Montana K-12 Digital Literacy and Computer Science Guidelines

A Resource for Schools

Distributed by:
Montana
Office of Public Instruction
Denise Juneau, State Superintendent
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Dear Colleagues,

I am pleased to provide you with the Montana Digital Literacy and Computer Science Guidelines. These are voluntary guidelines that schools can use if they choose. To be successful in today's digital world, students need to know how to use computers and other digital tools to solve problems, develop new innovations, and work across disciplines. The jobs of today and tomorrow require the ability to understand and use information in a variety of digital formats. From construction to healthcare and agriculture to education, technology plays an ever increasing role.

In an effort to ensure Montana's students have the digital knowledge and skills they need to succeed in life and career, the Office of Public Instruction convened an advisory committee representing business and industry, K-12, and higher education to address how to provide schools with best practices to teach digital literacy and computer science. The committee reviewed examples from other states and the proposed standards from the National Computer Science Association.

The committee chose the Massachusetts Digital Literacy and Computer Science Framework as the model for Montana's new guidelines. Committee members made additional recommendations to the Framework, and OPI sent the document to teachers and administrators from small and large schools and to partner organizations for their feedback. The response was positive with the caveat that teachers may need additional professional development to effectively implement the guidelines. The OPI and the advisory committee are working on a digital literacy and computer science professional development plan that will provide teachers high-quality professional learning opportunities. A resource list and a list of current professional development opportunities is included in this document.

I appreciate all the work schools are doing to ensure all our students are college and career ready.

Sincerely,

Denise Juneau
Superintendent of Public Instruction

The Montana Office of Public Instruction provides vision, advocacy, support, and leadership for schools and communities to ensure that all students meet today's challenges and tomorrow's opportunities.

ACKNOWLEDGEMENTS

The Montana K-12 Digital Literacy and Computer Science Guidelines are the result of the contributions of many educators and professionals around the state. The Office of Public Instruction would like to thank all of the Montana groups who participated in the research, review, and recommendation of these guidelines.

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MONTANA K-12 DIGITAL LITERACY AND COMPUTER SCIENCE GUIDELINES

Purpose Statement

The purpose of the Digital Literacy and Computer Science (DLCS) guidelines is to provide schools with a framework to prepare students for success in college and careers. Montana students need to learn how to safely navigate a digital world and employers from all industries want a workforce that can solve problems using technology. These guidelines are adapted from the *Massachusetts Digital Literacy and Computer Science Framework* http://www.doe.mass.edu/frameworks/dlcs.pdf from the Massachusetts Department of Elementary and Secondary Education.

The Digital Literacy and Computer Science Guidelines:

- Focus on skills and practices necessary for success in reasoning, creating, and problem solving.
- Progress from Kindergarten through grade 12.
- Integrate across other content areas.

The following guiding principles are intended to guide the development of programs that effectively engage students in learning and understanding digital literacy and computer science. Strong DLCS programs effectively support student learning so students are prepared for a rapidly changing world.

Guiding Principle 1: Equity

The goal is for every Montana student to have access to quality digital literacy and computer science education. These guidelines provide for meeting the needs of all students from those requiring tutorial support to those with talent in digital literacy and computer science.

Guiding Principle 2: Literacy Across Content Areas

Reading, writing, and communication skills are necessary elements of learning and engaging in digital literacy and computer science. Supporting the development of students' literacy skills will allow them to deepen their understanding of digital literacy and computer science concepts.

Guiding Principle 3: Planning and Support

Students are more likely to succeed if they have the curricular and instructional support that encourages their interests in digital literacy and computer science. Furthermore, students who are motivated to continue their studies and to persist in more advanced and challenging courses and pursue careers in STEM fields.

CONTENT AREAS

Progressions of Core Concepts

The Kindergarten through grade 12 guidelines are organized by grade level for grades K-5 and by grade band for grades 6-8 and 9-12.
Within each grade or grade band, the guidelines are grouped into two content areas:

- **Digital Literacy:** 1) Computing and Society and 2) Digital Tools and Collaboration
- **Computer Science:** 1) Computing Systems and 2) Computational Thinking

DIGITAL LITERACY

1. Computing and Society (CAS)

Technology impacts all people and has global consequences on communications, assistive technology, social networking, and the economy. Computing is a key component of many professions and the content of digital media influences all citizens and society. The principles of privacy, ethics, security, and copyright law influence digital safety and security, as well as interpersonal and societal relations.

a) **Safety and Security:** Responsible citizens in the modern world apply principles of personal privacy and network security to the use of computing systems, software, the Internet, media, and data.
b) **Ethics and Laws:** Ethics include standards of conduct, fairness, and responsible use of the Internet, data, media, and computing devices. An understanding of principles and laws of software licenses, copyrights, and acceptable use policies are necessary to be responsible citizens in the modern world.
c) **Interpersonal and Societal Impact**: Using computing devices, assistive technologies, as well as applying a computational perspective to solving problems changes the way people think, work, live, and play. Most professions rely on technology and advances in computing foster innovations in many fields.

2. Digital Tools and Collaboration (DTC)

Digital tools are applications that produce, manipulate, or store data in a digital format (e.g., word processors, drawing programs, image/video/music editors, simulators, Computer-Aided Design (CAD) applications, publishing programs). The use of digital tools is integral to success in school and career.

a) **Digital Tools:** Digital tools are used to create, manipulate, analyze, edit, publish, or develop artifacts. Individuals and groups identify, evaluate, select, and adapt new tools as they emerge.
b) **Collaboration and Communication**: A variety of digital tools are used to work collaboratively anytime and anywhere, inside and outside the classroom, both synchronously and asynchronously, to develop artifacts or solve problems, contribute to the learning of others, and communicate.

COMPUTER SCIENCE

1. Computing Systems (CS)

Computing systems consist of components such as devices, software, interfaces, and networks that connect communities, devices, people, and services. These systems allow people to create, collaborate, and learn via human-computer partnerships.

a) **Computing Devices:** Computing devices take many forms (e.g., car, insulin pump, or robot), and are not limited to personal computers, phones, and tablets. These devices use many types of input data (collected via gesture, voice, movement, location, and other data) and run instructions in the form of programs to produce certain outputs (e.g., images, sounds, and actions).
b) **Human and Computer Tasks:** Some tasks, such as repetitive tasks or those involving complex computations, are best done by computers, while other tasks that do not have defined rules or are dynamic in nature, are best done by humans. Many tasks, however, are done through human-computer partnerships. Human-computer partnerships, characterized by the interaction of humans with devices and systems that work together, achieve a purpose or solution that would not be independently possible.
c) **Networks:** Network components, including hardware and software, carry out specific functions to connect computing devices, people, and services. The Internet facilitates global communication and relies on considerations of network functionality and security.
d) **Services:** Data storage and computing occurs in many interconnected devices creating computational services that are the building blocks of computing systems. These services make use of data, algorithms, hardware, and connectivity that may occur on remote systems.

2. Computational Thinking (CT)

Computational thinking is a problem solving process that requires people to think in new ways by using computing to solve problems and create solutions. The capacity of computers to rapidly and precisely execute programs provides new ways of designing, creating, and problem solving possible.

a) **Abstraction**: Abstraction is a process of reducing complexity by focusing on the main idea. By ignoring details that are irrelevant to the question at hand and bringing together related and useful details, abstraction reduces complexity and allows one to focus on the problem.
b) **Algorithms**: An algorithm is a sequence of precisely defined steps to solve a particular problem. Carefully designed algorithms are essential to solving complex problems using computers.
c) **Data:** Collecting, managing, and interpreting a vast amount of raw data is part of the foundation of our information society and economy. The storage of data impacts how data is used and accessed.
d) **Research:** A variety of digital tools are used to conduct research, answer questions, and develop artifacts to facilitate learning and convey understanding. Access to the Internet and digital tools allows people to gather, evaluate, organize, analyze, and synthesize information, data, and other media from a variety of sources.
e) **Programming and Development:** Programming articulates and communicates instructions in such a way that a computer can execute a task. Programming makes use of abstractions, algorithms, and data to implement ideas and solutions as executable code through an iterative process of

design and debugging. Software development is the application of engineering principles (usually by a team) to produce useful, reliable software at scale and to integrate software into other engineered artifacts.

f) **Modeling and Simulation:** Computational modeling and simulation help people to represent and understand complex processes and phenomena. Computational models and simulations are used, modified, and created to analyze, identify patterns, and answer questions of real phenomena and hypothetical scenarios.

KINDERGARTEN TO GRADE 2

Early elementary school students learn foundational concepts by integrating basic digital literacy skills with simple ideas about computational thinking. Students learn that tools help people do things better, or more easily, or do some things that could otherwise not be done at all. Through the exploration of differences between humans, computing devices, and digital tools, students begin to understand if, when, and how they should use technology. Students will develop the following knowledge and skills in digital literacy and computer science:

Digital Literacy

Computing and Society (CAS)

- Learn basic safety and security concepts and basic understanding of safe information sharing.
- Explore what is means to be a good digital citizen.
- Observe and describe how people use technology and how technology can influence people.

Digital Tools and Collaboration (DTC)

- Develop basic use of digital tools and research skills to create simple artifacts.
- Develop basic use of digital tools to communicate or exchange information.

Computer Science

Computing Systems (CS)

- Consider basic structures of computing systems and networks.
- Explore human and computer differences to determine when technology is beneficial.

Computational Thinking (CT)

- Explore abstraction through identification of common attributes.
- Create and enact a simple algorithm (steps to solve a problem or complete a task).
- Understand how information can be collected, used, and presented with computing devices or digital tools.
- Create a simple computer program.
- Use basic models and simulations.

GRADES 3 TO 5

Upper elementary students learn to differentiate tasks that are best done by computing systems or digital tools and those best done by humans. Students explore a variety of computing devices and digital tools and further develop their computational thinking and problem solving skills. Using presentation tools and demonstrating their work, students learn to describe and document their computational work in writing. Students will develop the following knowledge and skills in digital literacy and computer science:

Digital Literacy

Computing and Society (CAS)

- Understand safety and security concepts, safe and appropriate use of technology, and how to deal with cyberbullying.
- Demonstrate responsible use of technology, digital content, and interactions.
- Observe and describe how technology can influence people.
- Gain understanding of digital media messaging and equity of access to technology.

Digital Tools and Collaboration (DTC)

- Use digital tools and keyboarding skills to publish multimedia artifacts.
- Use digital tools to communicate or exchange information.
- Develop intermediate research skills to create artifacts and attribute credit.

Computer Science

Computing Systems (CS)

- Use different computing devices and troubleshoot and solve simple problems.
- Differentiate tasks that are best done by computing systems and humans.
- Understand the components of a network and basic network authentication.

Computational Thinking (CT)

- Create a new representation and breakdown a larger problem into subproblems.
- Write, debug, and analyze an algorithm (a process to follow in calculations or problem-solving operations).
- Understand databases and organizing and transforming data.
- Write and correct programs using successively sophisticated techniques.
- Create a model and use data from a simulation.

GRADES 6 TO 8

Middle school students learn to define problems more precisely and to conduct a thorough process of selecting the best devices, tools, and solutions. Students learn to differentiate problems that are best solved by computing systems or digital tools and those best solved by humans. Students will further develop their computational thinking problem solving skills in digital literacy and computer science:

Digital Literacy

Computing and Society (CAS)

- Understand safety and security concepts, online identity and privacy, and how to deal with cyberbullying and inappropriate content.
- Demonstrate responsible use of technology and laws regarding ownership of material/ideas, licensing, and fair use.
- Understand consequences of inappropriate technology use, including harassment and sexting.
- Examine the impact of emerging technology in schools, communities, and societies.
- Evaluate digital media bias and messaging.

Digital Tools and Collaboration (DTC)

- Use a variety of digital tools to create artifacts, online content, and online surveys.
- Understand that different digital tools have different uses.
- Advance research skills.

Computer Science

Computing Systems CS)

- Understand hardware and software components of a computing device and troubleshoot hardware and software problems.
- Use a variety of computing devices to manipulate data.
- Differentiate tasks/problems best solved by computing systems or by humans.
- Understand that network components carry out specific functions to connect computing devices, people, and services.

Computational Thinking (CT)

- Create a new representation, define functions, and use decomposition.
- Write, debug, and analyze advanced algorithms and basic programs.
- Understand how computing devices represent and manipulate information.
- Create, modify, and manipulate databases.
- Use a variety of data collection devices.
- Create a model and use and modify a simulation for analysis.

GRADES 9 TO 12

High school students build on K–8 experiences and learn more technical and sophisticated applications. Students refine their skills in differentiating problems or subproblems that are best solved by computing systems or digital tools and those best solved by humans. Students will further develop their computational thinking problem solving skills in digital literacy and computer science, which will facilitate the selection and appropriate use of technology:

Digital Literacy

Computing and Society (CAS)

- Understand safety and security concepts, security and recovery strategies, and how to deal with cyber bullying and peer pressure.
- Analyze the impact and intent of new technology laws.
- Interpret license agreements and permissions.
- Examine the impact of technology, assistive technology, and cybercrime in people's lives, commerce, and society.

Digital Tools and Collaboration (DTC)

- Select and use appropriate digital tools or resources to create an artifact or solve a problem.
- Communicate and publish online.
- Use research skills including advanced searches, digital source evaluation, and synthesis of information.

Computer Science

Computing Systems (CS)

- Select and use appropriate computing devices to accomplish a real-world task.
- Understand how computing device components work.
- Use troubleshooting strategies to solve routine hardware and software problems.
- Simplify complex computing tasks or problems into subproblems to plan solutions.
- Understand how networks communicate, how they are vulnerable, and what issues may impact their functionality.
- Evaluate the benefits of using a service with respect to function and quality.

Computational Thinking (CT)

- Create a new representation through generalization and decomposition.
- Write and debug algorithms in a structured language.
- Understand how different data representation affects storage and quality.
- Create, modify, and manipulate data structures, data sets, and data visualizations.
- Use an iterative design process to create an artifact or solve a problem.
- Create models and simulations to formulate, test, analyze, and refine a hypothesis.

Digital Literacy: Computing and Society

Safety and Security- by the end of each grade or grade band, students will be able to:

K	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grades 6-8	Grades 9-12
Demonstrate proper ergonomics when using devices	Demonstrate proper care of devices (e.g., shutting down, storage)	Explain proper care of devices (e.g., shutting down, storage)	Describe how to use proper ergonomics when using devices (e.g., body position, lighting, positioning of equipment)	Explain the proper use and operation of security technologies (e.g., passwords, virus and spam prevention, pop-up blockers)	Compare ways to employ safe practices and avoid the risks/dangers associated with various forms of online communication	Identify threats and how to actively protect devices and networks from viruses, intrusion, and other activities	Evaluate and design an ergonomic work environment
Identify personal information that should or should not be shared online	Create a password	Demonstrate understanding of strong passwords and that passwords should be protected and not shared with others	Discuss appropriate and inappropriate uses of technology when posting to social media, sending e-mail/ texts, and browsing the Internet	Evaluate appropriate and inappropriate uses of technology when posting to social media, sending e-mail/ texts, and browsing the Internet	Discuss how cyberbullying can be prevented	Demonstrate safe practices when collaborating online, including how to anticipate potentially dangerous situations	Evaluate safe practices when collaborating online, including how to anticipate potentially dangerous situations
Explain why personal information should be kept private	Describe safe and unsafe examples of online communication	Describe the importance of reporting inappropriate electronic content or contact	Demonstrate how to report inappropriate electronic content or contact	Discuss importance of reporting inappropriate electronic content or contact	Analyze strategies to prevent cyberbullying and harassment	Explain the connection between the amount of data on the Internet, personal online identity, and personal privacy	Construct strategies to combat cyberbullying and harassment
				Discuss the potential loss of ownership when sharing personal information online	Identify the mental health consequences of cyberbullying	Explain how peer pressure in social computing settings can influence choices	Apply strategies for managing negative peer pressure and encouraging positive peer communication

Ethics and Law- By the end of each grade or grade band, students will be able to:

K	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grades 6-8	Grades 9-12
Explain that most digital artifacts have owners	Explain the importance of giving credit to creators and owners when using their work	Define good digital citizenship as using technology safely and responsibly	Demonstrate responsible use of technology as outlined in the school's Acceptable Use Policy	Explain the guidelines for the fair use of downloading, sharing, or modifying of digital artifacts	Discuss the purpose of copyright and the possible consequences for inappropriate use of digital artifacts protected by copyright	Analyze how copyright law and licensing protect the owner of intellectual property	Demonstrate mastery of the school's Acceptable Use Policy
		Demonstrate responsible use of technology and resources as outlined in school's Acceptable Use Policy	Describe the difference between digital artifacts that are open or free and those that are protected by copyright	Discuss why laws exist to help ensure people with disabilities can access electronic and information technology	Explain possible consequences of violating intellectual property law and plagiarism	Apply fair use for using copyrighted materials (e.g., images, music, video, text)	Compare and analyze computer-related laws and their impact on digital privacy, security, intellectual property, network access, contracts, and consequences of sexting and harassment
						Discuss the legal consequences of sending or receiving inappropriate content	Analyze the legal and ethical implications associated with malicious hacking and software piracy
						Differentiate between open source and proprietary software licenses and their applicability to different types of software and media	Interpret software license agreements and application permissions

Ethics and Law continued

K	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grades 6-8	Grades 9-12
						Discuss software license agreements and application permissions	
						Explain positive and malicious purposes of hacking	

Interpersonal and Societal Impact- By the end of each grade or grade band, students will be able to:

K	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grades 6-8	Grades 9-12
Describe how students, parents, and others use many types of technologies in their daily work and personal lives	Provide examples of when content is to provide information or to influence how people act	Discuss examples of when content is to provide information or to influence how people act	Explain why websites, digital resources, and artifacts may include advertisements and collect personal information	Discuss the different forms of web advertising (e.g., search ads, pay-per-click ads, banner ads, in-game ads, email ads)	Discuss the impact of the digital divide (unequal access to technology on the basis of differences such as income, education, age, and geographic location)	Discuss current events and emerging technologies and the effects they may have on education, the workplace, individuals, communities, and global society	Analyze the impact of the digital divide on access to critical information
			Identify resources in the community that can give people access to technology	Discuss ways in which people with disabilities access and use technology	Analyze how access to technology helps empower individuals and groups	Discuss the technology proficiencies needed in the classroom and the workplace and how to meet the needs	Analyze the impact of computing technology on business and commerce (e.g., automated tracking of goods, automated financial transactions, cloud computing)

Interpersonal and Societal Impact Continued

K	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grades 6-8	Grades 9-12
				Evaluate the bias of digital information sources, including websites	Identify why different groups may choose to use technology to promote their message	Analyze how media and technology can be used to misrepresent information	Create a digital artifact designed to be accessible (e.g., closed captioning for audio, alternative text for images)
						Discuss the social and economic implications associated with hacking, software piracy, and cyber terrorism	Analyze the beneficial and harmful effects of computing innovations (e.g., social networking, delivery of news and other public media, intercultural communication)
						Compare ways to use technology to support lifelong learning	Analyze the impact of values and points of view that are presented in media messages (e.g., racial, gender, political)

Digital Literacy: Digital Tools and Collaboration

Digital Tools - by the end of each grade or grade band, students will be able to:

K	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grades 6-8	Grades 9-12
Type his or her name and identify basic keys (e.g., spacebar, return/enter, numbers)	Type 5 words per minute	Type 10 words per minute	Type 15 words per minute	Type 20 words per minute	Type 25 words per minute	Explain the strengths, weaknesses, and capabilities of a variety of digital tools	Use digital tools to design and develop a significant digital artifact (e.g., multi-page website, online portfolio, simulation)
	Identify and use letters, numbers, and special keys on a keyboard (e.g., Back, Shift, Delete)	Operate a variety of digital tools (e.g., open/close, find, save/print, navigate)	Use digital tools to create multimedia artifacts that include text, images, and audio	Use digital tools to manipulate and publish multimedia artifacts	Navigate between local, networked, or online/cloud environments and transfer files between each environment	Identify the kinds of content associated with different file types and why different file types exist (e.g., formats for word processing, images, music)	Select digital tools or resources based on their efficiency and effectiveness to use for a project or assignment and justify the selection
						Integrate information from multiple file formats into a single artifact	
						Use advanced tools to design and create online content (e.g., digital portfolio, multimedia, blog, webpage)	

Collaboration and Communication- by the end of each grade or grade band, students will be able to:

K	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grades 6-8	Grades 9-12
Use a variety of digital tools to present information to others	Use a variety of digital tools to exchange information and receive feedback	Use digital tools and media resources to communicate ideas and details in a way that informs, persuades, or entertains	Communicate key ideas and details in a way that provides information using digital tools and media-rich resources	Communicate key ideas and details in a way that persuades by using digital tools and media-rich resources	Communicate key ideas and details in a way that entertains by using digital tools and media-rich resources	Communicate and publish key ideas and details in a way that informs, persuades, and/or entertains by using a variety of digital tools and media-rich resources	Communicate and publish key ideas and details to a variety of audiences by using digital tools and media-rich resources
					Demonstrate ability to communicate appropriately through online tools (e.g., e-mail, social media, texting, blog comments)	Collaborate synchronously and asynchronously through online digital tools	Collaborate on a project through online digital tools (e.g., science fair project, community service project, capstone project)

Computing Devices- by the end of each grade or grade band, students will be able to:

K	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grades 6-8	Grades 9-12
Identify different kinds of computing devices in the classroom and other places (e.g., laptops, tablets, smartphones, desktops)	Identify visible components of computing devices (e.g., keyboard, screen, monitor, printer, pointing device)	Demonstrate how computing devices function when applications, programs, or commands are executed	Demonstrate the function and purpose of various input and output devices (e.g., monitor, keyboard, speakers, controller, probes, sensors)	Describe the main functions of an operating system	Demonstrate ability to connect and record data, print, send command, connect to Internet, and search by using a range of computing devices (e.g., probes, sensors, printers, robots, computers)	Compare a range of application software	Select computing devices (e.g., probe, sensor, tablet) to accomplish a real-world task (e.g., collecting data in a field experiment) and justify the selection
Identify a range of computing devices and their appropriate uses (e.g., computers, smart phones, tablets, robots, e-textiles)	Operate a variety of computing systems (e.g., turn on and use input/output devices such as a mouse, keyboard, or touch screen)	Find, navigate, and launch a program	Describe the differences between hardware and software	Explain that some computing functions can remain active (e.g., locations function on smartphones)	Identify and solve hardware and software problems that may occur during everyday use	Describe the function of the main internal parts of a basic computing device	Examine how the components of computing devices are controlled by and react to programmed commands
						Describe the use of sensors, actuators, and control systems in an embodied system (e.g., robot, e-textile, installation art, smart room)	Apply strategies for identifying and solving routine hardware and software problems that occur in everyday life (e.g., update software patches, virus scan, empty trash)

Computing Devices Continued

K	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grades 6-8	Grades 9-12
						Design and demonstrate the use of a device (e.g., robot, e-textile) to accomplish a task	Analyze how computing devices manage and allocate shared resources (e.g., memory, Central Processing Unit)
							Discuss the historical rate of change in computing devices and the implications for the future

Human and Computer Tasks- by the end of each grade or grade band, students will be able to:

K	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grades 6-8	Grades 9-12
Describe how computing devices are machines and can be used to help humans with tasks	List tasks that are best completed by humans and tasks that are best completed by computing devices	Describe how different tools can solve the same problem (e.g., pen and paper, calculators, and smart phones can all solve some mathematical problems)	Compare human and computer performance on similar tasks to understand which is best suited to the task (e.g., sorting alphabetically, finding a path across a cluttered room)	Explain advantages and limitations of technology (e.g., a spell-checker can check thousands of words fast, but might not know whether "underserved" is correct or if the author's intent was to type "undeserved")	Explain how hardware and applications (e.g., Global Positioning System, text-to-speech translation) can enable everyone, including people with disabilities, to do things they could not do otherwise	Explain why some problems can be solved more easily by computers or by humans, based on a general understanding of types of tasks at which each excels	Identify a problem that cannot be solved by humans or machines alone and design a solution for it by breaking the task into subproblems suited for a human or machine to accomplish (e.g., a human-computer team playing chess, forecasting weather, piloting airplanes)
					Compare how humans and machines interact to solve problems that cannot be solved by either alone (e.g., big data experiments)	Modify a task previously done without aid of technology and develop a way to complete the task by using technology	

Networks- by the end of each grade or grade band, students will be able to:

K	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grades 6-8	Grades 9-12
		Describe how networks link computers and devices locally and around the world allowing people to access and communicate information	Discuss the need for usernames and passwords as they relate to access permissions, privacy, and security	Discuss how a network is made up of a variety of components and identify the common components (e.g., links, nodes, networking devices)	Explain why devices are numbered or labeled in networks (e.g., the World Wide Web, the Internet Protocol address)	Explain the differences between physical (wired), local and wide area, wireless, and mobile networks	Analyze how network topologies and protocols enable users, devices, and systems to communicate with each other
					Demonstrate sources of and means for accessing information within a network (e.g., websites, email protocols, search engines)	Model the components of a network including devices, routers, switches, cables, wires, and transponders	Examine common network vulnerabilities (e.g., cyber-attacks, identity theft, privacy)
						Describe how information, both text and non-text, is translated and communicated between digital devices over a network	Examine the issues (e.g., latency, bandwidth, firewalls, server capability) that impact network functionality

Services- by the end of each grade or grade band, students will be able to:

K	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grades 6-8	Grades 9-12
					Identify common services (e.g., driving directions apps that access remote map services, digital personal assistants that access remote information services)	Compare capabilities of devices that are enabled through services (e.g., a wearable fitness device that stores data in the cloud, a mobile device that uses location services for navigation)	Analyze the value of using an existing service versus building the equivalent functionality (e.g., using a reference search engine versus creating a database of references for a project)
							Explain the concept of quality of service (e.g., security, availability, performance) for service providers (e.g., online storefronts that must supply secure transactions for buyer and seller)

Abstraction- by the end of each grade or grade band, students will be able to:

K	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grades 6-8	Grades 9-12
List the attributes of a common object, (e.g., cars have a color, type or model, number of seats)	Collect information via survey and organize information into categories	Collect information via survey, organize, and represent information in pictograph or bar graph.	Organize information in different ways to make it more useful and relevant (e.g., sorting, tables)	Sort data in tables and generate bar graphs and other charts from data	Make assertions based on certain categories and attributes of larger data sets	Discuss how data is abstracted (e.g., street address as an abstraction for locations; car make, model, and license plate number as an abstraction for cars)	Discuss and give an example of the value of generalizing and decomposing aspects of a problem in order to solve it more effectively
					Define a simple function that represents a more complex task or problem and that can be reused to solve similar tasks and problems	Use decomposition to define and apply a hierarchical classification scheme to a complex system (e.g., the human body, animal classification, or in computation)	

Algorithms- by the end of each grade or grade band, students will be able to:

K	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grades 6-8	Grades 9-12
	Create a simple algorithm, without using computers to complete a task (e.g., making a sandwich, getting ready for school, checking a book out of the library)	Demonstrate an algorithm using tangible materials (e.g., manipulatives) or present the algorithm in a visual medium (e.g., storyboard)	Define an algorithm as a sequence of instructions that can be processed by a computer	Demonstrate that different solutions exist for the same problem or sub-problem	Create an algorithm to solve a problem (e.g., move a character, robot, or person through a maze)	Design solutions that use repetition and conditionals	Demonstrate that the design of an algorithm is distinct from its expression in a programming language
				Demonstrate logical reasoning to predict outcomes of an algorithm	Detect and correct errors in various algorithms	Use logical reasoning to predict outputs given varying inputs	Represent algorithms using structured language, such as pseudocode
						Decompose a problem and create a sub-solution for each of its parts (e.g., video game, robot obstacle course)	Explain how a recursive solution to a problem repeatedly applies the same solution to smaller instances of the problem
						Describe how more than one algorithm can solve a problem	Analyze ways to characterize how well algorithms perform
						Define boundaries that need to be taken into account for an algorithm to produce correct results	

Data- by the end of each grade or grade band, students will be able to:

K	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grades 6-8	Grades 9-12
	Identify different kinds of information (e.g., text, charts, graphs, numbers, pictures, audio, video, collections of objects)	Collect information on a topic, issue, problem, or question by using age-appropriate digital technologies	Describe examples of databases from everyday life (e.g., library catalogs, school records, telephone directories, contact lists)	Collect data to answer a question by using a variety of computing methods (e.g., sorting, totaling, averaging)	Manipulate data to answer a question by using a variety of computing methods (e.g., sorting, totaling, averaging)	Demonstrate that numbers can be represented in different base systems (e.g., binary, octal, and hexadecimal) and text can be represented in different ways	Describe how data types, structures, and compression in programs affect data storage and quality
	Explain that computers can save information as data that can be stored, searched, retrieved, and deleted	Propose a solution to a problem or question based on an analysis of information	Create information visuals (e.g., charts, infographics)	Evaluate the effectiveness of information visuals to communicate data	Describe how computers store, manipulate, and transfer data types and files (e.g., integers, real numbers, Boolean Operators) in a binary system	Demonstrate how computers store, transfer, and manipulate data types and files (e.g., integers, real numbers, Boolean Operators) in a binary system	Create an appropriate multidimensional data structure that can be filtered, sorted, and searched
						Create or modify a database to analyze data and propose solutions for a task/problem	Create, evaluate, and revise data visualization for communication and knowledge
						Perform operations (sorting, filtering, and searching) in a database to organize and display information in a variety of ways	Analyze a complex data set to answer a question or test a hypothesis (e.g., analyze weather or financial data to predict patterns)
						Use data-collection technology to view, organize, analyze, and report results for content-related problems	

Research- by the end of each grade or grade band, students will be able to:

K	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grades 6-8	Grades 9-12
	Conduct basic keyword searches to gather information from teacher-provided digital sources (e.g., online library catalog, databases)	Identify digital information sources to answer research questions (e.g., online library catalog, online databases, websites)	Create an artifact that answers a research question with clearly expressed thoughts and ideas	Gather and organize information from digital sources by quoting, paraphrasing, and summarizing	Evaluate digital sources for accuracy and relevance	Perform advanced searches to locate information using a variety of digital sources	Generate, evaluate, and prioritize questions that can be researched through digital resources or tools
		Acknowledge and name sources of information or media (e.g., title of book, author of book, website)	Perform searches to locate information using two or more keywords and techniques to refine and limit such searches	Cite text-based sources using a school- or district-adopted format	Create an artifact that answers a research question and clearly communicates thoughts and ideas	Evaluate quality of digital sources for reliability including currency, relevancy, authority, accuracy, and purpose of digital information	Research a problem in computer code and use the findings to make the code function as intended
			Provide basic source information (e.g., Uniform Resource Locator, date accessed for non-text-based sources such as images, audio, video)	Discuss reasons for basic source information (e.g. Uniform Resource Locator, date accessed for non-text-based sources such as images, audio, video)	Demonstrate ways to provide basic source information (e.g. Uniform Resource Locator, date accessed for non-text-based sources such as images, audio, video)	Organize and analyze information from digital sources by quoting, paraphrasing, and summarizing	Evaluate digital sources needed to solve a given problem (e.g., reliability, point of view, relevancy)
						Create an artifact, individually and collaboratively, that answers a research question and communicates results and conclusions	Organize, analyze, and synthesize information using a variety of digital tools

Research Continued

K	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grades 6-8	Grades 9-12
						Use digital citation tools to cite sources when using a school- or district-adopted format	Create an artifact that answers a research question, communicates results and conclusions, and cites sources
							Demonstrate how specialized computing devices can be used for problem solving, decision- making, and creativity in all subject areas

Programming and Development- by the end of each grade or grade band, students will be able to:

K	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grades 6-8	Grades 9-12
Define a computer program as a set of commands created by people to perform a task	Explain that computers can only follow the program's instructions	Create a program using visual instructions or tools that do not require a textual programming language (e.g., unplugged programming activities, a block-based programming language)	Discuss why programs need known starting values (e.g., set initial score to zero in a game)	Use arithmetic operators, conditionals, and repetition in programs	Create, test, and modify a program in a graphical environment (e.g., block-based visual programming language)	Compare algorithms to solve a problem based on a given criteria (e.g., time, resource, accessibility)	Use a development process in creating a computational artifact that leads to a minimum viable product and includes reflection, analysis, and iteration
					Use interactive debugging to detect and correct bugging errors	Implement solutions using programming language including looping behavior, conditional statements, expressions, variables, and functions	Create a program using visual instructions or tools that do not require a textual programming language (e.g., unplugged programming activities, a block-based programming language)
						Trace programs step-by-step in order to predict their behavior	Analyze trade-offs among multiple approaches to solve a problem
						Create a program that implements an algorithm to achieve a given goal	Use appropriate conditional structures in programs

Programming and Development Continued

K	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grades 6-8	Grades 9-12
							Use a programming language or tool feature to enforce operator precedence
							Use global and local scope appropriately in program design
							Employ an appropriate component or library to facilitate programming solutions
							Use an iterative design process, including learning from mistakes, to gain a better understanding of the problem domain
							Engage in systematic testing and debugging methods to ensure program function
							Use proper documentation so others understand a program's design and implementation

Modeling and Simulation- by the end of each grade or grade band, students will be able to:

K	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grades 6-8	Grades 9-12
	Describe how models represent a real-life system (e.g., globe, map, solar system, digital elevation model, weather map)	Define simulation and identify the concepts illustrated by a simple simulation (e.g., growth and health, butterfly life cycle)	Create a simple model of a system (e.g., water cycle, solar system) and explain what the model shows and does not show	Identify the concepts, features, and behaviors illustrated by a simulation (e.g., object motion, weather, ecosystem)	Use data from a simulation to answer a question	Create a model of a real-world system and explain why some features and behaviors were required in the model and why some were not used	Create models and simulations to help formulate, test, and refine hypotheses
						Use and modify simulations to analyze and illustrate a concept (e.g., light rays/mechanical waves interaction with materials, genetic variation)	Form a model from a hypothesis generated from research and run a simulation to collect and analyze data to test that hypothesis
						Use computer simulations to gather, analyze, and report results for content-related problems	

RESOURCES

Organizations and Key Documents Referenced

Massachusetts Digital Literacy and Computer Science Framework

K-12 Computer Science Framework

Montana 2010 K-12 Technology Content Standards

Code.org

Hour of Code

UPCOMING MONTANA DLCS PROFESSIONAL DEVELOPMENT OPPORTUNITIES

Course	K-12	MT University System
Computer Science in the Classroom: An Introduction to Computational Thinking	One week teacher training course offered in the summer	Summer 2017, CSCI 591, 2 credits, MSU https://www.cs.montana.edu/paxton/classes/msse/
The Joy and Beauty of Computing	One week teacher training course in the summer	Summer 2017, CSCI 107, 1 credit, MSU https://www.cs.montana.edu/paxton/classes/msse/592.html
The Joy and Beauty of Data	New course that will be piloted at Bozeman High School during	Spring Semester 2017, CSCI 1xx, 3 credits, MSU Information about the prospective course is located at https://www.cs.montana.edu/paxton/classes/jbd/
Computer Science in the Classroom: The Joy and Beauty of Data	One-week teacher training course in the summer	Summer 2017, CSCI 5xx, 2 credits, MSU Prerequisite: CSCI 591 20 teachers will receive a $1,000 honorarium and the cost of tuition