

# High School

## Computational Thinking

### 1 Develop, utilize and evaluate algorithms, to model and solve problems.

- 1 Computational thinking is used to create algorithmic solutions to real-world problems. [CS.HS.1.1](#)
  - a Identify and create different types of algorithms (sort, search, etc.). [CS.HS.1.1.A](#)
  - b Predict the outcome of different types of algorithms. [CS.HS.1.1.B](#)
  - c Create or adapt algorithms to solve problems for multiple purposes (e.g., personal interests, stakeholder needs). [CS.HS.1.1.C](#)
  - d Use an algorithm that involves mathematical operations and functions to solve problems. [CS.HS.1.1.D](#)
  - e Use an iterative approach to utilizing and/or developing an algorithm. [CS.HS.1.1.E](#)
  - f Recognize problems that cannot be solved computationally. [CS.HS.1.1.F](#)
  - g Identify and describe algorithms that exist within their personal lives. [CS.HS.1.1.G](#)

- 2 Algorithms can be represented and used in different ways (e.g., languages, diagrams, pseudocode). [CS.HS.1.2](#)

- a Illustrate the flow of execution of an iterative algorithm (e.g., recursion). [CS.HS.1.2.A](#)
- b Explain the value of heuristic algorithms to model ways to solve problems. [CS.HS.1.2.B](#)
- c Adapt algorithms used in one problem to solve a related or different problem. [CS.HS.1.2.C](#)
- d Use multiple methods to represent an algorithm (e.g., diagram, programming 4 language, unplugged). [CS.HS.1.2.D](#)

- 3 Algorithm development and use is an ongoing process that involves adapting, critiquing and troubleshooting programs and/or processes. [CS.HS.1.3](#)

- a Describe pros and cons of the performance of algorithms for the same task. [CS.HS.1.3.A](#)
- b Use an iterative approach to developing an algorithm. [CS.HS.1.3.B](#)
- c Test and troubleshoot so that algorithms produce reasonable results. [CS.HS.1.3.C](#)

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## 2 Systematically analyze a problem using decomposition and abstraction to formulate a solution.

- 4 Large, complex problems can be broken down into smaller, more manageable components. [CS.HS.1.4](#)
  - a Demonstrate how the process of decomposition is iterative and used to solve problems. [CS.HS.1.4.A](#)
  - b Formulate possible solutions based on the decomposition of a problem. [CS.HS.1.4.B](#)
- 5 Abstraction is used to reduce complexity of larger problems by focusing on main ideas. [CS.HS.1.5](#)
  - a Describe how abstraction is central to computational thinking. [CS.HS.1.5.A](#)
  - b Identify and prioritize the most relevant parts of a problem while filtering out extraneous details. [CS.HS.1.5.B](#)
  - c Demonstrate different ways to represent key problem components. [CS.HS.1.5.C](#)

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## 3 Represent and analyze data in order to generate new knowledge and capability.

- 6 Data can be represented in different ways for storage and exchange. [CS.HS.1.6](#)
    - a Identify different types of data that are exchanged and produced by computers (e.g., protocols). [CS.HS.1.6.A](#)
    - b Evaluate the trade-offs for how data elements are organized and where data are stored (e.g., PNG/GIF, structured/unstructured). [CS.HS.1.6.B](#)
    - c Compare and contrast various data structures/techniques for storing and processing data (e.g., arrays, lists, tables). [CS.HS.1.6.C](#)
  - 7 Many problems appropriate for solving with a computer are organized around patterns. [CS.HS.1.7](#)
    - a Provide multiple versions of data visualization in order to deepen problem analysis. [CS.HS.1.7.A](#)
    - b Interpret and analyze data to make informed decisions. [CS.HS.1.7.B](#)
  - 8 Data from a computer program can be visually presented to better understand and articulate solutions to a problem. [CS.HS.1.8](#)
    - a Analyze computer output in different forms (e.g., plain text, CSV, graphs, images). [CS.HS.1.8.A](#)
    - b Design visualizations using the appropriate tool(s) with the end user in mind. [CS.HS.1.8.B](#)
    - c Provide multiple versions of data visualization in order to deepen problem analysis. [CS.HS.1.8.C](#)
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## Computing Systems and Networks

### 4 Use systems thinking to describe networks and common software and hardware components.

- 1 Communication between computers (and over the internet) can be configured in many different ways and consist of several hardware and software components. **CS.HS.2.1**
  - a Describe key protocols and underlying processes of internet-based services, (e.g., https) and discuss impact of technology change on communication protocols. **CS.HS.2.1.A**
  - b Illustrate and describe the basic components and various network types and topologies (e.g., personal, local, metropolitan, and wide). **CS.HS.2.1.B**
  - c Explain the difference between decimal, hexadecimal, octal and binary number formats and how they are used in computing environments. **CS.HS.2.1.C**
- 2 Computer hardware, the lowest level of a computer system, consists of many different parts, each providing a specialized function. **CS.HS.2.2**
  - a Explain the difference between memory and disk storage, internal and external storage, Random Access Memory (RAM), flash, cloud. **CS.HS.2.2.A**
  - b Explain how to maintain safety when working on PCs, e.g., electromagnetic precautions. **CS.HS.2.2.B**
  - c Describe how computing devices are engineered for fault tolerance and reliability, and identify potential sources of weakness (e.g., redundant power supplies, RAID, SAN/NAS connections). **CS.HS.2.2.C**
- 3 Computer software is written for specific purposes. **CS.HS.2.3**
  - a Identify and differentiate between different kinds of software (e.g., operating systems vs. applications) and their purposes. **CS.HS.2.3.A**
  - b Explain what an operating system is, and why it is important for a computer or computing device (e.g., Linux, Windows, iOS). **CS.HS.2.3.B**
  - c Describe how software interacts with hardware to complete tasks. **CS.HS.2.3.C**
- 4 Systems thinking is a way of holistically examining the various components and use cases that go into a given design. **CS.HS.2.4**
  - a Explain the integration of hardware, software and network communications components to create a networked system. **CS.HS.2.4.A**
  - b Summarize security approaches using a systems approach perspective. **CS.HS.2.4.B**

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**5 Develop systems solutions from a set of specifications to complete a design process.**

- 5 Stakeholder considerations drive system design. [CS.HS.2.5](#)
  - a Identify stakeholder's problems/needs. [CS.HS.2.5.A](#)
  - b Articulate design requirements back to the stakeholder. [CS.HS.2.5.B](#)
  - c Illustrate options for considerations and develop conceptual model. [CS.HS.2.5.C](#)
  - d Perform system analysis based on stakeholder considerations. [CS.HS.2.5.D](#)

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**6 Recognize and analyze security concepts.**

- 6 Robust computing systems require multiple methods of recovery. [CS.HS.2.6](#)
    - a Describe elements of an effective backup system. [CS.HS.2.6.A](#)
    - b Compare backup systems for computer users, or a network. [CS.HS.2.6.B](#)
    - c List the various backup methodologies (e.g., full, differential), and why one would pick one over the other, or use all. [CS.HS.2.6.C](#)
    - d Explain the ways an organization would continue to operate in light of a systems failure. [CS.HS.2.6.](#)
  - 7 Robust computing systems require data protection. [CS.HS.2.7](#)
    - a Identify examples of threats to systems and data. [CS.HS.2.7.A](#)
    - b Describe the process by which intruders gain entry into a production system (e.g., reconnaissance). [CS.HS.2.7.B](#)
    - c Describe and compare methods to test/validate how well systems and data are protected. [CS.HS.2.7.C](#)
    - d Investigate different career pathways relating to systems security. [CS.HS.2.7.D](#)
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**7 Design and create programs, individually and collaboratively, for a variety of disciplines.**

- 1 The creation of a computer program requires a design process. **CS.HS.3.1**
  - a Analyze and apply a design methodology to identify constraints and requirements of an identified problem. **CS.HS.3.1.A**
  - b Utilize tools and resources such as pseudocode, flowcharts, wireframes, etc., as part of the design process. **CS.HS.3.1.B**
  - c Determine and use graphical or text-based languages. **CS.HS.3.1.C**
  - d Understand and apply core programming concepts. **CS.HS.3.1.D**
- 2 The process of programming involves solving computational problems. **CS.HS.3.2**
  - a Write code per selected design. **CS.HS.3.2.A**
  - b Create code comments to communicate to other developers and ensure documentation of code. **CS.HS.3.2.B**
  - c Use various troubleshooting and debugging techniques to improve code. **CS.HS.3.2.C**
  - d Create appropriate variables to store and retrieve data. **CS.HS.3.2.D**
- 3 Collaborative tools, methods and strategies can be used to design, develop and update computational artifacts. **CS.HS.3.3**
  - a Integrate collaborative strategies to improve programming outputs. **CS.HS.3.3.A**
  - b Identify and analyze a variety of collaborative tools (e.g., commenting, development repositories) in order to determine the appropriateness for intended use. **CS.HS.3.3.B**
  - c Identify strategies such as peer reviews to test and refine artifacts in development. **CS.HS.3.3.C**
  - d Determine when to use standard software tools like APIs, libraries, version control repositories, etc. **CS.HS.3.3.**
- 4 Stakeholder-based design requirements and feedback are essential to a quality computational product or service. **CS.HS.3.4**
  - a Understand and apply principles of stakeholder-based design. **CS.HS.3.4.A**
  - b Guide/advise stakeholders on strategies and solutions best suited for their problem (i.e., type of platform). **CS.HS.3.4.B**
  - c Construct effective methods for gathering feedback from stakeholders. **CS.HS.3.4.C**
  - d Respond to feedback from stakeholders to improve computing solutions. **CS.HS.3.4.D**
  - e Create and share product support documentation for potential users. **CS.HS.3.4.E**
  - f Articulate lessons learned as a result of the design and creation process. **CS.HS.3.4.F**

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**8 Create computational artifacts that consider security from tampering, malicious or otherwise.**

- 5 Computing solutions can have impacts (personal, ethical, social, economic and cultural) based on their use. **CS.HS.3.5**
- a Investigate and understand privacy, security and protection laws. **CS.HS.3.5.A**
  - b Articulate the importance of securing personal data information on encrypted storage systems. **CS.HS.3.5.B**
  - c Identify and analyze current events to ensure the safety, security and well-being of all potential stakeholders and end users. **CS.HS.3.5.C**
  - d Identify influential computing innovations, and identify the beneficial and harmful effects they have had, or could have, on society, economy and culture. **CS.HS.3.5.D**
  - e Discuss and explain how diversity of design and issues of accessibility impact a wide range of users. **CS.HS.3.5.E**
  - f Demonstrate ways to improve the accessibility of computational technologies and artifacts. **CS.HS.3.5.F**
- 6 Security and software licensing can present constraints and restrictions in computational design and development. **CS.HS.3.6**
- a Describe how software licensing influences program development. **CS.HS.3.6.A**
  - b Investigate and develop solutions that discourage online software piracy. **CS.HS.3.6.B**
  - c Explore and integrate security measures such as encryption, authentication and verification strategies to secure developed computer programs. **CS.HS.3.6.C**
  - d Research and abide by intellectual property laws and patents. **CS.HS.3.6.D**
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### 6 Recognize and analyze security concepts.

- 1 Confidentiality, integrity, and availability (CIA) are core principles of cybersecurity. **CS.HS.4.1**
  - a Define confidentiality, integrity and availability in the context of cybersecurity, and share a basic example of each. **CS.HS.4.1.A**
  - b Analyze real-life scenarios to identify which of the core principles are at risk or have been compromised and explain why. **CS.HS.4.1.B**
  - c Critically analyze case studies of cyber security incidents and identify where breaches in CIA have occurred. **CS.HS.4.1.C**
  - d Research real-world examples of cyber security breaches and share their findings, focusing on how CIA principles were impacted. **CS.HS.4.1.D**
- 2 Encryption is fundamental to data security and privacy and is important in cybersecurity. **CS.HS.4.2**
  - a Compare and contrast applications based on their privacy policies and permissions, evaluating the impact on individuals and society. **CS.HS.4.2.A**
  - b Synthesize understanding of privacy practices to inform peers on healthy vs harmful practices. **CS.HS.4.2.B**
  - c Explain the individual risks of a data breach to an organization housing personal data. (Department of Homeland Security (DHS) through CISA Grant given to Cyber.org, 2021) **CS.HS.4.2.C**
  - d Compare and contrast the harms and benefits between ensuring privacy and enabling convenience and usability (Dark, Daugherty, Emry, Massey, & Peyrot, 2021) **CS.HS.4.2.D**
  - e Compare and contrast situations where one would want to be anonymous vs. identifiable and provide an example where one party desires anonymity but the other party desires clear identification. **CS.HS.4.2.E**
  - f Discuss and/or give an example of how privacy decisions made today may have negative implications in the future. **CS.HS.4.2.F**
  - g Describe one or more systems used on a regular basis which reveals information about a user's pattern of life. **CS.HS.4.2.G**
  - h Explain why trying every possible combination (a brute force attack) will always break encryption if given enough time. **CS.HS.4.2.H**
  - i Describe ways encryption is used today. **CS.HS.4.2.I**
  - j Evaluate strengths and weaknesses of an encryption method in context. **CS.HS.4.2.J**

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## 9 Create a security risk profile that recognizes and analyzes security concepts.

- 3 Anticipate, identify and understand cyber security threats from the prospective adversary (attacker) and incorporate this into a security risk profile that takes into consideration the potential damage of a compromise vs the cost and inconvenience of implementing security. **CS.HS.4.3**
    - a Build a list of common threats students face and explain how an adversary may try to exploit those threats (adversarial thinking). **CS.HS.4.3.A**
    - b Analyze real-life scenarios to identify which of the core principles are at risk or have been compromised and explain why. (This covers “Demonstrate adversarial thinking for a given problem. example: attack trees”) **CS.HS.4.3.B**
    - c Explain how social behaviors and human factors can impact the cybersecurity of a system design. (Dark, Daugherty, Emry, Massey, & Peyrot, 2021) **CS.HS.4.3.C**
    - d Evaluate digital habits and practices to identify potential risks and predict how an adversary might seek to exploit vulnerabilities. **CS.HS.4.3.D**
    - e Analyze the motives of threat actors (Dark, Daugherty, Emry, Massey, & Peyrot, 2021) **CS.HS.4.3.E**
    - f Explain the variety of ways in which a security vulnerability could be created and exploited (for example: system error, social engineering, or input by an adversary). **CS.HS.4.3.F**
    - g Explain the difference between protecting against a random failure versus protecting against an intentional attack. **CS.HS.4.3.G**
    - h Give an example of a system where the risk of a potential incident requires a high degree of security and an example where the risk of a potential compromise requires only a minor degree of security. **CS.HS.4.3.H**
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## Artificial Intelligence (AI)

### 10 Use AI tools to analyze and understand the world and to create and inspire ideas.

- 1 AI tools are used for solving real-world problems. **CS.HS.5.1**
  - a Explain the evolution of AI, the scope and limitations of current AI and the future of AI. **CS.HS.5.1.A**
  - b Describe the purpose of different AI tools. **CS.HS.5.1.B**
  - c Explain the potential ethical dilemmas and biases in developing, training, and using AI tools. **CS.HS.5.1.C**
  - d Distinguish between AI and general computer programming. **CS.HS.5.1.D**
  - e Describe real-world applications of AI, such as personal assistants, recommendation systems, advertising systems, and autonomous vehicles. **CS.HS.5.1.E**
  - f Examine the differences between narrow AI and general AI, and their implications. **CS.HS.5.1.F**
  - g Discuss the use of the term “learning” with respect to specific AI tools and techniques. **CS.HS.5.1.G**
  - h Evaluate the kinds of data that can be used for AI problems and how they are used to train AI models. **CS.HS.5.1.H**
  - i Evaluate, select and use appropriate AI technology to solve a problem. **CS.HS.5.1.I**
- 2 AI tools can be applied to produce novel creations and inspire creativity. **CS.HS.5.2**
  - a Develop and evaluate an AI-based solution to address a real-world objective. **CS.HS.5.2.A**
  - b Describe how AI can create novel outcomes by identifying patterns in data from the domain of interest. **CS.HS.5.2.B**

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## 11 Evaluate the uses of AI.

- 3 Using AI tools requires evaluation of their results and assessment of their appropriateness for specific applications. **CS.HS.5.3**
    - a Explain the potential limitations of AI; for example, insufficient or inaccurate data inputs, inability of the system to recognize its own errors, and flaws in the underlying algorithms. **CS.HS.5.3.A**
    - b Evaluate the results produced by an AI tool before using it. **CS.HS.5.3.B**
    - c Discuss challenges and considerations of AI with respect to personal privacy. **CS.HS.5.3.C**
    - d Evaluate the implications of AI on job markets and its role in automation and productivity. **CS.HS.5.3.D**
    - e Recognize the importance and challenges of human oversight in AI decision-making. **CS.HS.5.3.E**
    - f Recognize the purpose and suitability of AI tools for achieving specific outcomes. **CS.HS.5.3.F**
  - 4 The development of AI systems can create ethical and legal dilemmas that will need to be resolved. **CS.HS.5.4**
    - a Identify arguments regarding the dilemmas created by advances in artificial intelligence. **CS.HS.5.4.A**
    - b Explain why computational artifacts can be attributed to an AI system rather than its initial programmers. **CS.HS.5.4.B**
    - c Describe the "Turing Test" and its implications for distinguishing human and artificial intelligences. **CS.HS.5.4.C**
    - d Articulate arguments against "artificial intelligence" qualifying as "actual intelligence" and counterarguments that refute those specific arguments. **CS.HS.5.4.D**
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### 13 Practice responsible, ethical, and safe use of computing technology and the Internet.

- 1 Digital citizenship involves multiple practices intended to promote safety, well-being respectful discourse, ethical use of information, and positive relationships. **CS.HS.6.1**
  - a Describe how active and passive social media use can lead to positive and negative feelings. **CS.HS.6.1.A**
  - b Identify research trends related to the health impact of screen time. **CS.HS.6.1.B**
  - c Brainstorm strategies for navigating challenging relationships in a digital environment. **CS.HS.6.1.C**
  - d Learn strategies for civil discourse in a digital environment and apply them to a scenario involving uncivil discourse. **CS.HS.6.1.D**
  - e Define "digital reputation," and identify examples of social media posts that can have a positive or negative effect. **CS.HS.6.1.E**
  - f Explain why you should ask permission before posting pictures or information about someone else. **CS.HS.6.1.F**
  - g Identify strategies for protecting their privacy, including opting out of specific features and analyzing app or website privacy policies and terms of service. **CS.HS.6.1.G**
  - h Define "misinformation" and explore the consequences of spreading misinformation online. **CS.HS.6.1.H**
  - i Explore examples of confirmation bias, particularly related to news and online information. **CS.HS.6.1.I**