Colorado Computer Science

# 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

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

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.

**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

**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

**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

**Computer Programming**

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

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

**Cybersecurity**

**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

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

**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

**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

**Digital Citizenship**

**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