2016 Massachusetts Digital Literacy and Computer Science (DLCS) Curriculum Framework

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Description of Strands

Progressions of Core Concepts

The Kindergarten through grade 12 DLCS standards are organized by grade span: Kindergarten to grade 2, grade 3 to grade 5, grade 6 to grade 8, and grade 9 to grade 12. Within each grade span, standards are grouped into four **strands**: Computing and Society, Digital Tools and Collaboration, Computing Systems, and Computational Thinking. Each strand is further subdivided into **topics** comprised of related **standards**. DLCS **practices** are integrated throughout the standards and help define performance expectations that specify what students should know and be able to do.

1. **Computing and Society (CAS)**
   Computing impacts all people and has global consequences on such things as communications, assistive technology, social networking, and the economy. Society values many different computing innovations. Computing is a key component of many professions and the content of digital media influences all citizens and society. Global disparities in access to the Internet, media, and devices may lead to an imbalance in equity and power. 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**: The use of computing devices, assistive technologies and applying a computational perspective to solving problems changes the way people think, work, live, and play. Computational approaches lead to new understanding, discoveries, challenges, and questions. Most professions rely on technology and advances in computing foster innovations in many fields. Differential access to principles of computing, computing devices, digital tools, and media in the global society, has potentially significant effects.

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). Digital tools are critical for conducting research, communicating, collaborating and creating in social, work, and personal environments. 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.
   c) **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 (for validity, bias, relevance, accuracy, etc.), organize, analyze, and synthesize information, data and other media from a variety of sources. Effective use of information, data, and media requires consideration of validity, ethics, and attribution of sources.

3. Computing Systems (CS)

Computing systems are comprised of components, such as devices, software, interfaces, and networks that connect communities, devices, people, and services. They empower people to create, collaborate, and learn via human-computer partnerships. The design of many computing systems empowers people to debug, extend, and create new systems. Computing systems require troubleshooting and maintenance to consistently function.

a) **Computing Devices**: Computing devices take many forms (e.g., car, insulin pump, or robot), not just personal computers, phones and tablets. They 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). Computing will continue to be increasingly embedded into devices that are used in social, recreational, personal, and workplace environments.

b) **Human and Computer Partnerships**: 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 are characterized by the interaction of humans with devices and systems that work together to achieve a purpose or solution that would not be independently possible. These skills and knowledge inform the decision to use technology in creating, innovating, or solving a problem or sub-problem.

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.

4. Computational Thinking (CT)

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

- analyzing, modeling, and abstracting ideas and problems so people and computers can work with them;
- designing solutions and algorithms to manipulate these abstract representations (including data structures); and
- identifying and executing solutions (e.g., via programming).

a) **Abstraction**: Abstraction is a process of reducing complexity by focusing on the main idea. By hiding details irrelevant to the question at hand and bringing together related and useful details, abstraction reduces complexity and allows one to focus on the problem. This process creates a new representation which successfully reframes the problem. At the most basic level of abstraction, data structures are used to represent information so that algorithms can operate on the data to create a result.

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. Effective algorithms are efficient, clear, reusable, and accurate.
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. Computational tools enable insights and decisions through new techniques for data collection and analysis.
d) **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. The process of creating software includes understanding the development life cycle, such as testing, usability, documentation, and release. 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.
e) **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.

Description of Practices

Practices cultivate the internalization of dispositions and skills that students apply to solve digital literacy and computer science problems. As students progress through their education, they should acquire increasingly sophisticated practices. Effective instruction couples practices with digital literacy and computer science content to provide a context for performance.

1. **Creating**
   Digital literacy and computer science are disciplines in which students demonstrate creative thinking, construct knowledge, and develop innovative artifacts and processes using technology. Students engage in the creative aspects of computing by designing and developing interesting computational artifacts and by applying techniques to creatively solve problems. Skills include:
   - Creating artifacts or computational projects with practical, personal, and/or social intent;
   - Selecting appropriate methods, paths, or techniques to develop artifacts;
   - Using appropriate algorithmic and information-management principles and/or digital tools;
   - Applying critical thinking, digital tools, and technology to solve problems;
   - Making ethical and responsible choices in selecting tools, information, and media to create and share artifacts; and
   - Reviewing, revising, and iterating work to create high-quality artifacts.

2. **Connecting**
   Developments in computing have far-reaching effects on society and have led to significant innovations. The developments have implications for individuals, society, commercial markets, and innovation. Students study their effects and draw connections between different computing concepts. Skills include:
   - Describing the impact of computing on society (humanity), economies, laws, and histories; and
   - Distinguishing between ethical and unethical practices with respect to safe and responsible use of information, data, media, and computing devices.

3. **Abstracting**
   Computational thinking requires understanding and applying abstraction at multiple levels. Students use abstraction to develop models and to classify and manage information. Skills include:
   - Identifying abstractions;
   - Describing modeling in a computational context;
   - Using abstraction and decomposition when addressing complex tasks or designing complex systems;
   - Classifying data into groups and hierarchies; and
   - Identifying attributes (properties) of the data groups.

4. **Analyzing**
   Students use critical thinking and analytical skills to locate, evaluate, and analyze information, information sources, their own computational artifacts, and the computational artifacts others have produced. Skills include:
   - Asking questions to define a problem or information need;
   - Describing and articulating a problem or information need;

- Evaluating information sources, research, data, proposed solutions, models, or prototypes;
- Identifying ways to improve solutions or information quality; and
- Selecting and justifying appropriateness, precision, or quality of "best" solutions and information sources.

5. **Communicating**

Communication is the expression and exchange of information between two or more people. Communication includes written and oral mediums, as well as tangible representations supported by graphs, visualizations, demonstrations, stories, and analysis. Effective communication is accurate, clear, concise, persuasive, and responsible. Skills include:

- Evaluating various digital tools for best expression of a particular idea or set of information;
- Selecting and using digital media and tools to communicate effectively;
- Communicating to or with different audiences;
- Describing computation with accurate and precise language, notations, or visualizations where relevant;
- Summarizing the purpose of a proposed solution, model, prototype, or computational artifact;
- Justifying the design, appropriateness of choices, and selection of a solution; and
- Communicating responsibly, such as respecting intellectual property.

6. **Collaborating**

People working collaboratively in teams, locally or globally, can often achieve more than individuals working alone. Effective collaboration draws on diverse perspectives, skills, knowledge, and dispositions to address complex and open-ended problems or goals. Skills include:

- Collaborating with others to conduct research, solve a computational problem, or developing digital artifacts;
- Collaborating with others to create computational artifacts, computational projects, or digital by-products; and
- Exchanging knowledge and feedback with a partner or team member.

7. **Researching**

Students apply digital tools to gather, evaluate, and use information in a legal, safe, and ethical manner. Skills include:

- Defining a problem, research question, or goal;
- Identifying information needs, whether primary (e.g., raw data, experimentation, collection), or secondary (e.g., existing information);
- Employing research strategies to locate all possible sources;
- Evaluating and selecting the best sources of information for credibility, accuracy, and relevance, which may include original data, creating a prototype, or conducting other tangible work;
- Using information ethically: attributing sources of information (text, written, images, other media) using the appropriate citation format for the discipline;
- Organizing and analyzing information;
- Synthesizing and inferring information and data; and
- Creating a thesis that addresses the research question.

Grades 6 to 8

The goal for middle school students is to define problems more precisely, to conduct a more thorough process of selecting the best devices, tools, and solutions. Students learn to differentiate problems or sub-problems that are best solved by computing systems or digital tools and those best solved by humans. Students further develop their computational thinking problem solving skills, which facilitates the use of technology.

Grade 6 to 8 standards integrate all seven practices. Standards in this grade span ask students to demonstrate the ability to:

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.
- Communicate and publish online.
- Advance research skills.

Computing Systems CS)

- Understand hardware and software components of a computing device; 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.
- Understand the capabilities services can provide.

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.

By the time students reach middle school, they should have had numerous experiences in using technology to create artifacts and solve problems. Active engagement of middle school students with the practices is critical: students generally make up their minds about whether they identify with science and engineering by the time they leave grade 8. Students should have opportunities to develop the skills necessary for a meaningful progression of development in order to engage in reasoning, which is critical to success in civic life, post-secondary education, and career.

Grades 6 – 8: Computing and Society (CAS)

6-8.CAS.a	**Safety and Security**
6-8.CAS.a.1	Identify threats and actively protect devices and networks from viruses, intrusion, vandalism, and other malicious activities.
6-8.CAS.a.2	Describe how cyberbullying can be prevented and managed.
6-8.CAS.a.3	Explain the connection between the persistence of data on the Internet, personal online identity, and personal privacy.
6-8.CAS.a.4	Describe and use safe, appropriate, and responsible practices (netiquette) when participating in online communities (e.g., discussion groups, blogs, social networking sites).
6-8.CAS.a.5	Differentiate between appropriate and inappropriate content on the Internet.
6-8.CAS.b	**Ethics and Laws**
6-8.CAS.b.1	Explain how copyright law and licensing protect the owner of intellectual property.
6-8.CAS.b.2	Explain possible consequences of violating intellectual property law and plagiarism.
6-8.CAS.b.3	Apply fair use for using copyrighted materials (e.g., images, music, video, text).
6-8.CAS.b.4	Identify the legal consequences of sending or receiving inappropriate content (e.g., cyberbullying, harassment, sexting).
6-8.CAS.b.5	Differentiate among open source and proprietary software licenses and their applicability to different types of software and media.
6-8.CAS.b.6	Demonstrate compliance with the school's Acceptable Use Policy [AUP].
6-8.CAS.b.7	Identify software license agreements and application permissions.
6-8.CAS.b.8	Explain positive and malicious purposes of hacking.
6-8.CAS.b.9	License original content and extend license for sharing in the public domain (e.g., creative commons).
6-8.CAS.c	**Interpersonal and Societal Impact**
6-8.CAS.c.1	Describe current events and emerging technologies in computing and the effects they may have on education, the workplace, individuals, communities, and global society.
6-8.CAS.c.2	Identify and discuss the technology proficiencies needed in the classroom and the workplace, and how to meet the needs.
6-8.CAS.c.3	Relate the distribution of computing resources in a global society to issues of equity, access, and power.
6-8.CAS.c.4	Evaluate how media and technology can be used to distort, exaggerate, and misrepresent information.
6-8.CAS.c.5	Evaluate the bias of digital information sources, including websites.

Grades 6 – 8: Digital Tools and Collaboration (DTC)

6-8.DTC.a	Digital Tools
6-8.DTC.a.1	Identify and explain the strengths, weaknesses, and capabilities of a variety of digital tools.
6-8.DTC.a.2	Identify the kinds of content associated with different file types and why different file types exist (e.g., formats for word processing, images, music, three-dimensional drawings.).
6-8.DTC.a.3	Integrate information from multiple file formats into a single artifact.
6-8.DTC.a.4	Individually and collaboratively use advanced tools to design and create online content (e.g., digital portfolio, multimedia, blog, webpage).
6-8.DTC.a.5	Individually and collaboratively develop and conduct an online survey.
6-8.DTC.b	**Collaboration and Communication**
6-8.DTC.b.1	Communicate and publish key ideas and details individually or collaboratively in a way that informs, persuades, and/or entertains using a variety of digital tools and media-rich resources.
6-8.DTC.b.2	Collaborate synchronously and asynchronously through online digital tools.
6-8.DTC.b.3	Demonstrate ability to communicate appropriately through various online tools (e.g., e-mail, social media, texting, blog comments).
6-8.DTC.c	**Research**
6-8.DTC.c.1	Perform advanced searches to locate information using a variety of digital sources (e.g., Boolean Operators, limiters like reading level, subject, media type).
6-8.DTC.c.2	Evaluate quality of digital sources for reliability, including currency, relevancy, authority, accuracy, and purpose of digital information.
6-8.DTC.c.3	Gather, organize, and analyze information from digital sources by quoting, paraphrasing, and/or summarizing.
6-8.DTC.c.4	Create an artifact, individually and collaboratively, that answers a research question and communicates results and conclusions.
6-8.DTC.c.5	Use digital citation tools to cite sources using a school- or district-adopted format (e.g., Modern Language Association [MLA]), including proper citation for all text and non-text sources (e.g., images, audio, video).

Grades 6 – 8: Computing Systems (CS)

6-8.CS.a	**Computing Devices**
6-8.CS.a.1	Describe the main functions of an operating system.
6-8.CS.a.2	Recognize that there is a wide range of application software.
6-8.CS.a.3	Identify and describe the function of the main internal parts of a basic computing device (e.g., motherboard, hard drive, Central Processing Unit [CPU]).
6-8.CS.a.4	Identify and describe the use of sensors, actuators, and control systems in an embodied system (e.g., a robot, an e-textile, installation art, smart room).
6-8.CS.a.5	Individually and collaboratively design and demonstrate the use of a device (e.g., robot, e-textile) to accomplish a task.
6-8.CS.a.6	Use a variety of computing devices (e.g., probes, sensors, handheld devices, Global Positioning System [GPS]) to individually and collaboratively collect, analyze, and present information for content-related problems.
6-8.CS.a.7	Identify steps involved in diagnosing and solving routine hardware and software problems (e.g., power, connections, application window or toolbar, cables, ports, network resources, video, sound) that occur during everyday computer use.
6-8.CS.b	**Human and Computer Partnerships**
6-8.CS.b.1	Explain why some problems can be solved more easily by computers or humans based on a general understanding of types of tasks at which each excels.
6-8.CS.b.2	Describe how humans and machines interact to solve problems that cannot be solved by either alone (e.g., "big data" experiments that involve drawing conclusions by analyzing vast amounts of data).
6-8.CS.c	**Networks**
6-8.CS.c.1	Explain the difference between physical (wired), local and wide area, wireless, and mobile networks.
6-8.CS.c.2	Model the components of a network, including devices, routers, switches, cables, wires, and transponders.
6-8.CS.c.3	Describe how information, both text and non-text, is translated and communicated between digital devices over a computer network.
6-8.CS.d	**Services**
6-8.CS.d.1	Identify capabilities of devices that are enabled through services (e.g., a wearable device that stores fitness data in the cloud, a mobile device that uses location services for navigation).

Grades 6 – 8: Computational Thinking (CT)

6-8.CT.a	**Abstraction**
6-8.CT.a.1	Describe how data is abstracted by listing attributes of everyday items to represent, order and compare those items (e.g., street address as an abstraction for locations; car make, model, and license plate number as an abstraction for cars).
6-8.CT.a.2	Define a simple function that represents a more complex task/problem and can be reused to solve similar tasks/problems.
6-8.CT.a.3	Use decomposition to define and apply a hierarchical classification scheme to a complex system, such as the human body, animal classification, or in computing.
6-8.CT.b	**Algorithms**
6-8.CT.b.1	Design solutions that use repetition and conditionals.
6-8.CT.b.2	Use logical reasoning to predict outputs given varying inputs.
6-8.CT.b.3	Individually and collaboratively decompose a problem and create a sub-solution for each of its parts (e.g., video game, robot obstacle course, making dinner).
6-8.CT.b.4	Recognize that more than one algorithm can solve a given problem.
6-8.CT.b.5	Recognize that boundaries need to be taken into account for an algorithm to produce correct results.
6-8.CT.c	**Data**
6-8.CT.c.1	Demonstrate that numbers can be represented in different base systems (e.g., binary, octal, and hexadecimal) and text can be represented in different ways (e.g., American Standard Code for Information Interchange [ASCII]).
6-8.CT.c.2	Describe how computers store, manipulate, and transfer data types and files (e.g., integers, real numbers, Boolean Operators) in a binary system.
6-8.CT.c.3	Create, modify, and use a database (e.g., define field formats, add new records, manipulate data), individually and collaboratively, to analyze data and propose solutions for a task/problem.
6-8.CT.c.4	Perform a variety of operations such as sorting, filtering, and searching in a database to organize and display information in a variety of ways such as number formats (scientific notation and percentages), charts, tables, and graphs.
6-8.CT.c.5	Select and use data-collection technology (e.g., probes, handheld devices, geographic mapping systems) to individually and collaboratively gather, view, organize, analyze, and report results for content-related problems.
6-8.CT.d	**Programming and Development**
6-8.CT.d.1	Individually and collaboratively compare algorithms to solve a problem, based on a given criteria (e.g., time, resource, accessibility).
6-8.CT.d.2	Use functions to hide the detail in a program.
6-8.CT.d.3	Create a program, individually and collaboratively, that implements an algorithm to achieve a given goal.
6-8.CT.d.4	Implement problem solutions using a programming language, including all of the following: looping behavior, conditional statements, expressions, variables, and functions.
6-8.CT.d.5	Trace programs step-by-step in order to predict their behavior.

6-8.CT.d.6	Use an iterative approach to development and debugging to understand the dimensions of a problem clearly.
6-8.CT.e	**Modeling and Simulation**
6-8.CT.e.1	Create a model of a real-world system and explain why some details, features and behaviors were required in the model and why some could be ignored.
6-8.CT.e.2	Use and modify simulations to analyze and illustrate a concept in depth (e.g., light rays/mechanical waves interaction with materials, genetic variation).
6-8.CT.e.3	Select and use computer simulations, individually and collaboratively, to gather, view, analyze, and report results for content-related problems (e.g., migration, trade, cellular function).