

North Dakota Technology and Engineering Education

Content Standards

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North Dakota Department of Career and Technical Education

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North Dakota State Board for Career and Technical Education

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Career and Technical Education Standards Introduction

Mission

The mission of the State Board for Career and Technical Education (CTE) is to work with others to provide all North Dakota citizens with the technical skills, knowledge, and attitudes necessary for successful performance in a globally competitive workplace.

Vision

The State Board for Career and Technical Education (CTE) is committed to providing career awareness, work readiness skills, occupational preparation, and retraining of workers throughout the state. Career and technical education will span all educational levels, providing youth with exploration opportunities and the foundation skills needed to enter the world of work while providing adults with skills needed to enter, re-enter, or advance in the workforce.

Goal

North Dakota Career and Technical Education's goal is to create a competitive and knowledgeable work force. This is accomplished through a variety of educational program areas that are organized to prepare students for careers in their chosen fields, to take leadership roles, and balance their multiple roles in life. CTE programs prepare students with the knowledge and skills to make informed career choices, to integrate and apply academic concepts, to prepare for successful participation in a global society, and to engage in lifelong learning.

Standards Development Process

Standards development is a multi-phase process. Existing and/or industry standards are the basis for the North Dakota Program Standards. A team of expert secondary and postsecondary teachers, business and industry representatives, and the state program supervisor draft the standards document. Once the document is finalized, the State Board for Career and Technical Education approves and adopts the standards.

Course Frameworks are also developed by the writing team. A framework includes a brief overview of the course content, topical units of study, and identifies the standards recommended for inclusion within the course. The frameworks are tailored to prepare young people for the opportunities in North Dakota. School Districts will use the frameworks as a guide for developing curriculum that reflects local needs.

Key Principles of Career and Technical Education

We believe that Career Technical Education:

1. Draws its curricula, standards, and organizing principles from the workplace.

The workplace provides the context, objectives, and organizing constructs for instruction and assessment. The workplace also defines the standards of performance necessary, including those required for academic, technical, and employability skills.

2. Is a critical and integral component of the total educational system, offering career-oriented benefits for all students.

CTE classes offer educational benefits to students pursuing careers requiring specific technical skills as well as providing a strong foundation for those pursuing a traditional four-year (or more) degree.

3. Is a critical and integral component of the workforce development system, providing the essential foundation for a thriving economy.

Preparation of a well-prepared, qualified workforce requires solid academics, good work ethics, and specific technical skills as well as the ability to communicate, work with others, solve problems, and use information. CTE contributes directly to this preparation by providing a curriculum tied to specific workplace requirements.

4. Maintains high levels of excellence supported through identification of academic and workplace standards, measurement of performance (accountability), and high expectations for participant success.

Career Technical Education is committed to continuous improvement, attention to industry certification, and the development of highly qualified teachers.

5. Is robust and flexible enough to respond to the needs of the multiple educational environments, customers, and levels of specialization.

CTE involves a large and complex delivery system that (1) integrates career exploration, (2) provides effective tools for organizing all curricula, (3) facilitates the teaching and use of technology, (4) is integrated into the total learning experience, (5) enhances the learning of academic subjects, (6) teaches broad occupational skills, (7) includes all aspects of the industry, (8) teaches how to balance family and work responsibilities, (9) provides job-specific training, (10) is offered at multiple levels of the educational continuum, and (11) is delivered through a variety of educational environments.

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Standard 1	<i>NATURE AND CHARACTERISTICS OF TECHNOLOGY AND ENGINEERING</i>	
Topic 1.1	Grades PreK - 2	
	Student Competencies	
	1.1.1	Compare the natural world and human-made world.
	1.1.2	Explain the tools and techniques that people use to help them do things.
	1.1.3	Demonstrate that creating can be done by anyone.
	1.1.4	Discuss the roles of scientists, engineers, technologists, and others who work with technology.
Topic 1.2	Grades 3 - 5	
	Student Competencies	
	1.2.1	Compare how things found in nature differ from things that are human-made, noting differences and similarities in how they are produced and used.
	1.2.2	Describe the unique relationship between science and technology, and how the natural world can contribute to the human-made world to foster innovation.
	1.2.3	Differentiate between the roles of scientists, engineers, technologists, and others in creating and maintaining technological systems.
	1.2.4	Design solutions by safely using tools, materials, and skills.
	1.2.5	Explain how solutions to problems are shaped by economic, political, and cultural forces.
Topic 1.3	Grades 6 - 8	
	Student Competencies	
	1.3.1	Develop innovative products and systems that solve problems and extend capabilities based on individual or collective needs and wants.
	1.3.2	Compare and contrast the contributions of science, engineering, mathematics, and technology in the development of technological systems.
	1.3.3	Explain how technology and engineering are closely linked to creativity, which can result in both intended and unintended innovations.
	1.3.4	Apply creative problem-solving strategies to the improvement of existing devices or processes or the development of new approaches.
Topic 1.4	Grades 9 - 12	
	Student Competencies	
	1.4.1	Explain how the world around them guides technological development and engineering design.
	1.4.2	Assess how similarities and differences among scientific, mathematical, engineering, and technological knowledge and skills contributed to the design of a product or system.
	1.4.3	Analyze the rate of technological development and predict future diffusion and adoption of new technologies.
	1.4.4	Conduct research to inform intentional inventions and innovations that address specific needs and wants.

	1.4.5	Develop a plan that incorporates knowledge from science, mathematics, and other disciplines to design or improve a technological product of system.
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Standard 2	<i>CORE CONCEPTS OF TECHNOLOGY AND ENGINEERING</i>	
Topic 2.1	Grades PreK - 2	
	Student Competencies	
	2.1.1	Illustrate how systems have parts or components that work together to accomplish a goal.
	2.1.2	Safely use tools to complete tasks.
	2.1.3	Explain that materials are selected for use because they possess desirable properties and characteristics.
	2.1.4	Develop a plan in order to complete a task.
	2.1.5	Collaborate effectively as a member of a team.
Topic 2.2	Grades 3 - 5	
	Student Competencies	
	2.2.1	Describe how a subsystem is a system that operates as part of another, larger system.
	2.2.2	Illustrate how, when parts of a system are missing, it may not work as planned.
	2.2.3	Identify the resources needed to get a technical job done, such as people, materials, capital, tools, machines, knowledge, energy, and time.
	2.2.4	Describe the properties of different materials
	2.2.5	Demonstrate how tools and machines extend human capabilities, such as holding, lifting, carrying, fastening, separating, and computing.
	2.2.6	Describe requirements of designing or making a product or system.
	2.2.7	Create a new product that improves someone's life.
Topic 2.3	Grades 6 - 8	
	Student Competencies	
	2.3.1	Differentiate between inputs, processes, outputs, and feedback in technological systems.
	2.3.2	Illustrate how systems thinking involves considering relationships between every part, as well as how the system interacts with the environment in which it is used.
	2.3.3	Create an open-loop system that has no feedback path and requires human intervention.
	2.3.4	Create a closed-loop system that has a feedback path and requires no human intervention.
	2.3.5	Predict outcomes of a future product or system at the beginning of the design process.
	2.3.6	Compare how different technologies involve different sets of processes.
	2.3.7	Defend decisions related to a design problem.

Topic 2.4		Grades 9 - 12
Student Competencies		
	2.4.1	Demonstrate the use of conceptual, graphical, virtual, mathematical, and physical modeling to identify conflicting considerations before the entire system is developed and to aid in design decision making.
	2.4.2	Diagnose a flawed system embedded within a larger technological, social, or environmental system.
	2.4.3	Analyze the stability of a technological system and how it is influenced by all the components in the system, especially those in the feedback loop.
	2.4.4	Select resources that involve tradeoffs between competing values, such as availability, cost, desirability, and waste, while solving problems.
	2.4.5	Cite examples of the criteria and constraints of a product or system and how they affect final design.
	2.4.6	Implement quality control as a planned process to ensure that a product, service, or system meets established criteria.
	2.4.7	Use management processes in planning, organizing, and controlling work.

Standard 3	<i>INTEGRATION OF KNOWLEDGE, TECHNOLOGIES, AND PRACTICES</i>	
Topic 3.1	Grades PreK - 2	
	Student Competencies	
	3.1.1	Apply concepts and skills from technology and engineering activities that reinforce concepts and skills across multiple content areas.
	3.1.2	Draw connections between technology and human experiences.
Topic 3.2	Grades 3 - 5	
	Student Competencies	
	3.2.1	Demonstrate how simple technologies are often combined to form more complex systems.
	3.2.2	Explain how various relationships can exist between technology and engineering and other content areas.
Topic 3.3	Grades 6 - 8	
	Student Competencies	
	3.3.1	Analyze how different technological systems often interact with economic, environmental, and social systems.
	3.3.2	Apply a product, system, or process developed for one setting to another setting.
	3.3.3	Explain how knowledge gained from other content areas affects the development of technological products and systems.
Topic 3.4	Grades 9 – 12	
	Student Competencies	
	3.4.1	Analyze how technology transfer occurs when a user applies an existing innovation developed for one function to a different purpose.
	3.4.2	Evaluate how technology enhances opportunities for new products and services through globalization.
	3.4.3	Connect technological progress to the advancement of other areas of knowledge, and vice versa.

Standard 4	<i>IMPACT OF TECHNOLOGY</i>	
Topic 4.1	Grades PreK - 2	
	Student Competencies	
	4.1.1	Explain ways that technology helps with everyday tasks.
	4.1.2	Illustrate helpful and harmful effects of technology.
	4.1.3	Compare simple technologies to evaluate their impacts.
	4.1.4	Select ways to reduce, reuse, and recycle resources in daily life.
	4.1.5	Design new technologies that could improve their daily lives.
Topic 4.2	Grades 3 – 5	
	Student Competencies	
	4.2.1	Describe the helpful and harmful effects of technology.
	4.2.2	Judge technologies to determine the best one to use to complete a given task or meet a need.
	4.2.3	Classify resources used to create technologies as either renewable or non-renewable.
	4.2.4	Explain why responsible use of technology requires sustainable management of resources.
	4.2.5	Predict how certain aspects of their daily lives would be different without given technologies.
Topic 4.3	Grades 6 – 8	
	Student Competencies	
	4.3.1	Explain the ways that technology can have both positive and negative effects at the same time.
	4.3.2	Analyze how the creation and use of technologies consumes renewable and non-renewable resources and creates waste.
	4.3.3	Devise strategies for reducing, reusing, and recycling waste caused from the creation and use of technology.
	4.3.4	Analyze examples of technologies that have changed the way people think, interact, and communicate.
	4.3.5	Hypothesize what alternative outcomes (individual, cultural, and/or environmental) might have resulted had a different technological solution been selected.
Topic 4.4	Grades 9 - 12	
	Student Competencies	
	4.4.1	Evaluate ways that technology can impact individuals, society, and the environment.
	4.4.2	Critique whether existing and proposed technologies use resources sustainably.
	4.4.3	Assess a technology that minimizes resource use and resulting waste to achieve a goal.
	4.4.4	Develop a solution to a technological problem that has the least negative environmental and social impact.
	4.4.5	Evaluate how technologies alter human health and capabilities.

Standard 5	<i>INFLUENCE OF SOCIETY ON TECHNOLOGICAL DEVELOPMENT</i>	
Topic 5.1	Grades PreK - 2	
	Student Competencies	
	5.1.1	Explain the needs and wants of individuals and societies.
	5.1.2	Explore how technologies are developed to meet individual and society needs and wants.
	5.1.3	Investigate the use of technologies in the home and community.
Topic 5.2	Grades 3 - 5	
	Student Competencies	
	5.2.1	Determine factors that influence changes in a society's technological systems or infrastructure.
	5.2.2	Explain how technologies are developed or adapted when individual or societal needs and wants change.
Topic 5.3	Grades 6 - 8	
	Student Competencies	
	5.3.1	Analyze how an invention or innovation was influenced by its historical context.
	5.3.2	Evaluate trade-offs based on various perspectives as part of a decision process that recognizes the need for careful compromises among competing factors.
Topic 5.4	Grades 9 – 12	
	Student Competencies	
	5.4.1	Evaluate a technological innovation that arose from a specific society's unique need or want.
	5.4.2	Evaluate a technological innovation that was met with societal resistance, impacting its development.
	5.4.3	Design an appropriate technology for use in a different culture.

Standard 6	<i>HISTORY OF TECHNOLOGY</i>	
Topic 6.1	Grades PreK - 2	
	Student Competencies	
	6.1.1	Discuss how the way people live and work has changed throughout history because of technology.
Topic 6.2	Grades 3 - 5	
	Student Competencies	
	6.2.1	Create representations of the tools people made, how they cultivated food, made clothing, and built shelters to protect themselves.
Topic 6.3	Grades 6 - 8	
	Student Competencies	
	6.3.1	Compare various technologies and how they have contributed to human progress.
	6.3.2	Engage in a research and development process to simulate how inventions and innovations have evolved through systematic tests and refinements.
	6.3.3	Verify how specialization of function has been at the heart of many technological improvements.
Topic 6.4	Grades 9 – 12	
	Student Competencies	
	6.4.1	Relate how technological development has been evolutionary, often the result of a series of refinements to basic inventions or technological knowledge.
	6.4.2	Verify that the evolution of civilization has been directly affected by, and has in turn affected, the development and use of tools, materials, and processes.
	6.4.3	Evaluate how technology has been a powerful force in reshaping social, cultural, political, and economic landscapes throughout history.
	6.4.4	Analyze how the Industrial Revolution resulted in the development of mass production, sophisticated transportation, and communication systems, advanced construction practices, and improved education and leisure time.
	6.4.5	Investigate the widespread changes that have resulted from the Information Age, which has placed emphasis on the processing and exchange of information.

Standard 7	<i>DESIGN IN TECHNOLOGY AND ENGINEERING EDUCATION</i>	
Topic 7.1	Grades PreK - 2	
	Student Competencies	
	7.1.1	Apply design concepts, principles, and processes through play and exploration.
	7.1.2	Demonstrate that designs have requirements.
	7.1.3	Explain that design is a response to wants and needs.
	7.1.4	Discuss that all designs have different characteristics that can be described.
	7.1.5	Illustrate that there are different solutions to a design and that none are perfect.
	7.1.6	Differentiate essential skills of the technology and engineering design process.
	7.1.7	Apply skills necessary for making in design.
Topic 7.2	Grades 3 - 5	
	Student Competencies	
	7.2.1	Illustrate that there are multiple approaches to design.
	7.2.2	Apply the technology and engineering design process.
	7.2.3	Evaluate designs based on criteria, constraints, and standards.
	7.2.4	Interpret how good design improves the human condition.
	7.2.5	Apply universal principles and elements of design.
	7.2.6	Evaluate the strengths and weaknesses of existing design solutions, including their own solutions.
	7.2.7	Practice successful design skills.
	7.2.8	Apply tools, techniques, and materials in a safe manner as part of the design process.
Topic 7.3	Grades 6 – 8	
	Student Competencies	
	7.3.1	Illustrate the benefits and opportunities associated with different approaches to design.
	7.3.2	Apply the technology and engineering design process.
	7.3.3	Refine design solutions to address criteria and constraints.
	7.3.4	Create solutions to problems by identifying and applying human factors in design.
	7.3.5	Assess design quality based upon established principles and elements of design.
	7.3.6	Evaluate the strengths and weaknesses of different design solutions.
	7.3.7	Improve essential skills necessary to successfully design.
Topic 7.4	Grades 9 – 12	
	Student Competencies	
	7.4.1	Determine the best approach by evaluating the purpose of the design.
	7.4.2	Document trade-offs in the technology and engineering design process to produce the optimal design.

	7.4.3	Optimize a design by addressing desired qualities within criteria and constraints.
	7.4.4	Apply principles of human-centered design.
	7.4.5	Illustrate principles, elements, and factors of design.
	7.4.6	Implement the best possible solution to a design.
	7.4.7	Apply a broad range of design skills to their design process.
	7.4.8	Apply a broad range of making skills to their design process.

Standard 8	<i>APPLYING, MAINTAINING, AND ASSESSING TECHNOLOGICAL PRODUCTS AND SYSTEMS</i>	
Topic 8.1	Grades PreK - 2	
	Student Competencies	
	8.1.1	Analyze how things work.
	8.1.2	Identify and use everyday symbols.
	8.1.3	Describe qualities of everyday products.
Topic 8.2	Grades 3 – 5	
	Student Competencies	
	8.2.1	Follow directions to complete a technological task.
	8.2.2	Use appropriate symbols, numbers, and words to communicate key ideas about technological products and systems.
	8.2.3	Identify why a product or system is not working properly.
	8.2.4	Examine information to assess the trade-offs of using a product or system.
Topic 8.3	Grades 6 - 8	
	Student Competencies	
	8.3.1	Research information from various sources to use and maintain technological products or systems.
	8.3.2	Use tools, materials, and machines to safely diagnose, adjust, and repair systems.
	8.3.3	Use devices to control technological systems.
	8.3.4	Design methods to gather data about technological systems.
	8.3.5	Interpret the accuracy of information collected.
	8.3.6	Use instruments to gather data on the performance of everyday products.
Topic 8.4	Grades 9 – 12	
	Student Competencies	
	8.4.1	Use various approaches to communicate processes and procedures for using, maintaining, and assessing technological products and systems.
	8.4.2	Develop a device or system for the marketplace.
	8.4.3	Apply appropriate methods to diagnose, adjust, and repair systems to ensure precise, safe, and proper functionality.
	8.4.4	Synthesize data and analyze trends to make decisions about technological products, systems, or processes.
	8.4.5	Interpret the results of technology assessment to guide policy development.

TECHNOLOGY & ENGINEERING EDUCATION PRACTICES

The technology and engineering practices comprise abilities and disposition that are fundamental to student success. These practices help students engage with the human-designed products, systems and processes we use to satisfy our needs and wants.

TEP-1: Systems Thinking refers to the understanding that technologies contain interconnected components and that these technologies interact with the environments in which they operate and includes the universal systems model.

TEP-2: Creativity is the use of investigation, imagination, innovative thinking and physical skills to accomplish goals.

TEP-3: Making and Doing are at the heart of what make technology & engineering education so different from other fields. Students design, model, build and use technical products and systems.

TEP-4: Critical Thinking involves questioning, logical thinking, reasoning and elaboration in the process of making informed decisions. It also involves analytical thinking; an important component.

TEP-5: Optimism refers to a commitment to finding better solutions to design challenges through experimentation, modeling and adaptation. It reflects a positive view as well as persistence in looking for solutions to technological problems and challenges.

TEP-6: Collaboration refers to having the perspective, knowledge, capabilities and willingness to seek out and include team members when working on design challenges.

TEP-7: Communication in technology and engineering can be either to define problems by gaining an understanding of the wants and needs of the user of technology or as a means of developing and explaining choices made in the design process.

TEP-8: Attention to Ethics is at the core of being a human in society. Attention to ethics means focusing on the impact of technological products, systems and process on others and on the environment. Students should evaluate risks and consider trade-offs in their decision making.

TECHNOLOGY & ENGINEERING EDUCATION CONTEXTS

The technology and engineering contexts are grouped into eight areas that broadly represent the breadth of technological activity. Contexts are vehicles for teaching and applying core disciplinary standards and practices.

TEC-1: Computation, Automation, Artificial Intelligence and Robotics

TEC-2: Material Conversion and Processing

TEC-3: Transportation and Logistics

TEC-4: Energy and Power

TEC-5: Information and Communication

TEC-6: The Built Environment

TEC-7: Medical and Health-Related Technologies

TEC-8: Agricultural and Biological Technologies

Career Ready Practices

1. Act as a Responsible and Contributing Citizen and Employee

Career-ready individuals understand the obligations and responsibilities of being a member of a community and demonstrate this understanding every day through their interactions with others. They are conscientious of the impacts of their decisions on others and the environment around them, think about the near-term and long-term consequences of their actions, and seek to act in ways that contribute to the betterment of their teams, families, community, and workplace. They are reliable and consistent in going beyond the minimum expectation and in participating in activities that serve the greater good.

2. Apply Appropriate Academic and Technical Skills

Career-ready individuals readily access and use the knowledge and skills acquired through experience and education to be more productive. They make connections between abstract concepts with real-world applications and make correct insights about when it is appropriate to apply the use of an academic skill in a workplace situation.

3. Attend to Personal Health and Financial Well-Being

Career-ready individuals understand the relationship between personal health, workplace performance, and personal well-being; they act on that understanding to regularly practice health diet, exercise and mental health activities. Career-ready individuals also take regular action to contribute to their personal financial well-being, understanding that personal financial security provides the peace of mind required to contribute more fully to their own career success.

4. Communicate Clearly, Effectively, and with Reason

Career-ready individuals communicate thoughts, ideas, and action plans with clarity, whether using written, verbal, and/or visual methods. They communicate in the workplace with clarity and purpose to make maximum use of their own and others' time. They are excellent writers; they master conventions, word choice and organization and use effective tone and presentation skills to articulate ideas. They are skilled at interacting with others; they are active listeners and speak clearly and with purpose. Career-ready individuals think about the audience for their communication and prepare accordingly to ensure the desired outcome.

5. Consider the environmental, social, and economic impacts of decisions

Career-ready individuals understand the interrelated nature of their actions and regularly make decisions that positively impact and/or mitigate negative impact on other people, organizations and the environment. They are aware of and utilize new technologies, understandings, procedures, materials and regulations affecting the nature of their work as it relates to the impact on the social condition, the environment and profitability of the organization.

6. Demonstrate creativity and innovation

Career-ready individuals regularly think of ideas that solve problems in new and different ways, and they contribute those ideas in a useful and productive manner to improve their organization. They can consider unconventional ideas and suggestions as solutions to issues, tasks or problems, and they discern which ideas and suggestions will add greatest value. They seek new methods, practices and ideas from a variety of sources and seek to apply those ideas to their own workplace. They take action on their ideas and understand how to bring innovation to an organization.

7. Employ valid and reliable research strategies

Career-ready individuals are discerning in accepting and using new information to make decisions, change practices, or inform strategies. They use a reliable research process to search for new information and evaluate the validity of sources when considering the use and adoption of external information or practices. They use an informed process to test new ideas, information, and practices in their workplace situation.

8. Utilize critical thinking to make sense of problems and persevere in solving them

Career-ready individuals readily recognize problems in the workplace, understand the nature of the problem, and devise effective plans to solve the problem. They are aware of problems when they occur, quickly take action to address the problem, thoughtfully investigate the root cause of the problem prior to introducing solutions, and carefully consider the options to solve the problem. Once a solution is agreed upon, they follow through to ensure the problem is solved, whether through their own actions or the actions of others.

9. Model integrity, ethical leadership, and effective management

Career-ready individuals consistently act in ways that align to personal and community-held ideals and principles while employing strategies to positively influence others in the workplace. They have a clear understanding of integrity and act on this understanding in every decision. They use a variety of means to positively impact the direction and actions of a team or organization, and they apply insights into human behavior to change others' actions, attitudes, and/or beliefs. They recognize the near-term and long-term effects that management's actions and attitudes can have on productivity, morale, and organizational culture.

10. Plan education and career path aligned to personal goals

Career-ready individuals take personal ownership of their own educational and career goals, and they regularly act on a plan to attain these goals. They understand their own career interests, preferences, goals, and requirements. They have perspective regarding the pathways available to them and the time, effort, experience, and other requirements to pursue each, including a path of entrepreneurship. They recognize the value of each step in the educational and experiential process, and they recognize that nearly all career paths require ongoing education and experience. They seek counselors, mentors, and other experts to assist in the planning and execution of career and personal goals.

11. Use technology to enhance productivity

Career-ready individuals find and maximize the productive value of existing and new technology to accomplish workplace tasks and solve workplace problems. They are flexible and adaptive in acquiring and using new technology, being proficient with ubiquitous technology applications. They understand the inherent risks, personal and organizational, of technology applications, and they take actions to prevent or mitigate these risks.

12. Work productively in teams while using cultural/global competence

Career-ready individuals positively contribute to every team whether formal or informal. They apply an awareness of cultural differences to avoid barriers to productive and positive interaction. They find ways to increase the engagement and contribution of all team members. They plan and facilitate effective team meetings.