By the end of grade 12

Computer Science 8.1

CS Computing Systems 8.1.12.CS

The usability, dependability, security, and accessibility of devices within integrated systems are important considerations in their design as they evolve.

1 Describe ways in which integrated systems hide underlying implementation details to simplify user experiences. 8.1.12.CS.1

A computing system involves interaction among the user, hardware, application software, and system software.

2 Model interactions between application software, system software, and hardware. 8.1.12.CS.2

3 Compare the functions of application software, system software, and hardware. 8.1.12.CS.3

Successful troubleshooting of complex problems involves multiple approaches including research, analysis, reflection, interaction with peers, and drawing on past experiences.

4 Develop guidelines that convey systematic troubleshooting strategies that others can use to identify and fix errors. 8.1.12.CS.4

NI Networks and the Internet 8.1.12.NI

The scalability and reliability of the Internet are enabled by the hierarchy and redundancy in networks.Network topology is determined by many characteristics.

1 Evaluate the scalability and reliability of networks, by describing the relationship between routers, switches, servers, topology, and addressing. 8.1.12.NI.1

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 elvel of security implemented. Advanced attacks take advantage of common security vulnerabilities.

2 Evaluate security measures to address various common security threats. 8.1.12.NI.2

3 Explain how the needs of users and the sensitivity of data determine the level of security implemented. 8.1.12.NI.3

4 Explain how decisions on methods to protect data are influenced by whether the data is at rest, in transit, or in use. 8.1.12.NI.4

IC Impacts of Computing

The design and use of computing technologies and artifacts can positively or negatively affect equitable access to information and opportunities.

1 Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices. 8.1.12.IC.1

2 Test and refine computational artifacts ot reduce bias and equity deficits 8.1.12.IC.2

3 Predict the potential impacts and implications of emerging technologies on larger social, economic, and political structures, using evidence from credible sources. 8.1.12.IC.3

DA Data & Analysis

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.

1 Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change. 8.1.12.DA.1

Choices individuals make about how and where data is organized and stored affects cost, speed, reliability, accessibility, privacy, and integrity.

2 Describe the trade-offs in how and where data is organized and stored. 8.1.12.DA.2

4 Explain the relationship between binary numbers and the storage and use of data in a computing device. 8.1.12.DA.4

3 Translate between decimal numbers and binary numbers. 8.1.12.DA.3

Large data sets can be transformed, generalized, simplified, and presented in different ways to influence how individuals interpret and understand the underlying information.

5 Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena. 8.1.12.DA.5

The accuracy of predictions or inferences made from a computer model is affected by the amount quality, and diversity of data.

6 Create and refine computational models to better represent the relationships among different elements of data collected from a phenomenon or process. 8.1.12.DA.6

Algorithms & Programming

Individuals evaluate and select algorithms based on performance, reusability, and ease of implementation.

1 Design algorithms to solve computational problems using a combination of original and existing algorithms. 8.1.12.AP.1

Programmers choose data structures to manage program complexity based on functionality, storage, and performance trade-offs.

2 Create generalized computational solutions using collections instead of repeatedly using simple variables. 8.1.12.AP.2

Trade-offs related to implementation, readability, and program performance are considered when selecting and combining control structures.

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.3

4 Design and iteratively develop computational artifacts for practical intent, personal expression, or to address a societal issue. 8.1.12.AP.4

Complex programs are designed as a system of interacting modules, each with a specific role, coordinating for a common overall purpose. Modules allow for better management of complex tasks.

5 Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects. 8.1.12.AP.5

6 Create artifacts by using procedures within a program, combinations of data and procedures, or independent but interrelated programs. 8.1.12.AP.6

Complex programs are developed, tested, and analyzed by teams drawing on the members' diverse strengths using a variety of resources, libraries, and tools.

7 Collaboratively design and develop programs and artifacts for broad audiences by incorporating feedback from users. 8.1.12.AP.7

8 Evaluate and refine computational artifacts to make them more usable and accessible. 8.1.12.AP.8

9 Collaboratively document and present design decisions in the development of complex programs. 8.1.12.AP.9

Design Thinking

Engineering Design

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.

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.1
2. Create scaled engineering drawings for a new product or system and make modification to increase optimization based on feedback. 8.2.12.ED.2
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.3
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. 8.2.12.ED.4

Engineering design evaluation, a process for determining how well a solution meets requirements, involves systematic comparisons between requirements, specifications, and constraints.

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.5
6. Analyze the effects of changing resources when designing a specific product or system (e.g., materials, energy, tools, capital, labor). 8.2.12.ED.6

Interaction of Technology and Humans

Decisions to develop new technology are driven by societal and cultural opinions and demands that differ from culture to culture.

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. 8.2.12.ITH.1

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.

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.2
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. 8.2.12.ITH.3

Nature of Technology

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.

1. Explain how different groups can contribute to the overall design of a product. `8.2.12.NT.1`
2. Redesign an existing product to improve form or function. `8.2.12.NT.2`

Effects of Technology on the Natural World

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.

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.1`
2. Synthesize and analyze data collected to monitor the effects of a technological product or system on the environment. `8.2.12.ETW.2`
3. Identify a complex, global environmental or climate change issue, develop a systemic plan of investigation, and propose an innovative sustainable solution. `8.2.12.ETW.3`

Ethics & Culture

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.

1. Analyze controversial technological issues and determine the degree to which individuals, businesses, and governments have an ethical roles in decisions that are made. `8.2.12.EC.1`
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.2`
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.EC.3`
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. `8.2.12.EC.4`