STATE OF NEW JERSEY
DEPARTMENT OF EDUCATION

2020 New Jersey Student Learning Standards – Computer Science and Design Thinking

Introduction

Computer Science and Design Thinking

New approaches necessary for solving the critical challenges that we face as a society will require harnessing the power of technology and computing. Rapidly changing technologies and the proliferation of digital information have permeated and radically transformed learning, working, and everyday life. To be well-educated, global-minded individuals in a computing-intensive world, students must have a clear understanding of the concepts and practices of computer science. As education systems adapt to a vision of students who are not just computer users but also computationally literate creators who are proficient in the concepts and practices of computer science and design thinking, engaging students in computational thinking and human-centered approaches to design through the study of computer science and technology serves to prepare students to ethically produce and critically consume technology.

Mission

Computer science and design thinking education prepares students to succeed in today's knowledge-based economy by providing equitable and expanded access to high-quality, standards-based computer science and technological design education.

Vision

All students have equitable access to a rigorous computer science and design thinking education. Students will benefit from opportunities to engage in high-quality technology programs that foster their ability to:

- develop and apply computational and design thinking to address real-world problems and design creative solutions;
- engage as collaborators, innovators, and entrepreneurs on a clear pathway to success through postsecondary education and careers;
- navigate the dynamic digital landscape to become healthy, productive, 21st century global-minded individuals; and
- participate in an inclusive and diverse computing culture that appreciates and incorporates perspectives from people of different genders, ethnicities, and abilities.

Intent and Spirit of the Computer Science and Design Thinking Standards

All students receive computer science and design thinking instruction from Kindergarten through grade 12. The study of these disciplines focuses on deep understanding of concepts that enable students to think critically and systematically about leveraging technology to solve local and global issues. Authentic learning experiences that enable students to apply content knowledge, integrate concepts across disciplines, develop computational thinking skills, acquire and incorporate varied perspectives, and communicate with diverse audiences about the use and effects of computing prepares New Jersey students for college and careers.

Revised Standards

Framework for NJ Designed Standards

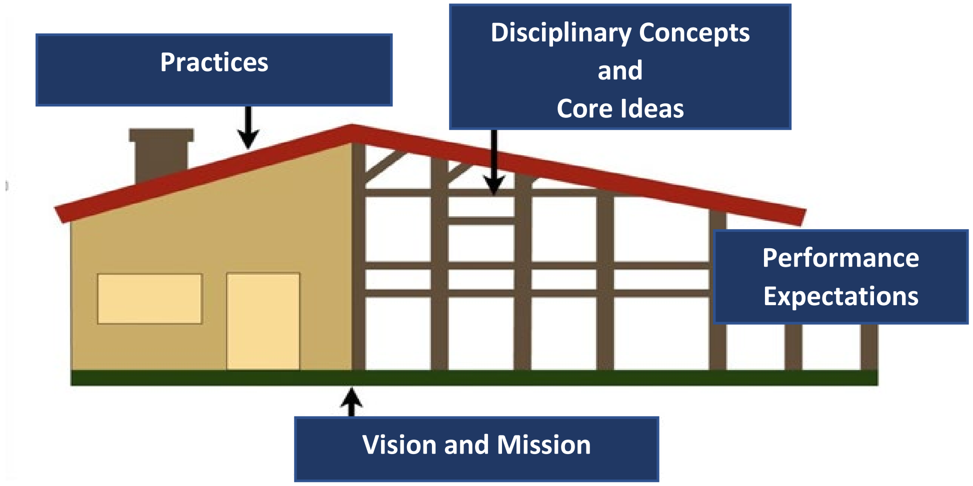
New to this version of the NJSLS-CS&DT are the following:

- Standard 8.1 Computer Science
  - Computer Science, previously a strand entitled 'Computational Thinking: Programming' in standard 8.2 of the 2014 NJSLS-Technology, outlines a comprehensive set of concepts and skills, such as data and analysis, algorithms and programming, and computing systems.
- Standard 8.2 Design Thinking
  - This standard, previously standard 8.2 Technology Education of the 2014 NJSLS – Technology, outlines the technological design concepts and skills essential for technological and engineering literacy. The new framework design, detailed previously, includes Engineering Design, Ethics and Culture, and the Effects of Technology on the Natural world among the disciplinary concepts.

* Please note that the concepts and skills previously included in 8.1 Educational Technology of the 2014 NJSLS – Technology have been expanded and integrated across multiple disciplinary concepts in the 2020 NJSLS – Career Readiness, Life Literacies, and Key Skills standard 9.4. Given the ubiquity of technology, our students will continue to be required to demonstrate increasing levels of proficiency to access, manage, evaluate, and synthesize information in their personal, academic, and professional lives. Therefore, the standards that were housed in one discipline have been enhanced and restructured to reflect the continued need for student learning in technology literacy, digital citizenship, and information and media literacy.

The design of this version of the NJSLS – Computer Science and Design Thinking (NJSLS-CS&DT) is intended to:

- promote the development of curricula and learning experiences that reflect the vision and mission of computer science and design thinking as stated in the beginning of this document;
- foster greater coherence and appropriate progressions across grade bands;
- prioritize the important ideas and core processes that are central to computing and have lasting value beyond the classroom; and
- reflect the habits of mind central to technology that lead to post-secondary success.



In this diagram:

- The *Vision and Mission* serve as the foundation for each content areas' standards. They describe the important role of the discipline in the world and reflect the various statutes, regulations, and policy.
- The *Performance Expectations* are the studs and serve as the framework for what students should know and be able to do. They incorporate the knowledge and skills that are most important for students to know in order to be prepared for post-secondary success.
- The *Disciplinary Concepts and Core Ideas* are the joists and play an integral role in the framing by making connections among the performance expectations. Core ideas help to prioritize the important ideas and core processes that are central to a discipline and have lasting value beyond the classroom. They provide clear guidance as to what should be the focus of learning by the end of each grade band (i.e., end of grades 2, 5, 8, and 12).
- The *Practices* are the roof and represent two key ideas. Positioned as the top of the house, they represent the apex of learning. The goal is for students to internalize the practices (habits of mind) and be able to apply them to new situations outside the school environment. The practices span across all aspects of the standards and are an integral part of K-12 students' learning of the disciplines.

Disciplinary Concepts and Core Ideas

Computing Systems

People interact with a wide variety of computing devices that collect, store, analyze, and act upon information in ways that can affect human capabilities both positively and negatively. The physical components (hardware) and instructions (software) that make up a computing system communicate and process information in digital form.

By the end of grade 2	By the end of grade 5	By the end of grade 8	By the end of grade 12
• Individuals use computing devices to perform a variety of tasks accurately and quickly. Computing devices interpret and follow the instructions they are given literally. • A computing system is composed of software and hardware. • Describing a problem is the first step toward finding a solution when computing systems do not work as expected.	• Computing devices may be connected to other devices to form a system as a way to extend their capabilities. • Software and hardware work together as a system to accomplish tasks (e.g., sending, receiving, processing, and storing units of information). • Shared features allow for common troubleshooting strategies that can be effective for many systems.	• The study of human-computer interaction can improve the design of devices and extend the abilities of humans. • Software and hardware determine a computing system's capability to store and process information. The design or selection of a computing system involves multiple considerations and potential trade-offs. • Troubleshooting a problem is more effective when knowledge of the specific device along with a systematic process is used to identify the source of a problem.	• The usability, dependability, security, and accessibility of devices within integrated systems are important considerations in their design as they evolve. • A computing system involves interaction among the user, hardware, application software, and system software. • Successful troubleshooting of complex problems involves multiple approaches including research, analysis, reflection, interaction with peers, and drawing on past experiences.

Networks and the Internet

Computing devices typically do not operate in isolation. Networks connect computing devices to share information and resources and are an increasingly integral part of computing. Networks and communication systems provide greater connectivity in the computing world.

By the end of grade 2	By the end of grade 5	By the end of grade 8	By the end of grade 12
• Computer networks can be used to connect individuals to other individuals, places, information, and ideas. The Internet enables individuals to connect with others worldwide. • Connecting devices to a network or the Internet provides great benefits, but care must be taken to use authentication measures, such as strong passwords, to protect devices and information from unauthorized access.	• Information needs a physical or wireless path to travel to be sent and received. • Distinguishing between public and private information is important for safe and secure online interactions. • Information can be protected using various security measures (i.e., physical and digital).	• Protocols, packets and addressing are the key components for reliable delivery of information across networks. • The information sent and received across networks can be protected from unauthorized access and modification in a variety of ways. • The evolution of malware leads to understanding the key security measures and best practices needed to proactively address the threat to digital data.	• The scalability and reliability of the Internet are enabled by the hierarchy and redundancy in networks. • Network topology is determined by many characteristics. • Network security depends on a combination of hardware, software, and practices that protect data while it is at rest, in transit, and in use. • The needs of users and the sensitivity of data determine the level of security implemented. Advanced attacks take advantage of common security vulnerabilities.

Impacts of Computing

Computing affects many aspects of the world in both positive and negative ways at local, national, and global levels. Individuals and communities influence computing through their behaviors and cultural and social interactions, and, in turn, computing influences new cultural practices.

By the end of grade 2	By the end of grade 5	By the end of grade 8	By the end of grade 12
Computing technology has positively and negatively changed the way individuals live and work (e.g., entertainment, communication, productivity tools).	The development and modification of computing technology is driven by people's needs and wants and can affect individuals differently.	• Advancements in computing technology can change individuals' behaviors. • Society is faced with trade-offs due to the increasing globalization and automation that computing brings.	The design and use of computing technologies and artifacts can positively or negatively affect equitable access to information and opportunities.

Data & Analysis

Computing systems exist to process data. The amount of digital data generated in the world is rapidly expanding, so the need to process data effectively is increasingly important. Data is collected and stored so that it can be analyzed to better understand the world and make more accurate predictions.

By the end of grade 2	By the end of grade 5	By the end of grade 8	By the end of grade 12
• Individuals collect, use, and display data about individuals and the world around them. • Computers store data that can be retrieved later. Data can be copied, stored in multiple locations, and retrieved. • Data can be used to make predictions about the world.	• Data can be organized, displayed, and presented to highlight relationships • The type of data being stored affects the storage requirements. • Individuals can select, organize, and transform data into different visual representations and communicate insights gained from the data. • Many factors influence the accuracy of inferences and predictions.	• People use digital devices and tools to automate the collection, use, and transformation of data. • The manner in which data is collected and transformed is influenced by the type of digital device(s) available and the intended use of the data. • Data is represented in many formats. Software tools translate the low-level representation of bits into a form understandable by individuals. Data is organized and accessible based on the application used to store it. • The purpose of cleaning data is to remove errors and make it easier for computers to process. • Computer models can be used to simulate events, examine theories and inferences, or make predictions.	• Individuals select digital tools and design automated processes to collect, transform, generalize, simplify, and present large data sets in different ways to influence how other people interpret and understand the underlying information. • Choices individuals make about how and where data is organized and stored affects cost, speed, reliability, accessibility, privacy, and integrity. • Large data sets can be transformed, generalized, simplified, and presented in different ways to influence how individuals interpret and understand the underlying information. • The accuracy of predictions or inferences made from a computer model is affected by the amount, quality, and diversity of data.

Algorithms & Programming

An algorithm is a sequence of steps designed to accomplish a specific task. Algorithms are translated into programs, or code, to provide instructions for computing devices. Algorithms and programming control all computing systems, empowering people to communicate with the world in new ways and solve compelling problems.

By the end of grade 2	By the end of grade 5	By the end of grade 8	By the end of grade 12
• Individuals develop and follow directions as part of daily life. • A sequence of steps can be expressed as an algorithm that a computer can process. • Real world information can be stored and manipulated in programs as data (e.g., numbers, words, colors, images). • Computers follow precise sequences of steps that automate tasks. • Complex tasks can be broken down into simpler instructions, some of which can be broken down even further. • People work together to develop programs for a purpose, such as expressing ideas or addressing problems. • The development of a program involves identifying a sequence of events, goals, and expected outcomes, and addressing errors (when necessary).	• Different algorithms can achieve the same result. • Some algorithms are more appropriate for a specific use than others. • Programming languages provide variables, which are used to store and modify data. • A variety of control structures are used to change the flow of program execution (e.g., sequences, events, loops, conditionals). • Programs can be broken down into smaller parts to facilitate their design, implementation, and review. Programs can also be created by incorporating smaller portions of programs that already exist. • Individuals develop programs using an iterative process involving design, implementation, testing, and review.	• Individuals design algorithms that are reusable in many situations. • Algorithms that are readable are easier to follow, test, and debug. • Programmers create variables to store data values of different types and perform appropriate operations on their values. • Control structures are selected and combined in programs to solve more complex problems. • Programs use procedures to organize code and hide implementation details. Procedures can be repurposed in new programs. Defining parameters for procedures can generalize behavior and increase reusability. • Individuals design and test solutions to identify problems taking into consideration the diverse needs of the users and the community.	• Individuals evaluate and select algorithms based on performance, reusability, and ease of implementation. • Programmers choose data structures to manage program complexity based on functionality, storage, and performance trade-offs. • Trade-offs related to implementation, readability, and program performance are considered when selecting and combining control structures. • Complex programs are designed as systems of interacting modules, each with a specific role, coordinating for a common overall purpose. Modules allow for better management of complex tasks. • Complex programs are developed, tested, and analyzed by teams drawing on the members' diverse strengths using a variety of resources, libraries, and tools.

Engineering Design

People design for enjoyment and to solve problems, extend human capabilities, satisfy needs and wants, and improve the human condition. Engineering Design, a systematic approach to creating solutions to technological problems and finding ways to meet people's needs and desires, allows for the effective and efficient development of products and systems.

By the end of grade 2	By the end of grade 5	By the end of grade 8	By the end of grade 12
• Engineering design is a creative process for meeting human needs or wants that can result in multiple solutions. • Limitations (constraints) must be considered when engineering designs.	• Engineering design is a systematic and creative process of communicating and collaborating to meet a design challenge. • Often, several design solutions exist, each better in some way than the others. • Engineering design requirements include desired features and limitations that need to be considered.	• Engineering design is a systematic, creative and iterative process used to address local and global problems. • The process includes generating ideas, choosing the best solution, and making, testing, and redesigning models or prototypes. • Engineering design requirements and specifications involve making trade-offs between competing requirements and desired design features.	• Engineering design is a complex process in which creativity, content knowledge, research, and analysis are used to address local and global problems. • Decisions on trade-offs involve systematic comparisons of all costs and benefits, and final steps that may involve redesigning for optimization. • Engineering design evaluation, a process for determining how well a solution meets requirements, involves systematic comparisons between requirements, specifications, and constraints.

Interaction of Technology and Humans

Societies influence technological development. Societies are characterized by common elements such as shared values, differentiated roles, and cultural norms, as well as by entities such as community institutions, organizations, and businesses. Interaction of Technology and Humans concerns the ways society drives the improvement and creation of new technologies, and how technologies both serve and change society.

By the end of grade 2	By the end of grade 5	By the end of grade 8	By the end of grade 12
• Human needs and desires determine which new tools are developed. • Technology has changed the way people live and work. • Various tools can improve daily tasks and quality of life.	• Societal needs and wants determine which new tools are developed to address real-world problems. • A new tool may have favorable or unfavorable results as well as both positive and negative effects on society. • Technology spurs new businesses and careers.	• Economic, political, social, and cultural aspects of society drive development of new technological products, processes, and systems. • Technology interacts with society, sometimes bringing about changes in a society's economy, politics, and culture, and often leading to the creation of new needs and wants. • New needs and wants may create strains on local economies and workforces. • Improvements in technology are intended to make the completion of tasks easier, safer, and/or more efficient.	• Decisions to develop new technology are driven by societal and cultural opinions and demands that differ from culture to culture. • Changes caused by the introduction and use of a new technology can range from gradual to rapid and from subtle to obvious, and can change over time. These changes may vary from society to society as a result of differences in a society's economy, politics, and culture.

Nature of Technology

Human population, patterns and movement focus on the size, composition, distribution, and movement of human populations and how they are fundamental and active features on Earth's surface. This includes understanding that the expansion and redistribution of the human population affects patterns of settlement, environmental changes, and resource use. Patterns and movements of population also relate to physical phenomena including climate variability, landforms, and locations of various natural hazards and their effects on population size, composition, and distribution.

By the end of grade 2	By the end of grade 5	By the end of grade 8	By the end of grade 12
Innovation and the improvement of existing technology involves creative thinking.	• Technology innovation and improvement may be influenced by a variety of factors. • Engineers create and modify technologies to meet people's needs and wants; scientists ask questions about the natural world.	• Technology advances through the processes of innovation and invention which relies upon the imaginative and inventive nature of people. • Sometimes a technology developed for one purpose is adapted to serve other purposes. • Engineers use a systematic process of creating or modifying technologies that is fueled and constrained by physical laws, cultural norms, and economic resources. Scientists use systematic investigation to understand the natural world.	• Engineers use science, mathematics, and other disciplines to improve technology. Increased collaboration among engineers, scientists, and mathematicians can improve their work and designs. • Technology, product, or system redesign can be more difficult than the original design.

Effects of Technology on the Natural World

Many of engineering and technology's impacts on society and the environment are widely regarded as desirable. However, other impacts are regarded as less desirable. Effects of Technology on the Natural World concerns the positive and negative ways that technologies affect the natural world.

By the end of grade 2	By the end of grade 5	By the end of grade 8	By the end of grade 12
• The use of technology developed for the human designed world can affect the environment, including land, water, air, plants, and animals. • Technologies that use natural sources can have negative effects on the environment, its quality, and inhabitants. • Reusing and recycling materials can save money while preserving natural resources and avoiding damage to the environment.	• The technology developed for the human designed world can have unintended consequences for the environment. • Technology must be continually developed and made more efficient to reduce the need for non-renewable resources.	• Resources need to be utilized wisely to have positive effects on the environment and society. • Some technological decisions involve trade-offs between environmental and economic needs, while others have positive effects for both the economy and environment.	• Development and modification of any technological system needs to take into account how the operation of the system will affect natural resources and ecosystems. • Impacts of technological systems on the environment need to be monitored and must inform decision-making. • Many technologies have been designed to have a positive impact on the environment and to monitor environmental change over time.

Ethics & Culture

Ethics and Culture concerns the profound effects that technologies have on people, how those effects can widen or narrow disparities, and the responsibility that people have for the societal consequences of their technological decisions.

By the end of grade 2	By the end of grade 5	By the end of grade 8	By the end of grade 12
The availability of technology for essential tasks varies in different parts of the world.	Technological choices and opportunities vary due to factors such as differences in economic resources, location, and cultural values.	Technological disparities have consequences for public health and prosperity.	• The ability to ethically integrate new technologies requires deciding whether to introduce a technology, taking into consideration local resources and the role of culture in acceptance. • Consequences of technological use may be different for different groups of people and may change over time. • Since technological decisions can have ethical implications, it is essential that individuals analyze issues by gathering evidence from multiple perspectives and conceiving of alternative possibilities before proposing solutions.

Computer Science and Design Thinking Practices

The practices describe the behaviors and ways of thinking that computationally literate students use to fully engage in today's data-rich and interconnected world. Computational thinking is at the heart of the practices and refers to the thought processes involved in expressing solutions as computational steps that can be carried out by a computer. It requires understanding the capabilities of computers, formulating problems addressed by a computer, and designing algorithms that a computer can execute. Curriculum writers and educators will want to consider how they can design learning experiences that will enable their students to develop these skills in conjunction with the content knowledge reflected in the core ideas and performance expectations.

Practice	Description
1 Fostering an Inclusive Computing and Design Culture	Building an inclusive and diverse computing culture requires strategies for incorporating perspectives from people of different genders, ethnicities, and abilities. Incorporating these perspectives involves understanding the personal, ethical, social, economic, and cultural contexts in which people operate. Considering the needs of diverse users during the design process is essential to producing inclusive computational products. When engaging in this practice, students: • Include the unique perspectives of others and reflect on one's own perspectives when designing and developing computational products. • Address the needs of diverse end users during the design process to produce artifacts with broad accessibility and usability. • Employ self- and peer-advocacy to address bias in interactions, product design, and development methods.
2 Collaborating Around Computing and Design	Collaborative computing is the process of performing a computational task by working on pairs in teams. Because it involves asking for the contributions and feedback of others, effective collaboration can lead to better outcomes than working independently. Collaboration requires individuals to navigate and incorporate diverse perspectives, conflicting ideas, disparate skills, and distinct personalities. Students should use collaborative tools to effectively work together and to create complex artifacts. When engaging in this practice, students: • Cultivate working relationships with individuals possessing diverse perspectives, skills, and personalities. • Create team norms, expectations, and equitable workloads to increase efficiency and effectiveness. • Solicit and incorporate feedback from, and provide constructive feedback to, team members and other stakeholders. Evaluate and select technological tools that can be used to collaborate on a project.

Practice	Description
3 Recognizing and Defining Computational Problems	The ability to recognize appropriate and worthwhile opportunities to apply computation is a skill that develops over time and is central to computing. Solving a problem with a computational approach requires defining the problem, breaking it down into parts, and evaluating each part to determine whether a computational solution is appropriate. When engaging in this practice, students: • Identify complex, interdisciplinary, real-world problems that can be solved computationally. • Decompose complex real-world problems into manageable sub-problems that could integrate existing solutions or procedures. • Evaluate whether it is appropriate and feasible to solve a problem computationally.
4 Developing and Using Abstractions	Abstractions are formed by identifying patterns and extracting common features from specific examples in order to create generalizations. Using generalized solutions and parts of solutions designed for broad reuse simplifies the development process by managing complexity. When engaging in this practice, students: • Extract common features from a set of interrelated processes or complex phenomena. • Evaluate existing technological functionalities and incorporate them into new designs. • Create modules and develop points of interaction that can apply to multiple situations and reduce complexity. • Model phenomena and processes and simulate systems to understand and evaluate potential outcomes.
5 Creating Computational Artifacts	The process of developing computational artifacts embraces both creative expression and the exploration of ideas to create prototypes and solve computational problems. Students create artifacts that are personally relevant or beneficial to their community and beyond. Computational artifacts can be created by combining and modifying existing artifacts or by developing new artifacts. Examples of computational artifacts include programs, simulations, visualizations, digital animations, robotic systems, and apps. When engaging in this practice, students: • Plan the development of a computational artifact using an iterative process that includes reflection on and modification of the plan, taking into account key features, time and resource constraints, and user expectations. • Create a computational artifact for practical intent, personal expression, or to address a societal issue. • Modify an existing artifact to improve or customize it.

Practice	Description
6 Testing and Refining Computational Artifacts	Testing and refinement is the deliberate and iterative process of improving a computational artifact. This process includes debugging (identifying and fixing errors) and comparing actual outcomes to intended outcomes. Students also respond to the changing needs and expectations of end users and improve the performance, reliability, usability, and accessibility of artifacts. When engaging in this practice, students: • Systematically test computational artifacts by considering all scenarios and using test cases. • Identify and fix errors using a systematic process. • Evaluate and refine a computational artifact, multiple times, to enhance its performance, reliability, usability, and accessibility.
7 Communicating About Computing and Design	Communication involves personal expression and exchanging ideas with others. In computer science, students communicate with diverse audiences about the use and effects of computation and the appropriateness of computational choices. Students write clear comments, document their work, and communicate their ideas through multiple forms of media. Clear communication includes using precise language and carefully considering possible audiences. When engaging in this practice, students: • Select, organize, and interpret large data sets from multiple sources to support a claim. • Describe, justify, and document computational and/or design processes and solutions using appropriate terminology consistent with the intended audience and purpose. • Articulate ideas responsibly by observing intellectual property rights and giving appropriate attribution.

Standards in Action: Climate Change

Although the future of work is unclear, thought leaders assert that artificial intelligence, the Internet of Things, robotics, and machine learning will be ubiquitous in tomorrow's workplaces (Malyn-Smith et al, 2018). This vision of the future includes a new machine age, where humans will shape technology, technology will shape human interaction, and where technologies and humans will collaborate to discover and innovate (Mervis, 2016; Van Opstal, Evans, Bates, & Knuckles, 2008).

At the core of computer science and design thinking education, is the goal to prepare students with the essential knowledge and skills to make their local and global communities a better place to live. Learning experiences that enable students to apply content knowledge and employ computational thinking skills prepare students for the work of tomorrow by proposing solutions concerning the balancing of societal, environmental, and economic needs for a sustainable future. Further, leveraging topics such as computational sustainability and clean technology (Cleantech), technologies that either reduce or optimize the use of natural resources while reducing the negative effect that technology has on the planet and its ecosystems, is essential for developing a populace with the knowledge and skills necessary to mitigate the effects of climate change.

Structure of the NJSLS - Computer Science and Design Thinking

The *core ideas* are derived from the disciplinary concepts and students' understandings increase in sophistication over time as they engage with these ideas in new and varied contexts. The core ideas are what is most essential for students to learn and represent the knowledge and skills that they should be able to apply to new situations outside of the school experience. Curriculum writers and educators can use these core ideas as the basis for formative, summative, and benchmark assessments.

The *performance expectations* describe what students should know and be able to do. It is expected that curriculum writers and educators will bundle these performance expectations together in meaningful ways as a basis for classroom instruction and to guide the creation of formative, summative, and benchmark assessments.

Coding of Performance Expectations

To promote a unified vision of the NJSLS-CSDT, an abbreviated form of the disciplinary concepts is included in the alphanumeric code. The disciplinary concepts are abbreviated as follows:

- Computing Systems (CS)
- Networks and the Internet (NI)
- Impacts of Computing (IC)
- Data & Analysis (DA)
- Algorithms & Programming (AP)
- Engineering Design (ED)
- Interaction of Technology and Humans (ITH)
- Nature of Technology (NT)
- Effects of Technology on the Natural World (ETW)
- Ethics & Culture (EC)

For each standard, the performance expectation code should be interpreted as follows (e.g., 8.1.2.NI.1):

8.1	**2**	**NI**	**1**
Standard number	By the end of grade	Disciplinary Concept	Performance Expectation

New Jersey Legislative Statutes and Administrative Code

Curriculum Development: Integration of 21st Century Skills and Themes and Interdisciplinary Connections
District boards of education shall be responsible for the review and continuous improvement of curriculum and instruction based upon changes in knowledge, technology, assessment results, and modifications to the NJSLS, according to N.J.A.C. 6A:8-2.

1. District boards of education shall include interdisciplinary connections throughout the K–12 curriculum.
2. District boards of education shall integrate into the curriculum 21st century themes and skills (N.J.A.C. 6A:8-3.1(c).

Twenty-first century themes and skills integrated into all content standards areas (N.J.A.C. 6A:8-1.1(a)3).
"Twenty-first century themes and skills" means themes such as global awareness; financial, economic, business, and entrepreneurial literacy; civic literacy; health literacy; learning and innovation skills, including creativity and innovation, critical thinking and problem solving, and communication and collaboration; information, media, and technology skills; and life and career skills, including flexibility and adaptability, initiative and self-direction, social and cross-cultural skills, productivity and accountability, and leadership and responsibility.

Computer Science Endorsement Law: N.J.S.A. 18A:26-2.26
The State Board of Education shall authorize a computer science education endorsement to the instructional certificate. The endorsement shall authorize the holder to teach computer science in all public schools, and shall be required to teach computer science in grades 9 through 12 beginning at such time as the State board determines that there is a sufficient number of teachers holding the computer science education endorsement to make the requirement feasible.

Offer Courses in Computer Science Law: N.J.S.A. 18A:7C-1.1
No later than the beginning of the 2018-2019 school year, each public school enrolling students in grades nine through 12, other than a county vocational school district, shall offer a course in computer science. The course shall include, but need not be limited to, instruction in computational thinking, computer programming, the appropriate use of the Internet and development of Internet web pages, data security and the prevention of data breaches, ethical matters in computer science, and the global impact of advancements in computer science.

Certain Computer Science Course may satisfy credit requirement: N.J.S.A. 18A:7C-2.1
Beginning with the 2016-2017 grade nine class, the State Board of Education shall require that the local graduation requirements adopted by a board of education permit an Advanced Placement computer science course to satisfy a part of the total credit requirement in mathematics. For an Advanced Placement computer science course to satisfy a part of the mathematics credit requirement, the student must be concurrently enrolled in or have successfully completed algebra 1 and geometry or the content equivalent.

Amistad Law: N.J.S.A. 18A 52:16A-88
Every board of education shall incorporate the information regarding the contributions of African-Americans to our country in an appropriate place in the curriculum of elementary and secondary school students.

Holocaust Law: N.J.S.A. 18A:35-28
Every board of education shall include instruction on the Holocaust and genocides in an appropriate place in the curriculum of all elementary and secondary school pupils. The instruction shall further emphasize the personal responsibility that each citizen bears to fight racism and hatred whenever and wherever it happens.

LGBT and Disabilities Law: N.J.S.A. 18A:35-4.35
A board of education shall include instruction on the political, economic, and social contributions of persons with disabilities and lesbian, gay, bisexual, and transgender people, in an appropriate place in the curriculum of middle school and high school students as part of the district's implementation of the New Jersey Student Learning Standards (N.J.S.A.18A:35-4.36) A board of education shall have policies and procedures in place pertaining to the selection of instructional materials to implement the requirements of N.J.S.A. 18A:35-4.35.

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STATE OF NEW JERSEY
DEPARTMENT OF EDUCATION

2020 New Jersey Student Learning Standards – Computer Science and Design Thinking

8.1 Computer Science by the End of Grade 2

Computing Systems

Core Idea	Performance Expectations
Individuals use computing devices to perform a variety of tasks accurately and quickly. Computing devices interpret and follow the instructions they are given literally.	8.1.2.CS.1: Select and operate computing devices that perform a variety of tasks accurately and quickly based on user needs and preferences.
A computing system is composed of software and hardware.	8.1.2.CS.2: Explain the functions of common software and hardware components of computing systems.
Describing a problem is the first step toward finding a solution when computing systems do not work as expected.	8.1.2.CS.3: Describe basic hardware and software problems using accurate terminology.

Networks and the Internet

Core Idea	Performance Expectations
Computer networks can be used to connect individuals to other individuals, places, information, and ideas. The Internet enables individuals to connect with others worldwide.	• 8.1.2.NI.1: Model and describe how individuals use computers to connect to other individuals, places, information, and ideas through a network. • 8.1.2.NI.2: Describe how the Internet enables individuals to connect with others worldwide.

Core Idea	Performance Expectations
Connecting devices to a network or the Internet provides great benefits, but care must be taken to use authentication measures, such as strong passwords, to protect devices and information from unauthorized access.	• 8.1.2.NI.3: Create a password that secures access to a device. Explain why it is important to create unique passwords that are not shared with others. • 8.1.2.NI.4: Explain why access to devices need to be secured.

Impacts of Computing

Core Idea	Performance Expectations
Computing technology has positively and negatively changed the way individuals live and work (e.g., entertainment, communication, productivity tools).	8.1.2.IC.1: Compare how individuals live and work before and after the implementation of new computing technology.

Data & Analysis

Core Idea	Performance Expectations
Individuals collect, use, and display data about individuals and the world around them.	8.1.2.DA.1: Collect and present data, including climate change data, in various visual formats.
Computers store data that can be retrieved later.–Data can be copied, stored in multiple locations, and retrieved.	8.1.2.DA.2: Store, copy, search, retrieve, modify, and delete data using a computing device.
Data can be used to make predictions about the world.	• 8.1.2.DA.3: Identify and describe patterns in data visualizations. • 8.1.2.DA.4: Make predictions based on data using charts or graphs.

Algorithms & Programming

Core Idea	Performance Expectations
Individuals develop and follow directions as part of daily life. A sequence of steps can be expressed as an algorithm that a computer can process.	8.1.2.AP.1: Model daily processes by creating and following algorithms to complete tasks.
Real world information can be stored and manipulated in programs as data (e.g., numbers, words, colors, images).	8.1.2.AP.2: Model the way programs store and manipulate data by using numbers or other symbols to represent information.
Computers follow precise sequences of steps that automate tasks.	8.1.2.AP.3: Create programs with sequences and simple loops to accomplish tasks.
Complex tasks can be broken down into simpler instructions, some of which can be broken down even further.	8.1.2.AP.4: Break down a task into a sequence of steps.
People work together to develop programs for a purpose, such as expressing ideas or addressing problems. The development of a program involves identifying a sequence of events, goals, and expected outcomes, and addressing errors (when necessary).	• 8.1.2.AP.5: Describe a program's sequence of events, goals, and expected outcomes. • 8.1.2.AP.6: Debug errors in an algorithm or program that includes sequences and simple loops.

2020 New Jersey Student Learning Standards – Computer Science and Design Thinking

8.1 Computer Science by the End of Grade 5

Computing Systems

Core Idea	Performance Expectations
Computing devices may be connected to other devices to form a system as a way to extend their capabilities.	8.1.5.CS.1: Model how computing devices connect to other components to form a system.
Software and hardware work together as a system to accomplish tasks (e.g., sending, receiving, processing, and storing units of information).	8.1.5.CS.2: Model how computer software and hardware work together as a system to accomplish tasks.
Shared features allow for common troubleshooting strategies that can be effective for many systems.	8.1.5.CS.3: Identify potential solutions for simple hardware and software problems using common troubleshooting strategies.

Networks and the Internet

Core Idea	Performance Expectations
Information needs a physical or wireless path to travel to be sent and received.	8.1.5.NI.1: Develop models that successfully transmit and receive information using both wired and wireless methods.

Core Idea	Performance Expectations
Distinguishing between public and private information is important for safe and secure online interactions. Information can be protected using various security measures (i.e., physical and digital).	8.1.5.NI.2: Describe physical and digital security measures for protecting sensitive personal information.

Impacts of Computing

Core Idea	Performance Expectations
The development and modification of computing technology is driven by individual's needs and wants and can affect individuals differently.	• 8.1.5.IC.1: Identify computing technologies that have impacted how individuals live and work and describe the factors that influenced the changes. • 8.1.5.IC.2: Identify possible ways to improve the accessibility and usability of computing technologies to address the diverse needs and wants of users.

Data & Analysis

Core Idea	Performance Expectations
Data can be organized, displayed, and presented to highlight relationships.	8.1.5.DA.1: Collect, organize, and display data in order to highlight relationships or support a claim.
The type of data being stored affects the storage requirements.	8.1.5.DA.2: Compare the amount of storage space required for different types of data.
Individuals can select, organize, and transform data into different visual representations and communicate insights gained from the data.	• 8.1.5.DA.3: Organize and present collected data visually to communicate insights gained from different views of the data. • 8.1.5.DA.4: Organize and present climate change data visually to highlight relationships or support a claim.
Many factors influence the accuracy of inferences and predictions.	8.1.5.DA.5: Propose cause and effect relationships, predict outcomes, or communicate ideas using data.

Algorithms & Programming

Core Idea	Performance Expectations
Different algorithms can achieve the same result. Some algorithms are more appropriate for a specific use than others.	8.1.5.AP.1: Compare and refine multiple algorithms for the same task and determine which is the most appropriate.
Programming languages provide variables, which are used to store and modify data.	8.1.5.AP.2: Create programs that use clearly named variables to store and modify data.
A variety of control structures are used to change the flow of program execution (e.g., sequences, events, loops, conditionals).	8.1.5.AP.3: Create programs that include sequences, events, loops, and conditionals.
Programs can be broken down into smaller parts to facilitate their design, implementation, and review. Programs can also be created by incorporating smaller portions of programs that already exist.	• 8.1.5.AP.4: Break down problems into smaller, manageable sub-problems to facilitate program development. • 8.1.5.AP.5: Modify, remix, or incorporate pieces of existing programs into one's own work to add additional features or create a new program.
Individuals develop programs using an iterative process involving design, implementation, testing, and review.	8.1.5.AP.6: Develop programs using an iterative process, implement the program design, and test the program to ensure it works as intended.

2020 New Jersey Student Learning Standards – Computer Science and Design Thinking

8.1 Computer Science by the End of Grade 8

Computing Systems

Core Idea	Performance Expectations
The study of human–computer interaction can improve the design of devices and extend the abilities of humans.	8.1.8.CS.1: Recommend improvements to computing devices in order to improve the ways users interact with the devices.
Software and hardware determine a computing system's capability to store and process information. The design or selection of a computing system involves multiple considerations and potential trade-offs.	• 8.1.8.CS.2: Design a system that combines hardware and software components to process data. • 8.1.8.CS.3: Justify design decisions and explain potential system trade-offs.
Troubleshooting a problem is more effective when knowledge of the specific device along with a systematic process is used to identify the source of a problem.	8.1.8.CS.4: Systematically apply troubleshooting strategies to identify and resolve hardware and software problems in computing systems.

Networks and the Internet

Core Idea	Performance Expectations
Protocols, packets, and addressing are the key components for reliable delivery of information across networks.	• 8.1.8.NI.1: Model how information is broken down into smaller pieces, transmitted as addressed packets through multiple devices over networks and the Internet, and reassembled at the destination. • 8.1.8.NI.2: Model the role of protocols in transmitting data across networks and the Internet and how they enable secure and errorless communication.

Core Idea	Performance Expectations
The information sent and received across networks can be protected from unauthorized access and modification in a variety of ways. The evolution of malware leads to understanding the key security measures and best practices needed to proactively address the threat to digital data.	• 8.1.8.NI.3: Explain how network security depends on a combination of hardware, software, and practices that control access to data and systems. • 8.1.8.NI.4: Explain how new security measures have been created in response to key malware events.

Impacts of Computing

Core Idea	Performance Expectations
Advancements in computing technology can change individuals' behaviors. Society is faced with trade-offs due to the increasing globalization and automation that computing brings.	• 8.1.8.IC.1: Compare the trade-offs associated with computing technologies that affect individual's everyday activities and career options. • 8.1.8.IC.2: Describe issues of bias and accessibility in the design of existing technologies.

Data & Analysis

Core Idea	Performance Expectations
People use digital devices and tools to automate the collection, use, and transformation of data. The manner in which data is collected and transformed is influenced by the type of digital device(s) available and the intended use of the data.	8.1.8.DA.1: Organize and transform data collected using computational tools to make it usable for a specific purpose.
Data is represented in many formats. Software tools translate the low-level representation of bits into a form understandable by individuals. Data is organized and accessible based on the application used to store it.	• 8.1.8.DA.2: Explain the difference between how the computer stores data as bits and how the data is displayed. • 8.1.8.DA.3: Identify the appropriate tool to access data based on its file format.
The purpose of cleaning data is to remove errors and make it easier for computers to process.	• 8.1.8.DA.4: Transform data to remove errors and improve the accuracy of the data for analysis.
Computer models can be used to simulate events, examine theories and inferences, or make predictions.	• 8.1.8.DA.5: Test, analyze, and refine computational models. • 8.1.8.DA.6: Analyze climate change computational models and propose refinements.

Algorithms & Programming

Core Idea	Performance Expectations
Individuals design algorithms that are reusable in many situations. Algorithms that are readable are easier to follow, test, and debug.	8.1.8.AP.1: Design and illustrate algorithms that solve complex problems using flowcharts and/or pseudocode.
Programmers create variables to store data values of different types and perform appropriate operations on their values.	8.1.8.AP.2: Create clearly named variables that represent different data types and perform operations on their values.
Control structures are selected and combined in programs to solve more complex problems.	8.1.8.AP.3: Design and iteratively develop programs that combine control structures, including nested loops and compound conditionals.
Programs use procedures to organize code and hide implementation details. Procedures can be repurposed in new programs. Defining parameters for procedures can generalize behavior and increase reusability.	• 8.1.8.AP.4: Decompose problems and sub-problems into parts to facilitate the design, implementation, and review of programs. • 8.1.8.AP.5: Create procedures with parameters to organize code and make it easier to reuse.
Individuals design and test solutions to identify problems taking into consideration the diverse needs of the users and the community.	• 8.1.8.AP.6: Refine a solution that meets users' needs by incorporating feedback from team members and users. • 8.1.8.AP.7: Design programs, incorporating existing code, media, and libraries, and give attribution. • 8.1.8.AP.8: Systematically test and refine programs using a range of test cases and users. • 8.1.8.AP.9: Document programs in order to make them easier to follow, test, and debug.

2020 New Jersey Student Learning Standards – Computer Science and Design Thinking

8.1 Computer Science by the End of Grade 12

Computing Systems

Core Idea	Performance Expectations
The usability, dependability, security, and accessibility of devices within integrated systems are important considerations in their design as they evolve.	8.1.12.CS.1: Describe ways in which integrated systems hide underlying implementation details to simplify user experiences.
A computing system involves interaction among the user, hardware, application software, and system software.	• 8.1.12.CS.2: Model interactions between application software, system software, and hardware. • 8.1.12.CS.3: Compare the functions of application software, system software, and hardware.
Successful troubleshooting of complex problems involves multiple approaches including research, analysis, reflection, interaction with peers, and drawing on past experiences.	8.1.12.CS.4: Develop guidelines that convey systematic troubleshooting strategies that others can use to identify and fix errors.

Networks and the Internet

Core Idea	Performance Expectations
The scalability and reliability of the Internet are enabled by the hierarchy and redundancy in networks. Network topology is determined by many characteristics.	8.1.12.NI.1: Evaluate the scalability and reliability of networks, by describing the relationship between routers, switches, servers, topology, and addressing.
Network security depends on a combination of hardware, software, and practices that protect data while it is at rest, in transit, and in use. The needs of users and the sensitivity of data determine the level of security implemented. Advanced attacks take advantage of common security vulnerabilities.	• 8.1.12.NI.2: Evaluate security measures to address various common security threats. • 8.1.12.NI.3: Explain how the needs of users and the sensitivity of data determine the level of security implemented. • 8.1.12.NI.4: Explain how decisions on methods to protect data are influenced by whether the data is at rest, in transit, or in use.

Impacts of Computing

Core Idea	Performance Expectations
The design and use of computing technologies and artifacts can positively or negatively affect equitable access to information and opportunities.	• 8.1.12.IC.1: Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices. • 8.1.12.IC.2: Test and refine computational artifacts to reduce bias and equity deficits. • 8.1.12.IC.3: Predict the potential impacts and implications of emerging technologies on larger social, economic, and political structures, using evidence from credible sources.

Data & Analysis

Core Idea	Performance Expectations
Individuals select digital tools and design automated processes to collect, transform, generalize, simplify, and present large data sets in different ways to influence how other people interpret and understand the underlying information.	8.1.12.DA.1: Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change.
Choices individuals make about how and where data is organized and stored affects cost, speed, reliability, accessibility, privacy, and integrity.	• 8.1.12.DA.2: Describe the trade-offs in how and where data is organized and stored. • 8.1.12.DA.3: Translate between decimal numbers and binary numbers. • 8.1.12.DA.4: Explain the relationship between binary numbers and the storage and use of data in a computing device.
Large data sets can be transformed, generalized, simplified, and presented in different ways to influence how individuals interpret and understand the underlying information.	8.1.12.DA.5: Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena.
The accuracy of predictions or inferences made from a computer model is affected by the amount, quality, and diversity of data.	8.1.12.DA.6: Create and refine computational models to better represent the relationships among different elements of data collected from a phenomenon or process.

Algorithms & Programming

Core Idea	Performance Expectations
Individuals evaluate and select algorithms based on performance, reusability, and ease of implementation.	8.1.12.AP.1: Design algorithms to solve computational problems using a combination of original and existing algorithms.
Programmers choose data structures to manage program complexity based on functionality, storage, and performance trade-offs.	8.1.12.AP.2: Create generalized computational solutions using collections instead of repeatedly using simple variables.

Core Idea	Performance Expectations
Trade-offs related to implementation, readability, and program performance are considered when selecting and combining control structures.	• 8.1.12.AP.3: Select and combine control structures for a specific application based upon performance and readability, and identify trade-offs to justify the choice. • 8.1.12.AP.4: Design and iteratively develop computational artifacts for practical intent, personal expression, or to address a societal issue.
Complex programs are designed as systems of interacting modules, each with a specific role, coordinating for a common overall purpose. Modules allow for better management of complex tasks.	• 8.1.12.AP.5: Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects. • 8.1.12.AP.6: Create artifacts by using procedures within a program, combinations of data and procedures, or independent but interrelated programs.
Complex programs are developed, tested, and analyzed by teams drawing on the members' diverse strengths using a variety of resources, libraries, and tools.	• 8.1.12.AP.7: Collaboratively design and develop programs and artifacts for broad audiences by incorporating feedback from users. • 8.1.12.AP.8: Evaluate and refine computational artifacts to make them more usable and accessible. • 8.1.12.AP.9: Collaboratively document and present design decisions in the development of complex programs.

2020 New Jersey Student Learning Standards – Computer Science and Design Thinking

8.2 Design Thinking by the End of Grade 2

Engineering Design

Core Idea	Performance Expectations
Engineering design is a creative process for meeting human needs or wants that can result in multiple solutions.	• 8.2.2.ED.1: Communicate the function of a product or device. • 8.2.2.ED.2: Collaborate to solve a simple problem, or to illustrate how to build a product using the design process. • 8.2.2.ED.3: Select and use appropriate tools and materials to build a product using the design process.
Limitations (constraints) must be considered when engineering designs.	8.2.2.ED.4: Identify constraints and their role in the engineering design process.

Interaction of Technology and Humans

Core Idea	Performance Expectations
Human needs and desires determine which new tools are developed.	• 8.2.2.ITH.1: Identify products that are designed to meet human wants or needs. • 8.2.2.ITH.2: Explain the purpose of a product and its value.
Technology has changed the way people live and work. Various tools can improve daily tasks and quality of life.	• 8.2.2.ITH.3: Identify how technology impacts or improves life. • 8.2.2.ITH.4: Identify how various tools reduce work and improve daily tasks. • 8.2.2.ITH.5: Design a solution to a problem affecting the community in a collaborative team and explain the intended impact of the solution.

Nature of Technology

Core Idea	Performance Expectations
Innovation and the improvement of existing technology involves creative thinking.	• 8.2.2.NT.1: Model and explain how a product works after taking it apart, identifying the relationship of each part, and putting it back together. • 8.2.2.NT.2: Brainstorm how to build a product, improve a designed product, fix a product that has stopped working, or solve a simple problem.

Effects of Technology on the Natural World

Core Idea	Performance Expectations
The use of technology developed for the human designed world can affect the environment, including land, water, air, plants, and animals. Technologies that use natural sources can have negative effects on the environment, its quality, and inhabitants. Reusing and recycling materials can save money while preserving natural resources and avoiding damage to the environment.	• 8.2.2.ETW.1: Classify products as resulting from nature or produced as a result of technology. • 8.2.2.ETW.2: Identify the natural resources needed to create a product. • 8.2.2.ETW.3: Describe or model the system used for recycling technology. • 8.2.2.ETW.4: Explain how the disposal of or reusing a product affects the local and global environment.

Ethics & Culture

Core Idea	Performance Expectations
The availability of technology for essential tasks varies in different parts of the world.	8.2.2.EC.1: Identify and compare technology used in different schools, communities, regions, and parts of the world.

2020 New Jersey Student Learning Standards – Computer Science and Design Thinking

8.2 Design Thinking by the End of Grade 5

Engineering Design

Core Idea	Performance Expectations
Engineering design is a systematic and creative process of communicating and collaborating to meet a design challenge. Often, several design solutions exist, each better in some way than the others.	• 8.2.5.ED.1: Explain the functions of a system and its subsystems. • 8.2.5.ED.2: Collaborate with peers to collect information, brainstorm to solve a problem, and evaluate all possible solutions to provide the best results with supporting sketches or models. • 8.2.5.ED.3: Follow step by step directions to assemble a product or solve a problem, using appropriate tools to accomplish the task.
Engineering design requirements include desired features and limitations that need to be considered.	• 8.2.5.ED.4: Explain factors that influence the development and function of products and systems (e.g., resources, criteria, desired features, constraints). • 8.2.5.ED.5: Describe how specifications and limitations impact the engineering design process. • 8.2.5.ED.6: Evaluate and test alternative solutions to a problem using the constraints and trade-offs identified in the design process.

Interaction of Technology and Humans

Core Idea	Performance Expectations
Societal needs and wants determine which new tools are developed to address real-world problems.	8.2.5.ITH.1: Explain how societal needs and wants influence the development and function of a product and a system.
A new tool may have favorable or unfavorable results as well as both positive and negative effects on society. Technology spurs new businesses and careers.	• 8.2.5.ITH.2: Evaluate how well a new tool has met its intended purpose and identify any shortcomings it might have. • 8.2.5.ITH.3: Analyze the effectiveness of a new product or system and identify the positive and/or negative consequences resulting from its use. • 8.2.5.ITH.4: Describe a technology/tool that has made the way people live easier or has led to a new business or career.

Nature of Technology

Core Idea	Performance Expectations
Technology innovation and improvement may be influenced by a variety of factors. Engineers create and modify technologies to meet people's needs and wants; scientists ask questions about the natural world.	• 8.2.5.NT.1: Troubleshoot a product that has stopped working and brainstorm ideas to correct the problem. • 8.2.5.NT.2: Identify new technologies resulting from the demands, values, and interests of individuals, businesses, industries, and societies. • 8.2.5.NT.3: Redesign an existing product for a different purpose in a collaborative team. • 8.2.5.NT.4: Identify how improvement in the understanding of materials science impacts technologies.

Effects of Technology on the Natural World

Core Idea	Performance Expectations
The technology developed for the human designed world can have unintended consequences for the environment. Technology must be continually developed and made more efficient to reduce the need for non-renewable resources.	• 8.2.5.ETW.1: Describe how resources such as material, energy, information, time, tools, people, and capital are used in products or systems. • 8.2.5.ETW.2: Describe ways that various technologies are used to reduce improper use of resources. • 8.2.5.ETW.3: Explain why human-designed systems, products, and environments need to be constantly monitored, maintained, and improved. • 8.2.5.ETW.4: Explain the impact that resources, such as energy and materials used to develop technology, have on the environment. • 8.2.5.ETW.5: Identify the impact of a specific technology on the environment and determine what can be done to increase positive effects and to reduce any negative effects, such as climate change.

Ethics & Culture

Core Idea	Performance Expectations
Technological choices and opportunities vary due to factors such as differences in economic resources, location, and cultural values.	8.2.5.EC.1: Analyze how technology has contributed to or reduced inequities in local and global communities and determine its short- and long-term effects.

2020 New Jersey Student Learning Standards – Computer Science and Design Thinking

8.2 Design Thinking by the End of Grade 8

Engineering Design

Core Idea	Performance Expectations
Engineering design is a systematic, creative, and iterative process used to address local and global problems. The process includes generating ideas, choosing the best solution, and making, testing, and redesigning models or prototypes.	• 8.2.8.ED.1: Evaluate the function, value, and aesthetics of a technological product or system, from the perspective of the user and the producer. • 8.2.8.ED.2: Identify the steps in the design process that could be used to solve a problem. • 8.2.8.ED.3: Develop a proposal for a solution to a real-world problem that includes a model (e.g., physical prototype, graphical/technical sketch). • 8.2.8.ED.4: Investigate a malfunctioning system, identify its impact, and explain the step-by-step process used to troubleshoot, evaluate, and test options to repair the product in a collaborative team.
Engineering design requirements and specifications involve making trade-offs between competing requirements and desired design features.	• 8.2.8.ED.5: Explain the need for optimization in a design process. • 8.2.8.ED.6: Analyze how trade-offs can impact the design of a product. • 8.2.8.ED.7: Design a product to address a real-world problem and document the iterative design process, including decisions made as a result of specific constraints and trade-offs (e.g., annotated sketches).

Interaction of Technology and Humans

Core Idea	Performance Expectations
Economic, political, social and cultural aspects of society drive development of new technological products, processes, and systems.	8.2.8.ITH.1: Explain how the development and use of technology influences economic, political, social, and cultural issues.

Core Idea	Performance Expectations
Technology interacts with society, sometimes bringing about changes in a society's economy, politics, and culture, and often leading to the creation of new needs and wants. New needs and wants may create strains on local economies and workforces. Improvements in technology are intended to make the completion of tasks easier, safer, and/or more efficient.	• 8.2.8.ITH.2: Compare how technologies have influenced society over time. • 8.2.8.ITH.3: Evaluate the impact of sustainability on the development of a designed product or system. • 8.2.8.ITH.4: Identify technologies that have been designed to reduce the negative consequences of other technologies and explain the change in impact. • 8.2.8.ITH.5: Compare the impacts of a given technology on different societies, noting factors that may make a technology appropriate and sustainable in one society but not in another.

Nature of Technology

Core Idea	Performance Expectations
Technology advances through the processes of innovation and invention which relies upon the imaginative and inventive nature of people. Sometimes a technology developed for one purpose is adapted to serve other purposes. Engineers use a systematic process of creating or modifying technologies that is fueled and constrained by physical laws, cultural norms, and economic resources. Scientists use systematic investigation to understand the natural world.	• 8.2.8.NT.1: Examine a malfunctioning tool, product, or system and propose solutions to the problem. • 8.2.8.NT.2: Analyze an existing technological product that has been repurposed for a different function. • 8.2.8.NT.3: Examine a system, consider how each part relates to other parts, and redesign it for another purpose. • 8.2.8.NT.4: Explain how a product designed for a specific demand was modified to meet a new demand and led to a new product.

Effects of Technology on the Natural World

Core Idea	Performance Expectations
Resources need to be utilized wisely to have positive effects on the environment and society. Some technological decisions involve trade-offs between environmental and economic needs, while others have positive effects for both the economy and environment.	• 8.2.8.ETW.1: Illustrate how a product is upcycled into a new product and analyze the short- and long-term benefits and costs. • 8.2.8.ETW.2: Analyze the impact of modifying resources in a product or system (e.g., materials, energy, information, time, tools, people, capital). • 8.2.8.ETW.3: Analyze the design of a product that negatively impacts the environment or society and develop possible solutions to lessen its impact. • 8.2.8.ETW.4: Compare the environmental effects of two alternative technologies devised to address climate change issues and use data to justify which choice is best.

Ethics & Culture

Core Idea	Performance Expectations
Technological disparities have consequences for public health and prosperity.	• 8.2.8.EC.1: Explain ethical issues that may arise from the use of new technologies. • 8.2.8.EC.2: Examine the effects of ethical and unethical practices in product design and development.

2020 New Jersey Student Learning Standards – Computer Science and Design Thinking

8.2 Design Thinking by the End of Grade 12

Engineering Design

Core Idea	Performance Expectations
Engineering design is a complex process in which creativity, content knowledge, research, and analysis are used to address local and global problems. Decisions on trade-offs involve systematic comparisons of all costs and benefits, and final steps that may involve redesigning for optimization.	• 8.2.12.ED.1: Use research to design and create a product or system that addresses a problem and make modifications based on input from potential consumers. • 8.2.12.ED.2: Create scaled engineering drawings for a new product or system and make modification to increase optimization based on feedback. • 8.2.12.ED.3: Evaluate several models of the same type of product and make recommendations for a new design based on a cost benefit analysis. • 8.2.12.ED.4: Design a product or system that addresses a global problem and document decisions made based on research, constraints, trade-offs, and aesthetic and ethical considerations and share this information with an appropriate audience.
Engineering design evaluation, a process for determining how well a solution meets requirements, involves systematic comparisons between requirements, specifications, and constraints.	• 8.2.12.ED.5: Evaluate the effectiveness of a product or system based on factors that are related to its requirements, specifications, and constraints (e.g., safety, reliability, economic considerations, quality control, environmental concerns, manufacturability, maintenance and repair, ergonomics). • 8.2.12.ED.6: Analyze the effects of changing resources when designing a specific product or system (e.g., materials, energy, tools, capital, labor).

Interaction of Technology and Humans

Core Idea	Performance Expectations
Decisions to develop new technology are driven by societal and cultural opinions and demands that differ from culture to culture.	8.2.12.ITH.1: Analyze a product to determine the impact that economic, political, social, and/or cultural factors have had on its design, including its design constraints.
Changes caused by the introduction and use of a new technology can range from gradual to rapid and from subtle to obvious, and can change over time. These changes may vary from society to society as a result of differences in a society's economy, politics, and culture.	• 8.2.12.ITH.2: Propose an innovation to meet future demands supported by an analysis of the potential costs, benefits, trade-offs, and risks related to the use of the innovation. • 8.2.12.ITH.3: Analyze the impact that globalization, social media, and access to open source technologies has had on innovation and on a society's economy, politics, and culture.

Nature of Technology

Core Idea	Performance Expectations
Engineers use science, mathematics, and other disciplines to improve technology. Increased collaboration among engineers, scientists, and mathematicians can improve their work and designs. Technology, product, or system redesign can be more difficult than the original design.	• 8.2.12.NT.1: Explain how different groups can contribute to the overall design of a product. • 8.2.12.NT.2: Redesign an existing product to improve form or function.

Effects of Technology on the Natural World

Core Idea	Performance Expectations
Development and modification of any technological system needs to take into account how the operation of the system will affect natural resources and ecosystems. Impacts of technological systems on the environment need to be monitored and must inform decision-making. Many technologies have been designed to have a positive impact on the environment and to monitor environmental change over time.	• 8.2.12.ETW.1: Evaluate ethical considerations regarding the sustainability of environmental resources that are used for the design, creation, and maintenance of a chosen product. • 8.2.12.ETW.2: Synthesize and analyze data collected to monitor the effects of a technological product or system on the environment. • 8.2.12.ETW.3: Identify a complex, global environmental or climate change issue, develop a systemic plan of investigation, and propose an innovative sustainable solution.

Ethics & Culture

Core Idea	Performance Expectations
The ability to ethically integrate new technologies requires deciding whether to introduce a technology, taking into consideration local resources and the role of culture in acceptance. Consequences of technological use may be different for different groups of people and may change over time. Since technological decisions can have ethical implications, it is essential that individuals analyze issues by gathering evidence from multiple perspectives and conceiving of alternative possibilities before proposing solutions.	• 8.2.12.EC.1: Analyze controversial technological issues and determine the degree to which individuals, businesses, and governments have an ethical role in decisions that are made. • 8.2.12.EC.2: Assess the positive and negative impacts of emerging technologies on developing countries and evaluate how individuals, non-profit organizations, and governments have responded. • 8.2.12.EC.3: Synthesize data, analyze trends, and draw conclusions regarding the effect of a technology on the individual, culture, society, and environment and share this information with the appropriate audience. • 8.2.12.ETW.4: Research historical tensions between environmental and economic considerations as driven by human needs and wants in the development of a technological product and present the competing viewpoints.