



CTE Externship Aligned Lessons: Modern Manufacturing: Applied Math, Teamwork, & Problem Solving

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This resource was created by Tennessee teachers who participated in teacher externships sponsored by the Tennessee Department of Education, Division of Career and Technical Education. Many of the resources within the activities may be specific to industries where teachers completed their externship. Teachers may opt to substitute resources from companies within their region for better local alignment.

This resource is best for:

Teachers of:	Principles of Manufacturing and Business Principles	Career Cluster:	Advanced Manufacturing and Business Management & Administration
Addressing Standard(s):	<p>Principles of Manufacturing Standard 2) Students will demonstrate leadership, citizenship, and teamwork skills required for success in the school, community, and workplace.</p> <p>Business Principles Standard 1) The student will develop and apply concepts related to human relations, safety, career development, communications, and leadership skills for a global workplace.</p>	Grand-Band	9-10

Learning Objective: The goal of this activity is to develop a student’s understanding of how applied math, teamwork, and problem solving are used in different careers within the modern manufacturing industry so the student can be better prepared for the workforce while practicing the skills necessary to become proficient in the Tennessee Standards for Literacy in Technical Subjects. Teachers can use this activity to develop an understanding of how small math mistakes could have major financial and productive consequences, and teamwork and problem solving are critical in the automated manufacturing industry. Discussions, reading, research, and writing exercises are coordinated in class to help students learn about applied math in technical careers, the consequences of math mistakes, and the importance of problem solving and teamwork skills.



Texts	Text Complexity Analysis
<p>Text 1 Title: For Manufacturing Jobs, Workers Brush up on Math Author: Citation/Publication Information: Niala Boodhoo; July 7, 2012 Link: http://www.npr.org/2012/07/10/155837962/for-manufacturing-jobs-workers-brush-up-on-math</p>	<p>Quantitative: Lexile: 950</p> <p>Qualitative: Article is an informational transcript in a conversational tone that discusses the importance of math in manufacturing jobs with limited domain specific vocabulary.</p> <p>Reader and Task: Considering the purpose and conventionality of this article, high school students should be able to maintain motivation and engagement. Close reading is necessary to determine explicit connections and domain specific words.</p>
<p>Text 2 Title: Mathematics at Work: Manufacturing Author: Citation/Publication Information: Achieve, Inc. Link: http://www.achieve.org/files/MathatWork-Manufacturing.pdf</p>	<p>Quantitative: Lexile:1475</p> <p>Qualitative: Article is an informational text in a conversational tone that discusses the importance of math, teamwork, and problem solving so manufacturing companies can stay competitive in a global marketplace.</p> <p>Reader and Task: Considering the purpose and conventionality of this article, high school students should be able to maintain motivation and engagement. Close reading is necessary to determine explicit connections and domain specific words.</p>



ELA/Literacy Standards addressed by task	
Strand	Grades 9-10
Reading for Technical Subjects: Key Ideas and Details	1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanation or descriptions.
Reading for Technical Subjects: Key Ideas and Details	2. Determine the central ideas or conclusions of a text, trace the text’s explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.
Reading for Technical Subjects: Craft and Structure	5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).
Writing for Technical Subjects: Text Types and Purpose	<ol style="list-style-type: none"> 1. Write arguments focused on discipline specific content. <ol style="list-style-type: none"> a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence. b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while point out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form that anticipates the audience’s knowledge level and concerns. c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims. d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. e. Provide a concluding statement or section that follows from or supports the argument presented.
Writing for Technical Subjects: Production and Distribution of Writing	4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.



Tennessee CTE Standards addressed by task	
Principles of Manufacturing	<p>2.0 Students will demonstrate leadership, citizenship, and teamwork skills required for success in the school, community, and workplace.</p> <p>2.3 Assess situations, apply problem-solving techniques, and decision-making skills within the school, community, and workplace.</p> <p>2.4 Participate as a team member in a learning environment.</p> <p>2.5 Respect the opinions, customs, and individual differences of others.</p> <p>2.6 Build personal career development by identifying career interests, strengths, and opportunities.</p>
Business Principles	<p>1.0. The student will develop and apply concepts related to human relations, safety, career development, communications, and leadership skills for a global workplace.</p> <p>1.2 Demonstrate the interpersonal, teamwork, and leadership skills needed to function in diverse business settings, including the global marketplace.</p> <p>1.3 Communicate effectively as writers, listeners, and speakers in diverse social and business settings.</p> <p>1.4 Apply the critical-thinking and soft skills needed to function in students' multiple roles as citizens, consumers, workers, managers, business owners, and directors of their own futures.</p> <p>1.6 Investigate the life-long learning skills that foster flexible career paths and confidence in adapting to a workplace that demands constant retooling.</p> <p>1.7 Assess personal skills, abilities, aptitudes, and personal strengths and weaknesses as they relate to career exploration and apply knowledge gained from individual assessment to research and develop an individual career plan.</p>

What key insights should students take from these resources?
<ol style="list-style-type: none"> 1. The importance of mathematics in manufacturing careers, especially when using technology. 2. Understand the implications of financial and productive consequences when math mistakes are made. 3. The importance problem solving skills are in the manufacturing industry. 4. Teamwork is an important part of careers in manufacturing facilities. 5. Student assessment of their current skills and compare to the necessary skills they need to learn and refine so they can be successful in careers in the manufacturing industry.



Text-Dependent Questions

Text 1: Answer the following questions, citing evidence from the text:

- Based on the text, describe what CNC equipment is and how it is used in the manufacturing industry.
- What are some consequences for a manufacturing company when incorrect math is used with CNC equipment?
- According to the author, why are employers having problems finding qualified employees who can effectively use CNC equipment?

Text 2: Answer the following questions, citing evidence from the text

- Describe what an education system needs to provide for their students so they will be skilled for the manufacturing industry in the United States according to the article.
- Which jobs have the highest median yearly salary? Which job has the greatest percent of change in number of total jobs? Describe the correlation between median yearly salary and education level for each job category.
- According to Toyota, the most important asset the company possesses is a “talented, multi-skilled employee.” Give a description of this employee, including specific mathematical skills.
- What does it mean to “articulate and communicate the complexity of a project?” Provide an example.
- According to author why was the pneumatics method chosen over other methods? What could have happened if other method was used?
- What were some challenges the team had to consider when solving the hood painting problem? How did they solve these challenges?
- Did employees reach the long term goals set for the hood painting team? How did you determine this?
- What math concepts were used to solve the hood painting problem? Explain how these concepts relate to career preparation for the production line.
- Explain how mathematics, teamwork, and communication skills keep Toyota competitive in the global marketplace. Provide justification.



Writing Mode	Writing Prompt
Argumentative	<p>Companies in the manufacturing industry need qualified, skilled employees to remain competitive in a global economy. Many companies are having difficulties finding qualified employees. Companies are looking for certain characteristics and skills in their employees, yet both are becoming harder to find.</p> <p>You are serving on the County Commission or Chamber of Commerce and are trying to recruit a manufacturing company to relocate to your county. Write an argumentative/persuasive letter to the president of the manufacturing company stating why your county has the skilled workforce they need. Introduce precise claims about your county's workforce and use evidence to support these claims. Include specific skills and educational attainment of potential employees which would qualify them for employment and additional supports your chamber would provide.</p>
Additional Resources	
<p>Suggested Additional Website References:</p> <ul style="list-style-type: none">• Hundai http://www.youtube.com/watch?v=KH-QJLewLnk or Yaris http://www.youtube.com/watch?v=KF1nSe5jei4	



Potential Lesson Plan Design:

Day 1:

- Begin class by having the students complete the “Know” and “Want to Know” from a KWL chart about manufacturing plants. Ask them to share their information.
- Discuss examples of products that could be made in a manufacturing plant. Show video about Hyundai (<http://www.youtube.com/watch?v=KH-QJLewLnk>).
- Have the students read the first text, highlighting vocabulary words they don’t know and what they think are key ideas of the text. Then have students need to write a paragraph summarizing the main idea of the text.
- When they have finished these activities, discuss the main idea of the text. When discussing the main idea, have the students discuss the unfamiliar vocabulary words they don’t know and provide some context for inferring unknown words.
- Group students in pairs and discuss their viewpoints of the text. Have one person from each pair describe the problems companies are having as they search for qualified applicants and share with group.
- As an exit activity, have the students complete what they have learned as part of the KWL chart.

Text Under Discussion	Sample Teacher Dialogue & Guiding Questions
<p>Text 1: For Manufacturing Jobs, Workers Brush up on Math</p>	<ul style="list-style-type: none"> • Describe why manufacturing companies are having a hard time finding qualified employees. • If CNC equipment will do work for the employee, why would math still be important? • Why would managers at manufacturing companies be upset when incorrect math is put into CNC equipment? • Do you think your job might be in jeopardy due to mathematical mistakes? Why or Why not?



Day 2:

- Review the concept of manufacturing and show the Yaris video (<http://www.youtube.com/watch?v=KF1nSe5jei4>). Discuss how the video was different from yesterday’s intro video.
- Have the students read the second text in its entirety.
- Create a Venn diagram to compare and contrast similar occurrences in each text. Use details from both texts to complete the Venn diagram. Discuss what the texts are about.
- Students will work with a partner to answer the test based questions. There will be a group discussion about their answers to the questions.
- Student will create a graphic organizer detailing the math concepts mentioned in the texts and compare it to their math skills. List the math classes where the student learned the concepts and which math classes would be needed to be prepared for a career in the manufacturing industry.
- Exit activity: Have students turn the details of the Venn diagram into sentences as they respond to the prompt “compare and contrast the importance of math skills and teamwork in the manufacturing industry.”

Text Under Discussion	Sample Teacher Dialogue & Guiding Questions
<p>Text 2: Mathematics at Work: Manufacturing</p>	<ul style="list-style-type: none"> • Describe why manufacturing companies are having a hard time finding qualified employees. • What is the current job market/labor projection for manufacturing? • According to Toyota, what is the single most important asset the company possesses? Based on your reading do you agree or disagree? Be sure to include evidence from the text in your explanation. • According to Toyota, why are teamwork and communication skills important to keep the company in the global marketplace? • How important, if at all, is a solid math foundation to the employees at Toyota? Cite evidence from the reading.



Day 3:

- Opening Activity: Review the KWL chart. Have the student complete the "Learned" section. Have a group discussion to make sure the "Want to Learn" information was covered.
- Have students review their lessons learned and present the writing prompt. Have students compose their informative essay/letter and use to assess understanding of math, teamwork and problem solving in the manufacturing industry during the remaining class time.

Discussion: These texts could be explored orally and used to form the basic foundation of a lesson or series of lessons. Close-reading questions should be developed in advance in order to drive student understanding of the material while also practicing reading skills. For information on how to develop questions for this type of discussion, visit http://www.tncore.org/literacy_in_science_and_technology/curricular_resources/text_dependent_questions.aspx.

Writing and/or Assessment: The writing prompt included can be either a constructed-response assessment or a longer-term writing assignment for students to develop and refine over time to gauge student understanding of technical content as well as reading and writing skills as outlined by the Tennessee Standards for Literacy in Technical Subjects. An appropriate writing rubric – such as those found at http://www.tncore.org/literacy_in_science_and_technology/assessment/scoring_resources.aspx – should be used to assess student work.

- **Task:** If using this material as a writing task, you may scaffold the texts with close readings and text-based questions to guide student exploration of the texts. A culminating task of this lesson or sequence of lessons could be the writing prompt – either assigned in class, as homework, or as a report that is drafted and refined over time to build writing skills.

Scaffolding and support for students with special needs, English language learners, and struggling readers: Consider pre-teaching synonyms of difficult vocabulary words. Lower-level readers and ELL students can still be challenged without being overloaded with difficulty. This strategy can also be used to differentiate for stronger readers by introducing new, and more challenging, vocabulary. Struggling readers would also benefit from visual aids to illustrate many of the ideas presented. Pictures, diagrams, and charts alongside the text will go far to aid students as they dissect the articles.

Note: Social, ethnic, racial, religious, and gender bias is best determined at the local level where educators have in-depth knowledge of the culture and values of the community in which students live. TDOE asks local districts to review these materials for social, ethnic, racial, religious, and gender bias before use in local schools.