changes to the product. *For example, students make a product with a 3-D printer, if feasible, after designing it. Otherwise, they could use available materials*.

6. Projects

6.1 Maker Movement and Maker Faire: **Research the Maker Movement and Maker Faire**, exploring associated websites and independent commentary (i.e., in news media, in scholarly magazines) to assess the impact they have had on today's culture of innovation. Develop a proposal to host a Maker Faire or similar exhibition/event in the school. Using research, justify the benefits of hosting such an event, citing the importance of the modern Maker Movement as it relates to fostering innovation.

6.2 Community and Societal Needs: Research **needs in the community or society in general** using the internet, news sources, and/or surveys of individuals outside the classroom. Based on information gathered, **apply an innovation process to create a product or technology that meets the need.** Create a multimedia presentation that defines the problem or need and illustrates an appropriate method to document the innovation process (such as an innovation portfolio). Use this documentation method to **record the process of developing the product or technology that meets the need or solves the problem**. Demonstrate visually how the process was applied in the multimedia presentation. *(Example activity: Stage a school junior Maker Faire or technology fair. Have students create, display, and present their products at this event. If possible students can use a 3-D printer to create a prototype or scale model of their product.)*

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.