THE STATE EDUCATION DEPARTMENT / THE UNIVERSITY OF THE STATE OF NEW YORK / ALBANY, NY 12234

TO: P-12 Education Committee

FROM: Kimberly Young Wilkins

SUBJECT: Conditional Approval of the Learning Standards for Computer Science and Digital Fluency

DATE: January 7, 2020

AUTHORIZATION(S):

SUMMARY

Issue for Decision

Should the Board of Regents provide conditional approval of the attached Learning Standards for Computer Science and Digital Fluency?

Reason for Consideration

Required by State statute (Part R of Chapter 56 of 2018). Additionally, to ensure successful implementation of the new standards, the timeline and rollout strategy will allow for professional development and curriculum development before full implementation of the new learning standards.

Proposed Handling

The Computer Science and Digital Fluency learning standards are presented to the P-12 Education Committee for conditional approval at the January 2020 meeting of the Board of Regents (Attachment A).

Background Information

Technology knowledge and skills are vital for full participation in 21st Century life. To comply with the 2018 statute requiring the development of Computer Science Standards, and to fulfil the expectation outlined in the 2010 USNY Statewide Technology Plan that "students, teachers, and leaders will have clear standards for what students should know and be able to do with technology," the Department has engaged with workgroups of stakeholders to create new Computer Science and Digital Fluency Standards.

Overview of the New Computer Science and Digital Fluency Standards

The NYS K-12 Computer Science and Digital Fluency Standards are organized into five Concepts: Impacts of Computing, Computational Thinking, Networks and Systems Design, Cybersecurity, and Digital Literacy.

Each Concept contains two or more Sub-Concepts. Within the Sub-Concepts are a number of standards. The standards are grouped into grade-bands: K-2, 3-5, 6-8, and 9-12. Students are expected to master the standards by the end of the last year of the grade band (i.e., end of second grade for the K-2 grade band).

Guiding Principles

In September 2018, the New York State Education Department (NYSED) convened a group of statewide experts on computer science and educational technology to assist in thinking through matters related to the creation of computer science and digital literacy standards for New York State. The group of experts recommended NYSED combine computer science and digital literacy under one “umbrella,” as has been done in several other states. The group also developed Guiding Principles for the development of the new standards:

1. **Equity and Access**: Equity and diversity should be attended to, allowing for engagement by all students and flexibility in how students may demonstrate proficiency. The standards support a cultural view of learning and human development in which multiple expressions of diversity are recognized and regarded as assets for teaching and learning—otherwise referred to as Culturally Responsive-Sustaining Education (CR-S).
2. **Interdisciplinary Connections**: The standards will complement and promote learning across disciplines.
3. **Coherence**: The standards will be focused on the most important knowledge and skills that all students need to know. The standards will be clearly written, demonstrate vertical and horizontal alignment, and articulate a clear learning progression.
4. **Relevance and Engagement**: The standards will motivate and empower students, allow for a focus on appropriate real-world challenges, and will prepare students to adapt and prosper in a world that is increasingly influenced and shaped by technological advancements.

In October 2018, the Department sent requests to the field for individuals with expertise in computer science and educational technology to assist the Department in writing and reviewing the standards. An Authoring Workgroup and Review Panel were formed to ensure representation from all NYS regions and community types. Workgroup members include teachers; administrators; business and industry experts; parents; representatives from higher education, BOCES, Big 4 school districts, and the NYC

Department of Education; and members of various professional organizations, including New York State United Teachers (NYSUT), the Computer Science Teachers Association (CSTA), and the NYS Association of Computers and Technology in Education (NYSCATE). NYSED also formed an Executive Standards Committee to provide final recommendations to NYSED Senior Leadership.

Authoring Workgroup

From October 2018 through March 2019, the Authoring Workgroup worked to produce a first draft of the new standards. In April 2019, the Authoring Workgroup members cross-reviewed standards written by colleagues and provided feedback to the Department. The Department also requested feedback on the first draft from consultant Dr. Kathi Fisler, a national expert in computer science education. Department staff, with assistance from the Northeast Comprehensive Center, compiled and synthesized the feedback, and then met with Workgroup Leads to discuss. The Workgroups then utilized the feedback to do a revision of the standards to produce the second draft.

Standards Review

The second draft of the Standards was then provided to the Review Panel. Each member of the Review Panel was asked to fill out a survey as a high-level review of all standards, and then was asked to do an in-depth review of the standards through one of the following "lenses" (perspectives):

Lenses	Description
Clarity and Focus	Standards should be limited in number and should be focused on the most important concepts and skills that should be acquired by students. High-quality standards are clearly written and presented in an error-free, legible, easy-to-use format that is accessible to both the targeted instructors and the general public.
Coherence and Progression	Standards should be organized as progressions that support student learning of content and practices over multiple grades. Coherence refers to how well a set of standards conveys a unified vision, establishing connections among the major areas of study, and shows a meaningful progression of content across grade spans.
Equity	Equity and diversity should be attended to, allowing for engagement by all students and flexibility in how students may demonstrate proficiency. The standards support a cultural view of learning and human development in which multiple expressions of diversity are recognized and regarded as assets for teaching and learning—otherwise referred to as Culturally Responsive-Sustaining Education (CR-S).
Interdisciplinary Connections	The standards should complement other NYS Learning Standards and promote learning across disciplines.

Lenses	Description
Rigor	Standards should establish and articulate the appropriate level of rigor to prepare all students for success in college and careers. "Rigor" in this context can be understood as "challenge;" a rigorous standard should challenge students to increase their knowledge and skills.
Relevant and Engaging	Standards should be connected to appropriate real-world challenges, should motivate and empower students, promote individual growth and life-long learning, and prepare students to adapt and prosper in a world that is increasingly influenced and shaped by technological advancements.
Specificity	Standards should be neither too broad nor too specific, and the "granularity," or the degree of specificity, should be consistent across the standards. High-quality standards are precise and provide sufficient detail to convey the level of performance expected without being overly prescriptive or limiting.

Once the review was complete, the Northeast Comprehensive Center compiled the comments and recommendations into a report, which was provided to Department staff and the Executive Standards Committee.

First Revision

In July and August 2019, Department staff and a computer science education consultant revised the standards to address the Review Panel feedback and Department policy and expectations. The draft was presented to the Executive Standards Committee and Department Senior Leadership in September. Revisions were made based on their input, and the draft was finalized for release for stakeholder feedback.

Stakeholder Feedback

The draft standards were then published to solicit broad stakeholder feedback from October 15 to November 15, 2019. NYSED received 410 survey responses representing 839 individuals and members of organizations across New York, with 564 leaving specific comments. The majority of responses were from K-12 educators and administrators; feedback was also received from higher education, advocacy groups, business/industry, nonprofit organizations, parents, students, and school board members. Approximately 60 percent of respondents indicated that they either moderately or strongly supported the standards overall; however, several themes clearly emerged as priorities for immediate revision.

Second Revision

NYSED convened a workgroup on December 4 and 5, 2019, to address the stakeholder feedback priorities and revise the standards accordingly, while still adhering to the Guiding Principles and ensuring the standards are rigorous and focus on the most important knowledge and skills.

Below is a list of the stakeholder feedback priorities for revision and the actions that were taken by the revision workgroup in response.

Priority for Revision	Actions Taken by Revision Workgroup
1. Too many standards overall, and some standards are redundant.	• Reduced number of standards from 45 to 35 by combining redundant standards and focusing on the most important knowledge and skills.
2. More attention needed in the K-2 band, specifically looking at developmental appropriateness, ability to meet the standards without the use of a device, and ensuring clarifying language and examples are relevant to K-2 classrooms.	• Revised K-2 standards to focus on thinking, creativity and problem solving, and ensure almost all standards can be met without the use of a device. • Revised 3-5 standards to ensure many standards can be met without the use of a device. • Revised standards, clarifying language, and examples.
3. Limit references to specific technologies to ensure specific technologies are not needed to address a standard, as well as to help ensure standards remain relevant in years to come.	• Standards, clarifying language, and examples were revised to eliminate references to specific technologies.
4. More examples of interdisciplinary connections should be identified.	• Examples were revised to include more interdisciplinary connections, and an additional Appendix was created to highlight additional examples.
5. More emphasis should be placed on Computational Thinking; important concepts such as abstraction and modeling are absent.	• The standards were reorganized and revised; Computational Thinking was elevated to its own concept area. • Standards in abstraction and modeling were added.

After the above work was completed, it was recommended to the Department that the K-2 band of the new standards needs additional review. The Department is committed to ensuring that this is the best possible set of standards for NYS students, and, as this is the foundation that will support further learning in this area, the program office concurs with this recommendation from the field. The Department would like additional time to work with the field and consider revisions to this area of the standards.

Immediate Next Steps

Tremendous effort by New York State Educators and Stakeholders has been made to date to ensure the new Computer Science and Digital Fluency Standards presented to the Board of Regents and the Commissioner of Education are of high quality, rigorous, and align to the Guiding Principles.

In order to ensure the new standards meet the needs of all students and align to the Board of Regents' ESSA Mission that every child has equitable access to the highest quality educational opportunities, services, and supports in schools that provide effective instruction aligned to the State's standards, as well as positive learning environments so that each child is prepared for success in college, career, and citizenship, NYSED staff have identified the following next steps:

- Engage further with early learning experts to ensure the K-2 grade band standards are developmentally appropriate, and that both the clarifying statements and provided examples are helpful and relevant to K-2 teachers.
- Return to the Board of Regents for final adoption of the standards in spring 2020.
- Begin to develop resources and guidance to aid the field in implementing the standards in accordance with the following proposed implementation timeline.

Timetable for Roll-out and Implementation

Upon approval by the Board of Regents, the projected timeline for implementation of the new Computer Science and Digital Fluency Standards is as follows:

Dates	Phase	Activities
Adoption – Aug. 2021	Awareness-Building	Roll-out and building awareness of the new standards and timeline for implementation
Sept. 2021 – Aug. 2023	Capacity-Building	Focus on curriculum development, resource acquisition, professional development
Sept. 2023 – Aug. 2024	Year 1 Implementation	All credit-bearing Computer Science courses will be aligned with NYS CS&DF Standards
September 2024	Full Implementation	CS&DF Standards implemented in all grade bands K-12

Related Regent's Items

None.

Recommendation

It is recommended that the Board of Regents take the following action:

VOTED: That the Board of Regents conditionally approves the learning standards for the new discipline of Computer Science and Digital Fluency, with the requirement that Department staff take the immediate next steps as outlined above.

Attachment

Appendix A

2018 – 2020 Computer Science and Digital Fluency Standards Workgroups

Thank you to all the individuals involved in the authoring, review, and revision of the New York State Computer Science and Digital Fluency Standards. Additional thanks to all the individuals who provided feedback through NYSED's Stakeholder Feedback Survey.

Executive Standards Committee

Dr. Leigh Ann DeLyser
Co-Founder and Executive Director
CSForALL

Dr. Cameron Fadjo
Assistant Superintendent for Instructional Services
Pleasantville Union Free School District

Dr. Kathi Fisler
Professor (Research) and Associate Director of Undergraduate Studies
Brown University

Ronald Summers
Senior Director of Computer Science Education Policy & Implementation
New York City Department of Education

Dr. Jeffrey Matteson
District Superintendent
Tompkins-Seneca-Tioga BOCES

David Rothfuss
Associate in Research & Educational Services
NYSUT

Ellen Sullivan
Assistant in Educational Services
NYSUT

Authoring Workgroup

Peter Apps	Science Teacher	York CSD
Christine M. Armstrong-Gabler	5th Grade Teacher	Olean CSD
Mark Belden	Technology Teacher	Schuylerville Middle School
Gregory Benedis-Grab	Head of Academic Technology and Computer Science	Packer Collegiate Institute
Lionel Bergeron	Director of Elementary Computer Science	NYCDOE
Lisa Blank	Director of STEM Programs	Watertown CSD
Aimee Bloom	Staff Development Specialist	Erie 2 BOCES
Stacy Bressette	Program Instructor/Curriculum Designer	Albany Can Code

Nicole Caratozzolo	Personalized Learning Coach	Geneva CSD
Jamie L. Cinelli	Kindergarten Teacher	Amherst CSD
JonAlf Dyrland-Weaver	Director of Computer Science/Teacher	Stuyvesant High School
Scott English	Technology Teacher	West Genesee CSD
Jamie W. Fagan	Computer Science Teacher	Webster CSD
Jessica Fletcher	Computer Science Teacher	Spackenkill Union Free SD
Laurie Guyon	Assistant Coordinator	WSWHE BOCES
Kristin Holmes*	Computer Science Teacher	Commack CSD
Dr. Susan Imberman	Associate Dean and Professor in Computer Science	CUNY
Diane Irwin	Science Coordinator	Ballston Spa CSD
Zachary Lind	Chief Information Officer	Ithaca City SD
Christine MacPherson	Director of Educational Technology	Hudson Falls CSD
Christie Maisano	Director of Technology	Pembroke CSD
Stephanie Maturo	Director of Instructional Technology	CiTi BOCES
Terry McSweeny	Assistant in Educational Services	NYSUT
Brandon Milonovich	Math/Computer Science Teacher	Ardsley UFSD
Dr. Lijun Ni	Lecturer	University of Albany
Stephanie Nocerino	Director of Instructional Technology	West Babylon
Christine Owens	Math and Computer Science Teacher	Syosset CSD
Peter Palij	Math and Computer Science Teacher	Mount Vernon CSD
Aankit Patel	Senior Director of Computer Science Academics	NYCDOE
Doreen Pietrantoni	Instructional Technology Specialist	Monroe 1 BOCES
Alana Y. Robinson	Special Education Technology Teacher	NYCDOE District 75

James Sanderson	Technology Education Teacher	McGraw Central School
Robert Sanford	Instructional Technology Specialist	Honeoye Falls-Lima CSD
Lauren Smith	ENL/AIS Teacher	Amherst Schools
Dr. Andrea Tejedor*	Assist Superintendent for Curriculum, Instruction and Technology	Highland Falls-Fort Montgomery CSD
Daniel D. Thomas*	Technology Education Teacher	South Western CSD
Jo Ann Westhall	Prek-6 Computer Science Teacher	NYCDOE District 26
Heather Westlund	Technology Special Area Teacher	Silver Creek Central School
Dr. Pauline White*	Teaching Faculty, Computer Science	Siena College
Jennifer Wilkie	STEM Teacher	Ithaca City SD
Dr. Michael Zamansky*	Lecturer	Hunter College
Susan Zieres Teeple	Model Schools Coordinator	Sullivan County BOCES

* Authoring Group Lead

Review Panel

Eileen Anderson	Computer Technology Teacher	Fillmore CSD
Dustin Andrus	Regional Instructional Technology Specialist	Broome-Tioga BOCES
David Ashdown	Assistant Director for Instructional Technology Programs	WSWHE BOCES
Lisa Baerga	Associate Director of Secondary CS Academics	NYCDOE
Stephanie Bennett	Instructional Technology Specialist	Honeoye Falls-Lima CSD
Darlene Bowman	Teacher	District 75, NYCDOE
Daniel Breiman	Principal	Ithaca CSD
Valerie Brock	Computer Science Education Manager	NYCDOE

Lisa DiBello Wolski	Library Media Specialist	Frontier Central School District
Justin DiMatteo	Regional Technology Integration Instructional Specialist	TST BOCES
David R. Doty	Teacher	Cattaraugus Little Valley CSD
Jill Florio	Principal	Skano Elementary School-Shenendehowa CSD
Marissa Fraher	Library Media Specialist	Pleasantville UFSD
Daniel Gaylord	Computer Science Education Manager	NYCDOE
Sean Hannam	Parent	
Betsy Hardy	Director of Educational Technology	Fillmore CSD
Amy Hobson	Computer Science Education Manager	NYCDOE
Michelle Kennedy	Special Ed Teacher	NYCDOE
Susan Kirby-LeMon	Media Specialist	Skano Elementary School-Shenendehowa CSD
David C. Lasky	Technology Integration Specialist	Olean City SD
Stephen Malone	Teacher	Pawling CSD
Jodi Manne	Technology Teacher	Greenburgh CSD
Drey Martone	Associate Professor of Teacher Education	St. Rose
Tunisia Mitchell	Computer Science Education Manager	NYCDOE
Edward Moloney	Technology Teacher	Sag Harbor Pierson
Jennifer Myers	Senior Supervisor for School Improvement	SLL BOCES
Jose Olivares	Director of Computer Science Academics HS	NYCDOE
Bonnie M. Russell	Parent, NYS PTA Consultant	

Kacie Sandbrook	Teacher	Schalmont CSD
Jennifer Sangiacomo	Instructional Technology Integration Specialist	Cohoes CSD
Cerima Thomas	Technology Teacher	Middletown CSD
Rose Truglio	Teacher	Lindenhurst High
Sara Vogel	Research Assistant on Participating in Literacies and Computer Science	The Graduate Center-CUNY
Nicole Waskie-Laura	Assistant Director for Instructional Technology and Education Resources	Broome-Tioga BOCES
Kim Wegner	Lead Coordinator for Innovative Programs	WSWHE BOCES
Amanda Zullo	Instructional Planning and Assessment Coordinator	CVES BOCES

First Revision Consultant

Meg Ray
Teacher in Residence at Cornell Tech
Cornell University

Second Revision Workgroup

Lisa Blank	Director of STEM Programs	Watertown CSD
David Czechowski	Technology/CS Teacher	Hyde Park CSD
Dr. Cameron Fadjo	Assistant Superintendent for Instructional Services	Pleasantville UFSD
Daniel Gaylord	Computer Science Education Manager	NYCDOE
Diane Irwin	Science Coordinator	Ballston Spa CSD
Peter Palij	Math and Computer Science Teacher	Mount Vernon CSD
David Rothfuss	Associate in Research & Educational Services	NYSUT

Ellen Sullivan	Assistant in Educational Services	NYSUT
Ronald Summers	Senior Director of Computer Science Education Policy & Implementation	NYCDOE
Mike Sylofski	Managing Coordinator, E-Learning	NERIC
Dr. Pauline White	Teaching Faculty, Computer Science	Siena College
Dr. Michael Zamansky	Lecturer	Hunter College
Amanda Zullo	Instructional Planning and Assessment Coordinator	CVES BOCES

New York State Education Department Staff

Jason Breslin, NBCT
Chief of Education Programs
Office of Early Learning

Marybeth Casey
Director
Office of Curriculum and Instruction

Valerie Cosgrove
Supervisor, Education Programs
Office of Educational Design and Technology

Jian Liu (刘健)
Associate in Bilingual Education
Office of Bilingual Education and World Languages

Shannon Logan
Coordinator, Technology Policy
Office of Educational Design and Technology

Kelly Onorato
Associate, Education of Students with Disabilities
Office of Special Education

Erik Sweet
Supervisor, Education Programs
Office of Curriculum and Instruction

Draft New York State

Computer Science and Digital Fluency Learning Standards

Grades K-12

January 2020

New York State
EDUCATION DEPARTMENT
Knowledge › Skill › Opportunity

Table of Contents

Introduction

For New York State students to lead productive and successful lives upon graduation, they must understand and know how to use digital technologies. Technology knowledge and skills are vital for full participation in 21st Century life, work, and citizenship.

In 2018, the New York State Legislature passed, and the Governor signed into law[1], legislation requiring the New York State Education Department (NYSED) to create a workgroup and present draft NYS K-12 Computer Science Standards to the Commissioner of Education and the Board of Regents for approval.

The draft standards that have been released for public review and feedback represent the expertise, deep thinking, advocacy, and hard work of many New York State educators, administrators, parents, and representatives of professional organizations. The related areas of computer science and digital fluency have been combined under one "umbrella" to create a comprehensive, cohesive set of learning standards that represent the essential knowledge and skills in these areas that students should possess upon graduation in order to be successful in college, careers, and citizenship in the 21st Century.

According to the United States Department of Labor Bureau of Labor Statistics, "Employment of computer and information technology occupations is projected to grow 13 percent from 2016 to 2026, faster than the average for all occupations. These occupations are projected to add about 557,100 new jobs." And these hundreds of thousands of new jobs offer significantly higher-than-average pay; the average wage for computer and information technology occupations is higher than all other occupations.[2]

NYSED understands and respects the fact that not all students will pursue a career in technology. It is important to note, however, that for all other occupations, the number of jobs that require medium- to high-level technology skills are growing, and the number of jobs requiring no technology skill are shrinking.[3]

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[1] Part R of Chapter 56 of the Laws of 2018

[2] https://www.bls.gov/ooh/computer-and-information-technology/home.htm 5/10/19.

[3] https://www.cfr.org/report/the-work-ahead/report/findings.html#_edn14, https://www.brookings.edu/wp-content/uploads/2017/11/mpp_2017nov15_digitalization_full_report.pdf, 5/10/19

As New Yorkers, we must prepare all students to live and work in our dynamic, technology-driven 21st-century world. This imperative is the basis of the vision for the draft New York State K-12 Computer Science and Digital Fluency Standards, presented here for public feedback.

Vision for the CS & DF Standards
Every student will know how to live productively and safely in a technology-dominated world. This includes understanding the essential features of digital technologies, why and how they work, and how to communicate and create using those technologies.

NYSED asks for your feedback and will consider all comments and recommendations for further revisions. Please complete the online survey to provide thoughts and comments on the draft standards.

Background

For several years, NYSED has been engaging with the field in parallel conversations on the topics of digital literacy and computer science.

NYSED views digital literacy as vital to success in college, careers, and citizenship. The NY Statewide Learning Technology Plan (2010) identifies that "technology is a path for teaching and learning, but it is also a body of practices, skill, and knowledge to be learned," and expresses the Board of Regents' expectation that "all New York State learners will develop technological literacy to enter college, become productive members of the workforce, and succeed as citizens."[4]

In February 2017, NYSED released a survey to the field that asked respondents to provide feedback on topics related to digital literacy. The survey was re-opened in May 2017 to ensure all stakeholders had the opportunity to respond. In total, NYSED received 3375 responses, over 70% of which were from New York State teachers. The remaining 30% included administrators, BOCES administrative staff, and members of educational organizations. 93% of respondents indicated that a need exists for a common statewide understanding of the technology knowledge and skills all students should demonstrate to be prepared for college, careers, and citizenship in the 21st Century. In addition, New York's approved Every Student Succeeds Act (ESSA) Plan includes the

[4] USNY Statewide Technology Plan

expectation that NYSED "will work with stakeholders to provide guidance regarding digital literacy for students."[5]

At the same time these efforts on digital literacy were occurring, the Department was holding conversations with the field on, and working to establish a teaching certification in, computer science. The Board of Regents approved amendments to the education regulations to establish a new certification area and tenure area for computer science in March 2018. The Department began engaging in conversations on developing computer science learning standards shortly thereafter, and when the law requiring standards was passed in April 2018, plans for development began in earnest.

[5] NYS Approved ESSA Plan, p. 188

Process for Developing the Standards

In September 2018, NYSED convened a group of statewide experts on computer science and educational technology to assist in thinking through matters related to the creation of computer science and digital literacy standards for New York State. The group of experts recommended NYSED combine computer science and digital literacy under one "umbrella," as has been done in several other states. The group also developed Guiding Principles for the development of the new standards.

Guiding Principles
1. **Equity and Access**: All New York State students, in all parts of the state, of all backgrounds and abilities, will be able to achieve the standards.
2. **Interdisciplinary Connections**: The standards will complement and promote learning across disciplines.
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In October 2018, NYSED sent requests to the field for individuals with expertise in computer science and educational technology to assist NYSED in writing and reviewing the standards. An Authoring Workgroup and Review Panel were formed to ensure representation from all NYS regions and community types. Workgroup members include teachers; administrators; business and industry experts; parents; representatives from higher education, BOCES, Big 4 school districts, and the NYC Department of Education; and members of various professional organizations, including NYSUT, the Computer Science Teachers Association (CSTA), and the NYS Association of Computers and Technology in Education (NYSCATE). NYSED also formed an Executive Standards Committee to provide final recommendations to NYSED Senior Leadership.

From October 2018 through March 2019, the Authoring Workgroup worked to produce a first draft of the new standards. At the first meeting, the Authoring Workgroup decided to develop six concept areas. These concept areas are currently identified as Computational Thinking and Programming, Networks and Artificial Intelligence, Data and Systems Design, Cybersecurity, Impacts of Computing, and Digital Literacy. The full Authoring Workgroup was divided into six Workgroups, one per concept area. The Workgroups were responsible for identifying sub-concepts within each concept area, and for writing the standards, clarifying statements, and examples. Each of the six concept area Workgroups had a Lead and 6-8 members who met regularly to draft standards for their assigned concept area.

In April 2019, the Workgroups cross-reviewed another Workgroup's standards and provided feedback to NYSED. NYSED also requested feedback on the first draft from consultant Dr. Kathi Fisler, a national expert in computer science education. NYSED staff, with assistance from the Northeast Comprehensive Center, compiled and synthesized the feedback, and then met with Workgroup Leads to discuss. The Workgroups then utilized the feedback to do a revision of the standards to produce the second draft.

The second draft of the Standards were then provided to the Review Panel. Each member of the Review Panel was asked to fill out a survey as a high-level review of all standards, and then was asked to do an in-depth review of the standards through one of the following "lenses" (perspectives):

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Once the review was complete, the Northeast Comprehensive Center compiled the comments and recommendations into a report, which was provided to NYSED staff and the Executive Standards Committee. In July and August 2019, NYSED staff and a computer science education consultant utilized the Review Panel feedback to revise the standards per Department policy and expectations. The draft was presented to the Executive Standards Committee and NYSED Senior Leadership in September. Final revisions were made based on their input.

The draft standards were then published to solicit broad stakeholder feedback from October 15 to November 15, 2019. NYSED received 410 survey responses representing 839 individuals and members of organizations across New York, with 564 leaving specific comments. The majority of responses were from K-12 educators and administrators; feedback was also received from higher education, advocacy groups, business/industry, nonprofit organizations, parents, students, and school board members. Approximately 60 percent of respondents indicated that they either moderately or strongly supported the standards overall; however, several themes clearly emerged as priorities for immediate revision.

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4. More examples of interdisciplinary connections should be identified.	• Examples were revised to include more interdisciplinary connections, and an additional Appendix was created to highlight additional examples.
5. More emphasis should be placed on Computational Thinking; important concepts such as abstraction and modeling are absent.	• The standards were reorganized and revised; Computational Thinking was elevated to its own concept area. • Standards in abstraction and modeling were added.

Defining Terms

COMPUTER SCIENCE can be defined as "the study of computers and algorithmic processes, including their principles, their hardware and software design, their applications, and their impact on society."[6] In other words, computer science is the study of why and how computers work.[7] Programming, or CODING, is one aspect of the computer science field of study, but is not the sole focus. Computer science emphasizes problem solving and pushes students to be active creators – rather than passive consumers – of computer technologies. In March 2018, the Board of Regents approved a new teacher certification area in computer science. Information on the new COMPUTER SCIENCE TEACHER CERTIFICATION can be found in the related Regents' Item.

DIGITAL LITERACY can be defined as the ability to use digital technologies to create, research, communicate, collaborate, and share information and work. Digital literacy involves both a knowledge of technology and the ability to use it. DIGITAL CITIZENSHIP, which can be defined as understanding and acting in safe, ethical, legal, and positive ways in online environments, is often viewed as one aspect of digital literacy. Digital literacy is not a teacher certification area, nor is it expected to be or become a "class" students take. Rather, digital literacy should be taught in all subjects and reinforced as students use technology in everyday learning, across all subjects.

DIGITAL LITERACY VS DIGITAL FLUENCY

Under recommendation from the field, NYSED is identifying the draft Standards as the Computer Science and Digital *Fluency* Standards.

In recent years, digital fluency has emerged as a term to describe the "next level" of understanding and skill beyond digital literacy. More than just the knowledge and skill to use digital technologies, digital fluency implies an ability to evaluate technologies, transfer understanding to move fluidly between technologies, and create something new with technology.

As there are areas where computer science and digital literacy overlap, a mastery of both areas is necessary to be considered digitally fluent.

EDUCATIONAL TECHNOLOGY, sometimes referred to as instructional technology, is the use of technology to enhance teaching and learning. While there is a teacher certification in this area (the Educational Technology Specialist Certification), educational technology, like digital literacy, is not a "class" students take.

[6] Tucker et. al, 2003, p. 6
[7] https://k12cs.org/defining-computer-science/ (30 July 2019)

TECHNOLOGY EDUCATION, in New York, evolved from the subject area called industrial arts. Although technology education programs offer students many opportunities to apply their mathematics and science skills, programs at the high school level offer additional opportunities to explore technology-related careers under the Career and Technical Education (CTE) umbrella. Technology education classes may teach how to use computing hardware and software within a focus on career skills.

There exist many other terms for describing various aspects of computing, computer education, and technology-related fields. Some schools have computer labs, for instance, or offer Computer Classes. These terms are broad, and the curriculum varies by school and district. There is no specific teacher certification required to teach a “computer class,” and curriculum decisions are made at the district level.

Organization of the Standards

The NYS K-12 Computer Science and Digital Fluency Standards are organized into five Concepts: Impacts of Computing, Computational Thinking, Networks and Systems Design, Cybersecurity, and Digital Literacy.

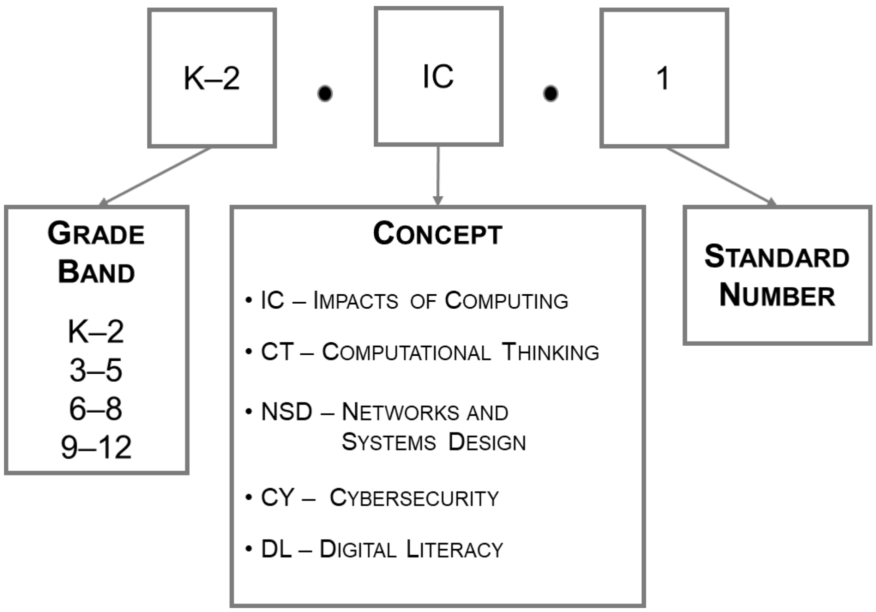
Each Concept contains two or more Sub-Concepts. Within the Sub-Concepts are a number of standards. The standards are grouped into grade-bands: K-2, 3-5, 6-8, and 9-12. Students are expected to master the standards by the end of the last year of the grade band (i.e. end of second grade for the K-2 grade band).

Concept	Sub-Concepts	Standards
Impacts of Computing	Society	1, 2
	Ethics	3, 4, 5
	Accessibility	6
	Career Paths	7
Computational Thinking	Modeling and Simulation	1
	Data Analysis and Visualization	2, 3
	Abstraction and Decomposition	4, 5
	Algorithms	6, 7, 8
	Programming	9, 10, 11, 12
Networks and Systems Design	Hardware and Software	1, 2, 3
	Networks and the Internet	4, 5
Cybersecurity	Risks	1
	Safeguards	2, 3, 4
	Response	5
Digital Literacy	Digital Use	1, 2, 3, 4
	Digital Citizenship	5, 6

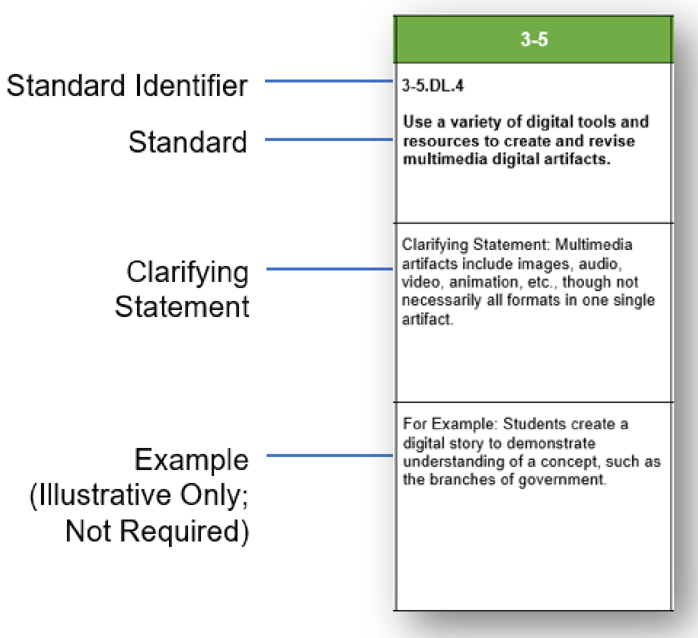
Please note that the organization is *not intended as a sequence*. Concepts, Sub-Concepts, and individual Standards may be taught in any order.

How to Read the Standards

The standards are identified by grade band, followed by the concept area, and finally the standard number.



Each standard is presented with an additional clarifying statement and one example of a classroom lesson for the standard. Please note that the examples were included to provide additional clarification.



NYS K-12 Computer Science and Digital Fluency Standards

Impacts of Computing

Computing affects many aspects of the world at local, national, and global levels. Individuals and communities influence computing through their behaviors and cultural and social interactions. In turn, computing influences new cultural practices. Informed citizens understand the ethical and social implications of the digital world, including equity and access to computing and computing technologies.

The Impacts of Computing standards promote an understanding of the evolving impact of computing technologies on society through many lenses, including personal, social, cultural, accessibility, legal, economic, and ethical.

Society	Computing can change or reinforce cultural practices and equity within society. Human social structures that support education, work, and communities have been affected by the ease of communication facilitated by computing. Governments enact laws to influence the impact of computing technologies on society.
Ethics	Computing is not done in a vacuum. The question of ethics in computing is for both creators and users of technology. If computer scientists and end users do not take into account biases and ethics of what has been built, algorithms and programs may have unintended impacts on societies.
Accessibility	The development and design of computing systems needs to take into account the needs and wants of diverse end users and purposefully consider potential perspectives of users with different backgrounds and ability levels. Identifying potential personal bias during the design and implementation process maximizes accessibility in product design, and awareness of professionally accepted accessibility standards helps to evaluate computational artifacts for accessibility.
Career Paths	The increased connectivity between people in different cultures and in different career fields has impacted the variety and types of careers that are possible. There are also many possible career paths within computer science itself, as well as different specialties within each field, that make computer science a broad and encompassing opportunity.

Impacts of Computing

SOCIETY

K-2	3-5	6-8	9-12
K-2.IC.1 **Identify how individuals lived and worked before and after the adoption or implementation of new computing technology.**	**3-5.IC.1** **Describe computing technologies that have changed the world, and express how those technologies influence, and are influenced by, cultural practices.**	**6-8.IC.1** **Compare and contrast tradeoffs associated with computing technologies that affect individuals and society.**	**9-12.IC.1** **Evaluate the impact of computing technologies on equity, access, and influence in a global society.**
Clarifying Statement: The focus should be on how computing technology has changed the way people live and work, including the similarities and differences of a task with or without computing technology.	Clarifying Statement: The focus should be on how computing technologies both influence and are influenced by society and culture.	Clarifying Statement: Topics that could be addressed include, but are not limited to, free speech, communication, and automation.	Clarifying Statement: The focus should be on how computing technologies can both perpetuate inequalities and help to bring about equity in society.
For Example: Students could discuss how words and phrases can easily be translated into other languages using computing technology and how this is accessible to anyone with an internet connection. Students could then discuss how people would have translated words and phrases from one language to another in the past, without computing technology.	For Example: Students could discuss how technology has influenced communication, relationships, and the practices of cultural traditions and customs. Alternatively, students might discuss how technologies, such as GPS systems, have changed how people travel, as well as the way they explore new places.	For Example: Students could identify trade-offs with a new and emerging technology, discussing how the technology could improve convenience, but also impact personal privacy.	For Example: Students could research how better access to information and/or resources affects a population and develop a strategy and/or recommendation to address the issue.

Impacts of Computing

SOCIETY

K-2	3-5	6-8	9-12
K-2.IC.2 **Identify rules related to computing technologies and digital information.**	**3-5.IC.2** **Explain how laws impact the use of computing technologies and digital information.**	**6-8.IC.2** **Evaluate the impact of laws or regulations on the development and use of computing technologies and digital information.**	**9-12.IC.2** **Debate laws and regulations that impact the development and use of computing technologies and digital information.**
Clarifying Statement: At this level, the focus is on how rules influence computing technologies.	Clarifying Statement: At this level, the focus is on how laws regulate the use of computing technologies and what might happen if those laws did not exist.	Clarifying Statement: At this level, the focus is on the potential consequences of laws related to computing technologies.	Clarifying Statement: At this level, the focus is on developing and defending a claim about how a specific law related to computing technologies impacts different stakeholders.
For Example: Explain how rules impact the use of computing technologies (ex. don’t share your password).	For Example: Students could explain how government regulation of the internet affects people’s access to information.	For Example: Students could research how laws protect intellectual property rights of digital materials and how those laws changed the music industry.	For Example: Students could write a persuasive essay about a legal dilemma related to an individual’s right to privacy being at odds with the safety, security, or well-being of a community.

Impacts of Computing

Ethics

K-2	3-5	6-8	9-12
K-2.IC.3 **Identify computing technologies in the world around us.**	**3-5.IC.3** **Explain current events that involve computing technologies.**	**6-8.IC.3** **Identify and discuss issues of ethics surrounding computing technologies and current events.**	**9-12.IC.3** **Debate issues of ethics related to real world computing technologies.**
Clarifying Statement: Computing technologies can be identified through personal experience or through text/media presented in class.	Clarifying Statement: Explanations should be grade level appropriate to ensure understanding of current events and the related computing technologies.	Clarifying Statement: At this level, students may require teacher support to discuss the possible ethical implications of computing technologies.	Clarifying Statement: The focus is on developing and defending a claim about a specific ethical dilemma related to computing technologies.
For Example: A teacher might keep a class log of all the different computing technologies that they use, see, or read about throughout one school day and compare it to other classrooms.	For Example: Students might read an informational text about an interdisciplinary topic and be able to explain the connection with computing technologies that were presented in the text.	For Example: A teacher might have students find current articles about computing technologies and discuss them in terms of ethical decisions and actions.	For Example: Students might develop and present an argument related to the ethical responsibilities of technology companies.

Impacts of Computing

Ethics

K-2	3-5	6-8	9-12
K-2.IC.4 **Compare the ideas of public and private places and public and private information.**	**3-5.IC.4** **Explain who has access to data in different digital spaces.**	**6-8.IC.4** **Identify and discuss issues of ethics related to the collection and use of data with different computing technologies.**	**9-12.IC.4** **Assess personal and societal trade-offs related to computing technologies and privacy.**
Clarifying Statement: Physical and digital spaces may be public, semi-public, or private.	Clarifying Statement: The focus is on identifying different groups who might have access to data stored or posted in different places, including companies.	Clarifying Statement: The focus is on exploring the ethics of data collection, biases in the data collection, and use by different stakeholders for a range of purposes.	Clarifying Statement: The focus is on discussing the personal and societal benefits and drawbacks of different types of data collection and use, in terms of ethics, policy, and culture.
For Example: Students could describe where a parent could help them post a picture that they want anyone to see, only family to see, or that they don't want anyone to see.	For Example: Students could explain that things posted to online accounts can be accessed by "friends" and "strangers" that they share data with.	For Example: Students could describe how facial recognition surveillance video is used in a store to track customers for security or information about purchase habits. Students might discuss who owns that data and what it is acceptable to do with the data.	For Example: Students could discuss the monitoring of road traffic. They might discuss the trade-offs: changing signals in real time to improve road efficiency and safety versus concerns around consent for personal data collection and potential sharing of personal data with other agencies like the police department or insurance companies.

Impacts of Computing

Ethics

K-2	3-5	6-8	9-12
K-2.IC.5 **Explain how computer decision making is used in daily life.**	**3-5.IC.5** **Explain how computer systems play a role in human decision-making**	**6-8.IC.5** **Analyze potential sources of bias that could be introduced to complex computer systems and the potential impact of these biases on individuals.**	**9-12.IC.5** **Describe ways that complex computer systems can be designed for inclusivity and to mitigate unintended consequences.**
Clarifying Statement: The focus is on identifying AI and understanding that it is a branch of computing technology.	Clarifying Statement: The focus is on explaining a range of ways that humans interact with AI to make decisions.	Clarifying Statement: The focus is on understanding different factors that introduce bias into an AI system and how those biases affect people.	Clarifying Statement: The focus is on applying an understanding of bias and ethical design in order to make recommendations for designing with inclusivity and social good in mind.
For Example: Students could name three characteristics for their perfect pet, and based on the combination of those variables, a "perfect pet" would be suggested by the teacher. The teacher might lead a discussion about how the computers make decisions by comparing information given to determine the best result or answer.	For Example: Students could discuss how recommendation algorithms influence what people select on video and music websites and applications. Alternatively, students could discuss AI that is designed to help professionals make decisions like algorithms that help doctors diagnose patients.	For Example: Students could argue that facial recognition software that works better for certain skin tones was likely developed with a homogeneous testing group and could be improved by sampling a more diverse population. Alternatively, Students could use a search engine to search images and search on the word "grandma" and discuss whether the results of the images are expected, representative, in what way biased.	For Example: Students might consider the ethical and social implications of police departments using artificial intelligence to identify and respond to potential criminal activity. Then make recommendations for how to make such a tool increase equity in policing and mitigate unintended bias caused by the system.

Impacts of Computing

ACCESSIBILITY

K-2	3-5	6-8	9-12
K-2.IC.6 **Identify factors that make a computing device or software application easier or more difficult to use.**	**3-5.IC.6** **Identify ways to improve the accessibility and usability of a computing device or software application for the diverse needs and wants of users.**	**6-8.IC.6** **Assess the accessibility of a computing device or software application in terms of user needs.**	**9-12.IC.6** **Create accessible computational artifacts that meet standard compliance requirements or otherwise meet the needs of users with disabilities.**
Clarifying Statement: The focus is on identifying in general terms that developers of computing devices and software make design decisions that affect product users.	Clarifying Statement: The focus is on identifying the needs and wants of diverse end users and purposefully considering potential perspectives of users with different backgrounds, ability levels, points of view, and disabilities.	Clarifying Statement: The focus is on testing and discussing the usability and accessibility of various technology tools (e.g., apps, games, and devices) with teacher guidance.	Clarifying Statement: At this level, considering accessibility becomes part of the design process and awareness of professionally accepted accessibility standards.
For Example: Students might compare a travel keyboard with a standard keyboard and note that one is easier to carry around but difficult to type with, while the other might be easier to type with but difficult pack into a bag.	For Example: Students could use both text and speech when they create and convey information in a game that they program. Students might make recommendations for making an app easier to navigate.	For Example: Students might notice that allowing a user to change font sizes and colors will not only make an interface usable for people with low vision but also benefits users in various situations, such as in bright daylight or a dark room.	For Example: Students could make sure that a website they are designing is ADA compliant. Students might consider the needs of users with learning disabilities when designing an educational app.

Impacts of Computing

Career Paths

K-2	3-5	6-8	9-12
K-2.IC.7 **Identify a diverse range of roles in computer science.**	**3-5.IC.7** **Identify a diverse range of role models in computer science.**	**6-8.IC.7** **Explore a range of computer science-related career paths**	**9-12.IC.7** **Investigate the use of computer science in multiple fields**
Clarifying Statement: The focus is not just on the roles in computer science, but also the skills and practices that are necessary for careers in that field.	Clarifying Statement: The emphasis of this standard is the opportunity to personally identify with a range people in fields related to computing technologies.	Clarifying Statement: At this level, the focus is on building awareness of the many different computer science-related careers.	Clarifying Statement: At this level, the focus is on making connections between computer science and the fields of interest of individual students.
For Example: Students could take on the role of “programmer” during computer science lessons. A teacher might emphasize that programmers collaborate to solve problems with code.	For Example: A teacher might provide leveled articles for students to read about people in computer science that reflect diversity in race/ethnicity, gender, disability, sexual orientation, and other characteristics.	For Example: A teacher might spotlight different careers and then have students develop a mind map for the classroom wall that connects all the different career pathways.	For Example: A student interested in fashion design could conduct interviews and do research to find out how computer science intersects with that field.

Computational Thinking

Computational thinking involves thinking about and solving problems in ways that can be carried out by a computer. Computational thinking not only underpins all theory and application of computer science, but also influences many other subject areas. Computational thinking includes both core *concepts*, such as algorithms and variables, and core *practices*, such as abstraction, decomposition, data analysis, modeling, and simulation, that are vital not only to the design and development of computer programs but also to the strategic use of computational power to solve problems across disciplines.

The process of creating meaningful and efficient solutions, often done in collaboration with others, typically involves these steps: defining the problem, breaking apart large problems into smaller ones, recombining existing solutions, analyzing different solutions, using data to inform new potential solutions, and looking at information in new ways to develop innovative solutions.

Computational thinking plays an important role in supporting the creation of solutions to problems, both large and small. Algorithms, programs, simulations, and data are essential to all computing systems, empowering people to communicate and collaborate with others around the world. The standards promote development of foundational skills, knowledge, and experience to solve problems by creating solutions that utilize computational thinking concepts and practices.

Modeling and Simulation	Modeling is the process of representing a system to allow one to observe, understand, or simulate it. Models can be used to simulate real world phenomena that are not easy to observe or reproduce, and often generate simulated data that can further understanding of the system or make predictions.
Data Analysis and Visualization	Data analysis is the process of cleaning, transforming, organizing, clustering, and categorizing data to discover useful information, draw conclusions, and aid in making decisions. Data can be visualized in a variety of ways (including graphs and charts) to aid in and communicate the results of the analysis.
Abstraction and Decomposition	Abstraction is the process of reducing complexity by focusing on key elements. The study of a complicated system often starts by simplifying it and addressing just the most important parts. Complex computer programs also rely on abstraction to isolate particular routines or tasks, especially if those tasks are common. A programmer can then call on that routine, often written by others, without needing to understand its details. Decomposition is the process of strategically breaking complicated problems or tasks into smaller parts that are simpler to understand, program, and debug.
Algorithms	An algorithm is a sequence of steps designed to accomplish a specific task. Algorithms can be translated into programs, or code, to provide instructions for computing devices. Algorithms are central to programming.
Programming	Programming is the process of designing and developing code to perform a specific task. It includes the transformation of an algorithm into a specific language that a computer can read and execute, testing code under controlled conditions to ensure its accuracy, debugging the code to resolve errors, and producing documentation both for end users to understand how to use the program and for other developers to assist in following the logic within the program.

Computational Thinking

Modeling and Simulation

K-2	3-5	6-8	9-12
K-2.CT.1 **Recognize and extend a pattern that exists in a natural or designed model.**	**3-5.CT.1** **Develop a model of a system that shows changes in output when there are changes in inputs.**	**6-8.CT.1** **Compare the results of alternative models or simulations to determine and evaluate how the input data and assumptions change the results.**	**9-12.CT.1** **Create a simple digital model that makes predictions of outcomes.**
Clarifying Statement: The emphasis is on learning about observed patterns in an existing model and then using that information to extend parts of the model.	Clarifying Statement: The emphasis is on understanding, at a conceptual level, that models or simulations can be created to respond to deliberate changes in inputs.	Clarifying Statement: The focus is on understanding that models or simulations are limited by the data that they use, rather than understanding specifically how they use that data.	Clarifying Statement: Students will use data to build alternative numerical models that can best represent a data set.
For Example: Students could start with a shape made of four tangram manipulatives and extend the pattern to create a continuous mosaic using the combined shape.	For Example: Students could use the movement of a rope to simulate a sound wave and then explain what happens (in terms of pitch) if they slow down (lower pitch) or speed up (higher pitch) the oscillations modeled by the simulation of sound waves using the rope.	For Example: Students could compare the accuracy of weather models based on research of the inputs.	For Example: Students collect data and use graphing software to create a linear graph, logarithmic graph, and polynomial graph to determine which best addresses the required output.

Computational Thinking

Data Analysis and Visualization

K-2	3-5	6-8	9-12
	3-5.CT.2 **Collect digital data related to a real-life question or need.**	**6-8.CT.2** **Collect and use digital data in a computational artifact.**	**9-12.CT.2** **Collect data from multiple sources for use in a computational artifact.**
	Clarifying Statement: Students should consider using digital tools to collect and organize multiple data points.	Clarifying Statement: Emphasis is on designing and following collection protocols. Data sources include, but are not limited to sensors, surveys, and polls.	Clarifying Statement: Emphasis is on designing and following collection protocols. Data sources include, but are not limited to sensors, web or database scrapers, and human input.
	For Example: Students could create a classroom poll or survey using digital tools and report the results to the class.	For Example: Students could collect temperature data with a sensor and distribute a digital form to community members for a community planning project in which they make recommendations about recreational needs in different types of weather.	For Example: Students could gather and analyze data on the mood and tone of different music genres using a variety of different tools. Students could use a web scraper or API to count the frequency of specific words in the song lyrics, a sound sensor to measure pitch, or a digital survey to capture people's moods after listening to each song.

Computational Thinking

DATA ANALYSIS AND VISUALIZATION

K-2	3-5	6-8	9-12
K-2.CT.3 **Present the same data in multiple visual formats in order to tell a story about the data.**	**3-5.CT.3** **Visualize a data set in order to highlight relationships and persuade an audience.**	**6-8.CT.3** **Refine and visualize a data set in order to persuade an audience.**	**9-12.CT.3** **Refine and visualize a large data set using an appropriate tool in order to persuade an audience.**
Clarifying Statement: The emphasis is on using the visual representation to make the data meaningful. Options for presenting data visually include tables, graphs, and charts.	Clarifying Statement: The emphasis is on identifying and organizing relevant data to emphasize particular parts of the data in support of a claim.	Clarifying Statement: Refining includes, but is not limited to, identifying relevant subsets of a data set, deleting unneeded data, and sorting and organizing data to highlight trends.	Clarifying Statement: Large data sets require use of a software tool or app to cross-reference, analyze, refine, and visualize subsets of the data.
For Example: Students could collect temperature data over a week then use it to create a data table and line graph. They could then use the graph to communicate what the weather was like that week. Alternatively, students could count and chart the number of pieces of each color of candy in a bag of candy, such as Skittles or M&Ms.	For Example: Students could use a spreadsheet program to create a data table and graph of student interests and hobbies in their class and sort them by category. Alternatively, students could sort a data set of sports teams by wins, points scored, or points allowed.	For Example: Students could access government data sets for science (tide, hurricane data, sunrise/sunset) and sort and analyze the data to get specific information to support a claim. Students can use a database program to create a pivot table to summarize multidimensional player stats from their favorite sport in order to tell a story or support a claim about a player’s career.	For Example: Students could build a custom filter for a mapping application that overlays weather data, then cross-reference weather with traffic patterns to find connections. Students could combine a data set on average household income and a data set on health by zip code in order to cross-reference instances of asthma and conditions related to the environment in order to persuade an audience to take action on environmental social justice issues.

Computational Thinking

Abstraction and Decomposition

K-2	3-5	6-8	9-12
K-2.CT.4 **Break down a larger problem into multiple smaller problems (decomposition).**	**3-5.CT.4** **Decompose a problem or task into smaller and smaller parts in order to identify where there is repetition.**	**6-8.CT.4** **Decompose a program into distinct parts in order to write functions to reduce repetition and increase readability.**	**9-12.CT.4** **Decompose a program into parts in order to understand how the program should be organized and written.**
Clarifying Statement: Students should start with a completed task and break it down into steps.	Clarifying Statement: Students should identify smaller steps that are used to solve a larger problem and will break down those steps until each is manageable. Students should notice where steps are repeated.	Clarifying Statement: Students should identify where there is repetition in code or potential to reuse a segment of code in order to develop that segment into a function or procedure.	Clarifying Statement: Students should think about the program they want to develop and break it down into sub-systems based on functionality. They should then break the subsystems into programmable parts, using functions or procedures when necessary.
For Example: Students could think about the steps needed to get ready to go home from school.	For Example: Students could plan a classroom party by separating the task (party) into subtasks such as food, activities, and prizes. The subtasks could then be broken down into further into steps like determining which activities could be present and planning what order to do each activity.	For Example: Give students a program that draws a number of boxes by having instructions to draw all lines. The students can decompose the program by writing a single function to draw a box (abstracting it out) and using it or calling it the same number of times.	For Example: Students who want to create an app that solves a community problem might first break down the project as: front-end, back-end, and data/API. They could then take one subsystem at a time and break it down further by programmable features (i.e. The front-end might need a form, a button, a menu, and a list of links.)

Computational Thinking

ABSTRACTION AND DECOMPOSITION

K-2	3-5	6-8	9-12
K-2.CT.5 **Identify multiple layers that make a common object work**	**3-5.CT.5** **Identify multiple layers of abstraction and perform actions on/with each layer**	**6-8.CT.5** **Identify multiple layers of abstraction and create generalizations that can be placed into one or more abstraction(s)**	**9-12.CT.5** **Create or remix one or more abstraction(s) utilizing multiple existing abstractions**
Clarifying Statement: Students should start with a physical object that contains multiple dependent working parts and then discuss how each part works, as well as how it contributes to the overall functioning of the object itself.	Clarifying Statement: Students should identify each part of a physical object, explain how each part works, and describe how each part contributes to the overall functioning of the object. Students should use parts individually and then together as a whole to accomplish a goal.	Clarifying Statement: Students should identify patterns within the parts of an object so that they can describe common behaviors. Subsequently, students should describe those common behaviors such that they can repeatedly be applied to the functioning of multiple parts within the object.	Clarifying Statement: Students should demonstrate an understanding of the concept of abstraction such that they are able to create or modify one working element of an object, resulting in a predictable outcome. Students should notice that patterns can be made general for reuse.
For Example: An analog wall clock is an abstraction that people use to tell time. Looking behind the clock face, we can see how time is represented by the gears, motors, and battery.	For Example: A calendar or assignment book uses abstraction to represent a year, month, or week in terms of days and hours, helping us to organize our time.	For Example: Students can combine variables that hold similar, related data to make an array. Alternatively, Students can generalize many similar functions to one function such as generalizing individual functions that draw a square, draw a triangle, and draw an octagon to a single function that draws a polygon based on an input for the number of sides.	For Example: Show how popular songs are abstractions of multiple parts of a song (intro, verse, chorus), each part of the song is itself an abstraction of the instruments in that section (drums, piano, bass, vocals, etc.), and that each instrument is an abstraction of the music in that section (notes, rhythm, meter, tempo). Students use this understanding to create remixes or original compositions based on different levels of abstraction using a medium of their choice.

Computational Thinking

ALGORITHMS

K-2	3-5	6-8	9-12
K-2.CT.6 **Follow an algorithm to complete a task and create simple algorithms.**	**3-5.CT.6** **Create and test an algorithm to complete a task.**	**6-8.CT.6** **Design an algorithm and use it within a program.**	**9-12.CT.6** **Demonstrate how at least two classic algorithms work.**
Clarifying Statement: The task can be a familiar, daily activity or more abstract. Algorithms at this stage may be short, containing at least three steps, and focus on sequencing.	Clarifying Statement: Student algorithms can be longer than in K-2 and reflect a task with a specific result that can be checked. Students will revise their algorithms based on the test results.	Clarifying Statement: Student algorithms may be approximations. Algorithms can be represented in a range of formats, including flowcharts, pseudocode, or written steps. Planning the output of a program, such as with a storyboard or wireframe, is not sufficient on its own.	Clarifying Statement: Students can meet this standard through unplugged modeling or through programming. Students should understand that classic algorithms are solved problems that can be reused. Students are not expected to memorize algorithms.
For Example: A teacher might lead students in following an algorithm that tells the class how to line up for recess. Students could create an algorithm on how to build a simple structure with manipulatives (with blocks, cups, etc.) or how to complete a simple classroom task. .	For Example: Students could develop an algorithm for creating a pixel art image and follow the algorithm to test if it produces the intended image. Alternatively, students could create an algorithm for moving a robot or other character through a maze and test the algorithm by programming the robot or other character and watching to see if it follows the intended route.	For Example: Students using block code could arrange blank cut-outs of the blocks in order, then write a pseudocode description on each paper block. Alternatively, students could draw a flowchart of how their program will run from start to finish.	For Example: Students could use merge sort and bubble sort to order a set of playing cards. Alternatively, students could remix a simple program that uses insertion sort to order a class generated data set.

Computational Thinking

ALGORITHMS

K-2	3-5	6-8	9-12
K-2.CT.7 **Create and compare two or more algorithms for the same task.**	**3-5.CT.7** **Compare two or more algorithms and select the most appropriate one for a task.**	**6-8.CT.7** **Compare and refine algorithms for a specific task.**	**9-12.CT.7** **Analyze trade-offs related to two or more algorithms for completing the same task.**
Clarifying Statement: The task can be a familiar, daily activity or more abstract. The focus is on finding more than one way to reach the same goal.	Clarifying Statement: Tasks can be unplugged or related to a computer program.	Clarifying Statement: The steps of an algorithm can be implicit. Tasks should be culturally relevant and familiar to students.	Clarifying Statement: The focus of this standard is a high-level understanding that algorithms involve trade-offs, especially related to memory use and speed. Students are not expected to get into specifics about the trade-offs.
For Example: Students could plan two routes for a robot or other character to reach the same location. Alternatively, students could write “How To” guides for the same task. Students might showcase their work, explaining the steps.	For Example: Students could compare algorithms for making a culturally relevant food item (i.e. pb&j, doner, bahn mi, etc.). Students could then choose an algorithm and explain the reason for their choice. Possible reasons students may provide for their choices might include the detail, the fewest steps, or an algorithm that describes a process most similar to how they make the food item at home.	For Example: Students could compare routes suggested by a mapping app and refine the route based on knowledge of the area near their school or home. Alternatively, students could write an algorithm to draw a geometric shape and refine the algorithm by creating new versions of it until it has no unnecessarily repeating code.	For Example: Students could be asked to look for a specific value in a sorted data set using a sequential search and then a binary search. They can count the number of comparisons it takes to find the value. Alternatively, students could model sorting algorithms with books on a bookshelf and contrast different methods in terms of shelf space and the time spent.

Computational Thinking

ALGORITHMS

K-2	3-5	6-8	9-12
K-2.CT.8 **Modify an algorithm for personal expression or to solve a problem.**	**3-5.CT.8** **Remix an artifact for personal expression or to solve a problem.**	**6-8.CT.8** **Modify, remix, or incorporate portions of an existing program into one's own work.**	**9-12.CT.8** **Identify a relevant module, library, or API and use it in a computer program to add a feature or functionality.**
Clarifying Statement: The emphasis is on making changes to an existing solution. Modifications could involve starting with a base algorithm and moving, taking away, or adding steps to make it their own.	Clarifying Statement: The emphasis is on remixing as a form of abstraction. Remixing could involve remixing an algorithm or program in a new context. Students should give attribution when remixing.	Clarifying Statement: The emphasis is on abstraction. This could include using portions of code from an existing program and modifying it to meet the needs of a new program. Students should give attribution when remixing.	Clarifying Statement: To meet this standard, students can use a module, library, or API, but do not need to use all three. The emphasis is on understanding that these are ways of accessing pre-built features or application data.
For Example: A teacher could provide students with an algorithm representing a process of getting ready for school in the morning. Student then might revise the algorithm to reflect their own morning routines.	For Example: Students could combine pictures and text into their own meme. Alternatively, a teacher might give all the students a chorus and have students incorporate or remix the chorus to create their own song.	For Example: A teacher might provide code that counts the score in one game and have students modify that code for another program in order to keep track of the number of times an image is clicked.	For Example: A student could import a library into their program that has built-in functionality for analyzing large data sets. Alternatively, a student could use a social media API to create a program that determines the most common geographical areas for particular hashtags.

Computational Thinking

Programming

K-2	3-5	6-8	9-12
K-2.CT.9 **Categorize and label data in multiple ways.**	**3-5.CT.9** **Work with variables in an algorithm or program.**	**6-8.CT.9** **Utilize variables to store and modify data when designing or remixing a program.**	**9-12.CT.9** **Design or remix a program that utilizes data structures to store and modify a set of related data.**
Clarifying Statement: At this level, the emphasis is on exploring categories and recognizing patterns that different types of data fit into and using a label as a stand-in for data.	Clarifying Statement: Unplugged options would involve modelling the use of variables. Programming options would involve declaring and initializing variables with a constant value.	Clarifying Statement: This would involve programming or modelling the use of variables with both constant and mutable values.	Clarifying Statement: Data structures include, but are not limited to, arrays and trees. Data structures are how data types in the program are related.
For Example: Given a set of animals, the teacher might have students come up with different possible labels for groups of like animals (i.e. birds, baby animals, plant-eating animals, animals that live in the Arctic).	For Example: Students could write out an algorithm for a repeating rhyme or song. They can use a variable to indicate where a word is changed each time the rhyme or song is repeated, as in “animal” in “Old MacDonald had a Farm” or “name” in “Happy Birthday.” Alternatively, students could use variables to set the drawing pen color in a program.	For Example: Students could create a fill-in-the-blank story that stores user input in different variables and displays the completed story back to the user. Alternatively, students could program a game that uses a score variable to store the users points while playing the game.	For Example: Students could create a website that includes a form field that stores user input and adds it to a dictionary with key/value pairs. Alternatively, students could create a unique class to group all the different enemy objects together in a video game.

Computational Thinking

Programming

K-2	3-5	6-8	9-12
K-2.CT.10 **Develop an algorithm that uses repetition structures for creative expression or to solve a problem.**	**3-5.CT.10** **Develop an algorithm or program that uses both repetition structures (e.g. loops) and conditionals for creative expression or to solve a problem.**	**6-8.CT.10** **Develop or remix a program that effectively combines one or more control structures for creative expression or to solve a problem.**	**9-12.CT.10** **Develop a program that effectively uses control structures in order to create a computer program for practical intent, personal expression, or to address a societal issue.**
Clarifying Statement: Repeating a set of instructions is common in algorithms and programs.	Clarifying Statement: In a programming context, a single program or unplugged model would include a “for loop” or “while loop” and single level “if statement.” They should be in the same algorithm or program, but do not need to work together.	Clarifying Statement: A single program should combine control structures in such a way that they work together to achieve an outcome that they could not achieve using only one.	Clarifying Statement: Different types of loops and conditionals should be used appropriately in order to achieve the desired output of a program created with a specific purpose in mind.
For Example: Students could choreograph a dance using an algorithm. They would indicate that dance steps are repeated.	For Example: Students could guide a paper mouse through a maze to find cheese by developing a set of rules for the “mouse” to follow. Rules could include the following: move forward one space and repeat until the mouse hits a wall, and if there is a wall, turn left then move forward. Alternatively, students could program a math quiz that uses conditionals to check the user’s answers and display a response. The students could use a loop to make a sprite dance when the user completes the quiz.	For Example: Students could use a nested loop to draw a grid. Alternatively, students could use a loop and compound conditional to print all multiples of three between one and one hundred.	For Example: Students could program a choose-your-own-adventure game that uses multiple choice options and probability to determine outcomes. Alternatively, students could program a game that utilizes multiple control structures within a game loop.

Computational Thinking

PROGRAMMING

K-2	3-5	6-8	9-12
K-2.CT.11 **Explain the steps of an algorithm for the purposes of debugging.**	**3-5.CT.11** **Explain each step of an algorithm that includes loops and conditionals for the purposes of to find and correct errors (debugging).**	**6-8.CT.11** **Read and interpret code to predict the outcome of various control structures for the purposes of debugging drawing on a range of debugging strategies.**	**9-12.CT.11** **Systematically test and refine programs using a range of test cases, based on anticipating common errors and user behavior.**
Clarifying Statement: This involves evaluating the steps in an algorithm to determine if they have the desired outcome.	Clarifying Statement: Debugging frequently involves stepping or tracing through a program as if you were the computer to reveal errors	Clarifying Statement: Programs can be debugged in numerous ways, including tracing and trying varying inputs. Perseverance is important in finding errors.	Clarifying Statement: The emphasis is on perseverance and the ability to use different test cases on their programs and identify what issues are being tested in each case.
For Example: Students could write, draw, or speak each step of an algorithm for brushing their teeth.	For Example: Students could predict how a sprite will behave in a certain condition. Alternatively, students could consider code snippets with bugs and collaborate with peers to find the errors by reading and discussing the code.	For Example: Students could trace through a program using a variety of inputs to determine the result.	For Example: Students could test the boundaries of input values and the outcome of each branch in a conditional statement.

Computational Thinking

PROGRAMMING

K-2	3-5	6-8	9-12
K-2.CT.12 **Use a planning process to outline the steps taken to solve a problem or complete a task.**	**3-5.CT.12** **Describe the steps taken and choices made to design and develop a solution using an iterative process.**	**6-8.CT.12** **Document the iterative design process of developing a computational artifact that incorporates user feedback and preferences.**	**9-12.CT.12** **Collaboratively design and develop a program or computational artifact for a specific audience and create documentation outlining implementation features to inform collaborators and users.**
Clarifying Statement: The planning process can be performed using writing, drawing, or speaking.	Clarifying Statement: An iterative design process involves defining the problem or goal, developing a solution or prototype, testing the solution or prototype, and repeating the process until the problem is solved or desired result is achieved. Describing can include talking or writing about the design and development choices for a computational artifact.	Clarifying Statement: At this level, the emphasis is on using the iterative design process to create a solution or prototype with the end user in mind and to document the steps taken by the student to gather and incorporate information about the user into the computational artifact.	Clarifying Statement: The focus is on the collaborative aspect of software development, as well as the importance of documenting the development process such that the reasons behind various development decisions can be understood by other software developers.
For Example: A common writing graphic organizer (e.g. story map or storyboard) can be used as a planning document with drawings that illustrate a story about walking from a classroom to the cafeteria that includes a beginning, middle, and end.	For Example: Starting with a specific issue or topic (e.g. animal extinction, bullying, hunger), students use the iterative design process to explore the issue or topic and then create and deliver a presentation to the class describing the different steps that were taken to arrive at a solution.	For Example: Conducting ‘empathy interviews’ (as part of the design thinking process), students can discover a particular problem or issue a person wants solved. Then, using this information, students can design a program/’app’ that is meant to solve the identified problem in a meaningful way.	For Example: Using a web-based version control platform to share and comment on a program/app, students can engage in collaborative practices common among software developers. Additionally, writing in-line comments within one or more source code file(s) allows students to communicate how a particular part of a program is intended to function.

Networks and Systems Design

Computing devices typically do not operate in isolation. Networks connect computing devices to share data and resources and are an increasingly integral part of computing. Networks and communication systems provide greater connectivity in the computing world by providing fast, secure communication, and facilitating innovation.

Individuals interact with data using a variety of input and output devices that are part of a more complex computing system. The hardware and software that make up a computing system process data in digital form. A basic understanding of hardware and software is useful when troubleshooting a computing system that does not work as intended.

The Networks and Systems Design standards aim to prepare students to understand the basic functioning of the computing systems and networks that are used as fundamental tools in our personal and professional lives.

Hardware & Software	A computing system is composed of hardware, software, and the individuals who use them. Hardware refers to the physical components that make up a computing device. Software refers to the program instructions that operate on such hardware.
Networks & The Internet	Networks are formed by connecting individual devices in a variety of ways. Data is stored on one or more devices in a network and transferred between devices using a set of protocols or rules. The internet is an example of a global network that transmits data between many devices around the world.

DRAFT NYS K-12 Computer Science and Digital Fluency Standards

Networks and Systems Design

Hardware & Software

K-2	3-5	6-8	9-12
K-2.NSD.1 **Describe different ways that humans can interact with computers.**	**3-5.NSD.1** **Propose improvements to the design of a computing technology based on an analysis of user interactions with that technology.**	**6-8.NSD.1** **Design a user interface for a computing technology that takes into account usability, accessibility, and desirability.**	**9-12.NSD.1** **Design a solution to a problem that utilizes embedded systems.**
Clarifying Statement: The emphasis is on understanding that humans and computers interact through inputs and outputs. This includes identifying the components of a computer system that help people input information and the parts that produce output.	Clarifying Statement: The emphasis is on thinking about the purpose of the computing technology and how the user interface could be optimized for that purpose.	Clarifying Statement: The emphasis is on designing (but not necessarily creating) a user interface. Designs could include things like written descriptions, drawings, and/or 3D prototypes.	Clarifying Statement: The emphasis is on designing (but not necessarily creating) solutions with embedded systems. Systems can be biological, mechanical, social, or some other type of system. Designs could include written descriptions, drawings, and/or 3D prototypes.
For Example: Students could label a diagram of a computing system with the words input and output. Alternatively, students could sort images of computer components into input and output columns on a t-chart.	For Example: Students could make recommendations on how to improve a tool, device, or app based on their experiences or those of their classmates.	For Example: Students could design a game controller that is accessible for a person with limited hand and arm movement. Students could design apps that encourage healthy living and take into account factors like motivation to use the app and ease of use.	For Example: Students might design medical devices that can be embedded inside a person to cure a specific illness, regulate a specific function of the body, or give enhanced ability. Students might propose embedded systems that address public health and safety such as coming up with solutions that use embedded systems in a car to address car accidents, texting while driving, pets overheating when left alone in a car, etc.

Networks and Systems Design

Hardware & Software

K-2	3-5	6-8	9-12
K-2.NSD.2 **Explain the function of common hardware and software components in computing systems, using descriptive/precise language.**	**3-5.NSD.2** **Model how computer hardware and software work together as a system to accomplish tasks.**	**6-8.NSD.2** **Design a project that combines hardware and software components to collect and use data to perform a function.**	**9-12.NSD.2** **Explain the levels of interaction existing between the application software, system software, and hardware of a computing system.**
Clarifying Statement: Hardware includes, but is not limited to, desktop computers, laptop computers, tablet devices, monitors, keyboards, mice, and printers. Software includes, but is not limited to, apps, web browsers, and operating systems.	Clarifying Statement: At this stage, a model should only include the basic elements of a computer system, including input, output, processor, and storage.	Clarifying Statement: The focus is on designing (but not necessarily creating) a system that involves collecting and exchanging data including input, output, storage, and processing.	Clarifying Statement: At this stage, knowledge of specific advanced terms of computer architecture and how specific levels work is not required. Rather the progression, in general terms, from voltage to binary signal to logic gates and so on to the level of human interaction, should be explored.
For Example: Students could label images of components and match components with their descriptions.	For Example: Students can draw the computing system, program an animation of how the computer system works, or act it out in some way.	For Example: Students could design an app for finding free filtered water stations in the area that would use GPS, magnetometer, and touch screen sensors as well as the phone's wifi and a map API.	For Example: Students could create a diagram representing the levels of interaction involved in text editing. They would show that software interacts with the operating system to receive input from the keyboard, convert the input to bits for storage, and interpret the bits as readable text to display on the monitor.

DRAFT NYS K-12 Computer Science and Digital Fluency Standards

Networks and Systems Design

Hardware & Software

K-2	3-5	6-8	9-12
K-2.NSD.3 **Describe basic hardware and software problems using descriptive/precise language.**	**3-5.NSD.3** **Determine potential solutions to solve simple hardware and software problems using common troubleshooting strategies.**	**6-8.NSD.3** **Identify and fix problems with computing devices and their components using a systematic troubleshooting method or guide.**	**9-12.NSD.3** **Develop and communicate multi-step troubleshooting strategies others can use to identify and fix problems with computing devices and their components.**
Clarifying Statement: At this stage, the focus is on communicating a problem with appropriate terminology, although students do not need to understand the causes.	Clarifying Statement: Examples of common troubleshooting strategies include: rebooting device, checking for power, checking network availability, closing and reopening an application, making sure speakers are turned on or headphones are plugged in, making sure that the caps lock key is not on, try using a different browser, and checking your settings within an application in an attempt to solve problems.	Clarifying Statement: The focus is on using a structured process, such as a checklist or flowchart, to troubleshoot problems with computing systems and to ensure that potential solutions are not overlooked.	Clarifying Statement: Some examples of multi-step troubleshooting problems include resolving connectivity problems, adjusting system configurations and settings, ensuring hardware and software compatibility, and transferring data from one device to another.
For Example: Students might notify a teacher when an application or device is not working as expected. Rather than saying, "It doesn't work," A student might describe things like, "The device will not turn on," or "The sound doesn't work."	For Example: A teacher might lead students in creating a classroom checklist for basic problems, such as the device not responding, no power, no network connection, application crashing, no sound, or password entry not working.	For Example: Students could follow a troubleshooting flowchart that guides them through a process of checking connections and settings, changing software to see if hardware will work, and swapping in working components.	For Example: Students could create step by step instructions for a help desk employee. Alternatively, students could create a troubleshooting flowchart for anyone using a school device.

Networks and Systems Design

Networks and the Internet

K-2	3-5	6-8	9-12
K-2.NSD.4 **Describe how protocols are used to facilitate communication.**	**3-5.NSD.4** **Model how data is structured to transmit through a network.**	**6-8.NSD.4** **Design a protocol for transmitting data through a multi-point network.**	**9-12.NSD.4** **Describe the design characteristics that allow data and information to be moved, stored and referenced over the Internet.**
Clarifying Statement: The focus is on identifying rules and conventions that allow for communication and data sharing.	Clarifying Statement: The focus is on understanding that data is broken down into smaller pieces and labeled to travel through a network and reassembled.	Clarifying Statement: The focus is on understanding how protocols enable communication and what additional data is necessary for transmission. Knowledge of the details of how specific protocols work is not expected.	Clarifying Statement: The focus is on understanding the design decisions that direct the coordination among systems composing the Internet that allow for scalability and reliability. Discussions should consider historical, cultural, and economic decisions related to the development of the Internet.
For Example: Students could explain how they would communicate an idea using the appropriate gestures or words to someone who doesn't speak their language.	For Example: The teacher could run a series of live simulations in which students act out the flow of information through servers, routers, and other devices to transmit a message. Alternatively, a teacher might have students cut up a map of the United States, then place the states in envelopes and transmit the "packets" through a physical network of students. At the destination, the packets could then be reassembled back into a map of the United States.	For Example: Students could devise a plan to represent a long text-based message as chunks of data and how it would be reassembled at the destination. An unplugged example would include the use of zip codes and barcodes for a letter to travel through the post office system.	For Example: Students could explain how hierarchy in the DNS supports scalability and reliability. Alternatively, students could create a computational artifact that explains the path of data transmission from their device to a website hosted on another continent and back using the network (including but not limited to servers, routers, etc.).

Networks and Systems Design

NETWORKS AND THE INTERNET

K-2	3-5	6-8	9-12
K-2.NSD.5 **Explain how data travels through a network.**	**3-5.NSD.5** **Describe that data can be stored locally or remotely in a network.**	**6-8.NSD.5** **Summarize how remote data is stored and accessed in a network.**	**9-12.NSD.5** **Describe how emerging technologies are impacting networks and how they are used.**
Clarifying Statement: The focus is on explaining that data can only be shared between computing devices or individuals when they are connected to the same network. Additionally, there should be an emphasis on understanding that there are multiple ways to connect to a network.	Clarifying Statement: The focus is on describing that data must be stored on a physical device. Access to remotely stored data is restricted by the networks, and to access non-local data a connection to the network is required.	Clarifying Statement: The focus is on explaining where the data associated with different apps, devices, and embedded systems is stored, how the data is synchronized, and how to connect to it.	Clarifying Statement: The focus is on discussing how specific emerging technologies impact networks in terms of scale, access, reliability, and security, and user behavior.
For Example: Students might explain various ways they can send information to someone else, such as car, letter, email, phone call, or video chat if they both have access to that shared network.	For Example: Students could explain the difference between owning a book (local copy) and borrowing it from a library (remote copy), or what information they might no longer be able to access if the internet went down.	For Example: Students could create a diagram that illustrates the use of remote storage in cloud computing, a school's data server, or distributed media. Students could discuss how local copies of data are synced with data from the remote server.	For Example: Students could discuss how the Internet of Things has impacted the privacy and security of networks. Alternatively, students might discuss how cloud computing affects the scale of networks and access to shared resources.

Cybersecurity

In a digital world, all individuals have a responsibility to protect data and the computing resources they access. Cybersecurity encompasses the physical, digital, and behavioral actions that can be taken to increase this security. These measures are meant to ensure the confidentiality and integrity of data and computing resources, as well as ensure that they are accessible to the users who are supposed to have access to them. Digital security includes understanding and identifying risks, implementing appropriate safeguards, and being prepared to respond to potential attacks.

The Cybersecurity standards prepare students to understand why data and computing resources need to be protected, who might access them, and why they might do so whether intentionally malicious or not. It is important that students know how to employ basic safeguards to protect data and computing resources and how to appropriately respond if a breach occurs.

Risks	Risk is a combination of a vulnerability, the likelihood that the vulnerability will be exploited, and the severity of consequences if the vulnerability is exploited. It is important to understand why data and resources need to be protected and how they might be compromised so the correct safeguards can be put into place.
Safeguards	Programmers and individuals must know how to protect their data and computing resources with common safety measures. When combined, various physical, digital, and behavioral precautions can create a level of digital security.
Response	When a security breach occurs, individuals must decide what actions to take. This takes into account what type of breach occurred and how to improve security moving forward.

DRAFT NYS K-12 Computer Science and Digital Fluency Standards

Cybersecurity

RISKS

K-2	3-5	6-8	9-12
K-2.CY.1 **Compare and contrast information that should be kept private with information that might be made public.**	**3-5.CY.1** **Explain why different types of information might need to be protected.**	**6-8.CY.1** **Determine the types of personal information and digital resources that an individual may have access to that needs to be protected**	**9-12.CY.1** **Determine the types of personal and organizational information and digital resources that an individual may have access to that needs to be protected.**
Clarifying Statement: The emphasis is on discussing the reasons that people would want to keep some types of information private and may want to share some information publicly.	Clarifying Statement: The emphasis is on discussing different reasons that adversaries may want to obtain, compromise, or leverage different types of information. At this stage, students should be focused on general concepts.	Clarifying Statement: The emphasis is on identifying personal information and devices that an individual may have access to and that adversaries may want to obtain or compromise. At this stage, students should focus on specific data and devices that they have access to.	Clarifying Statement: At this stage, the emphasis is on identifying both personal information and organizational information that an individual may have access to and that adversaries may want to compromise or obtain. Additionally, there is a focus on identifying devices and embedded systems that an individual may have access to and that adversaries may want to leverage in some way.
For Example: Students could take strips of paper with information like phone numbers, birthdays, pets names, passwords, etc. Then place the paper strips into the categories “ok to share with everyone,” “ok to share with people you know,” and “keep private” on a shared chart.	For Example: Students could discuss the type of data needed for different adversarial behaviors such as information that can be used for identity theft, cyberbullying, political influence, or ransomware attacks.	For Example: Students could think about their personal information and devices that need to be protected and discuss how adversaries might use the data or computing resources if accessed.	For Example: Students could research events in business, industry, and government involving organizational security breaches and pinpoint the type of data and resources compromised and how it was used.

Cybersecurity

Safeguards

K-2	3-5	6-8	9-12
K-2.CY.2 **Explain ways that information can be kept secure.**	**3-5.CY.2** **Describe common safeguards for protecting personal information.**	**6-8.CY.2** **Describe physical, digital, and behavioral safeguards that can be employed in different situations.**	**9-12.CY.2** **Describe physical, digital, and behavioral safeguards that can be employed to protect the confidentiality, integrity, and accessibility of information**
Clarifying Statement: The emphasis is on recognizing and avoiding potentially harmful behaviors, such as sharing private information online or walking away from public devices after using them without logging off.	Clarifying Statement: The emphasis is on describing common safeguards such as protecting devices and accounts with strong passwords, keeping software updated, and not sending sensitive information over SMS.	Clarifying Statement: The emphasis is on recommending different types of security measures including physical, digital, and behavioral, for a given situation.	Clarifying Statement: The emphasis is on considering the CIA Triad when recommending safeguards for a specific application or device.
For Example: Students could demonstrate that they know how to log in and out of any devices and accounts used for classroom work or other applications.	For Example: Students could create a guide to everyday digital security safeguards for students in another grade. The guide could teach them how to implement different safeguards in the classroom and at home.	For Example: The teacher might provide different scenarios and students can pick safeguards appropriate to the situation from a list that the class generated together.	For Example: Formulate recommendations for setting up a secure home or small business network.

Cybersecurity

Safeguards

K-2	3-5	6-8	9-12
K-2.CY.3 **Identify the benefits and drawbacks of sharing accounts, app access, or devices.**	**3-5.CY.3** **Describe trade-offs between allowing information to be public and keeping information private and secure.**	**6-8.CY.3** **Describe trade-offs of implementing specific security safeguards.**	**9-12.CY.3** **Explain specific trade-offs when selecting and implementing security recommendations.**
Clarifying Statement: The focus is on explaining how user habits and behaviors should be adjusted based on who shares a device.	Clarifying Statement: The focus is on considering the trade-offs of data sharing in different contexts.	Clarifying Statement: The focus is on thinking about how a specific safeguard impacts the confidentiality, integrity, and access of information. Additionally, there should be a focus on discussing if specific safeguards strengthen one part of the triad, but adversely affect another part.	Clarifying Statement: The focus is on making security recommendations and discussing trade-offs between the degree of confidentiality, the need for data integrity, the availability of information for legitimate use, and assurance that the information provided is genuine.
For Example: Students could discuss who has access to shared accounts and why it might be both helpful and risky. They might consider an account that is shared with family members to stream movies or an educational app that is shared by the entire class.	For Example: Students could list the pros and cons of sharing pictures and information about their activities on social media.	For Example: Students could examine the pros and cons of using different methods of authentication, for example passwords, biometrics, or key-fobs and the trade-offs of using single-factor vs multi-factor authentication.	For Example: Students could analyze high profile cybersecurity breaches from the perspectives of competing audiences, including individuals, corporations, privacy advocates, security experts, and government.

Cybersecurity

Safeguards

K-2	3-5	6-8	9-12
K-2.CY.4 **Model different ways to transmit information confidentially.**	**3-5.CY.4** **Model simple cryptographic methods.**	**6-8.CY.4** **Describe the limitations of cryptographic methods.**	**9-12.CY.4** **Evaluate applications of cryptographic methods.**
Clarifying Statement: The focus is on thinking of different ways that they might convey confidential information and test them out.	Clarifying Statement: The focus is on using cyphers to encrypt and decrypt messages as a means of safeguarding data.	Clarifying Statement: The focus is on recognizing that cryptography provides a level of security for data, and some types of encryption are weaker than others.	Clarifying Statement: The focus is on analyzing the role that cryptography and data security play in events that have shaped history and impact the future.
For Example: Students could brainstorm different ways to send a secret message.	For Example: Students could use a Caesar Shift or Vigenere Square to encrypt a message for a classmate. the classmate can use the same cypher to decrypt the message.	For Example: Students could do a basic frequency analysis of a message encrypted with a Caesar Shift to determine how easy it would be to break it.	For Example: Students could research the role of Navajo Code Talkers and the Enigma machine during World War II and how it relates to the use of private and public keys. Alternatively, students could do a report on the cryptography used to secure Bitcoin and what general ways it could be improved.

Cybersecurity

Response

K-2	3-5	6-8	9-12
K-2.CY.5 **Identify unusual behaviors of applications and devices that should be reported to a responsible adult.**	**3-5.CY.5** **Explain unusual behaviors of applications and devices.**	**6-8.CY.5** **Describe actions to be taken when an application or device reports a security problem or behaves unexpectedly.**	**9-12.CY.5** **Recommend multiple potential actions to take in response to various types of digital security breaches.**
Clarifying Statement: The emphasis is on recognizing situations in which students should notify a trusted adult when a device or application does not behave as expected. At this stage, they do not need to understand why the behavior is unusual or pinpoint what is unusual about the behavior.	Clarifying Statement: The emphasis is on describing simple forms of unusual behavior in common applications and devices, including unusual data or links.	Clarifying Statement: The emphasis is on explaining appropriate actions for common situations.	Clarifying Statement: The emphasis is on analyzing different types of breaches and planning appropriate actions that might be taken in response.
For Example: Students could explain that they should not click on pop-ups in an app or online unless instructed by an adult.	For Example: Students could review sample email messages and describe features that suggest suspicious behavior.	For Example: Students could explain the value of running malware scans and removal tools on devices as soon as unusual behavior is observed. Alternatively, students could recommend changing passwords immediately after an account is compromised.	For Example: Students could discuss how organizations could respond to data theft involving customer information.

Digital Literacy

Digital literacy is a multifaceted concept that extends beyond skills-based activities and incorporates both cognitive and technical skills. It refers to the ability to leverage computer technology to appropriately access digital information; to create, share, and modify artifacts, and to interact and collaborate with others. Digital literacy includes understanding the benefits and implications of using digital technologies to be successful in our contemporary world.

Digital Use	Computers are a part of everyday life. A variety of digital tools exist to create, revise, and publish digital artifacts, as well as communicate and collaborate with others.
Digital Citizenship	Digital citizenship focuses on empowering learners to use online resources, applications, and spaces to improve communities, make their voice heard, and curate a positive and effective digital footprint. It encourages students to engage respectfully online with people with different beliefs and better determining the validity of online sources of information.

Digital Literacy

Digital Use

K-2	3-5	6-8	9-12
K-2.DL.1 **Identify, locate, and use the main keys on a keyboard.**	**3-5.DL.1** **Type on a keyboard while demonstrating proper keyboarding technique.**	**6-8.DL.1** **Type on a keyboard while demonstrating proper keyboarding technique, with increased speed and accuracy.**	**9-12.DL.1** **Type proficiently on a keyboard.**
Clarifying Statement: In K and 1, students should explore keyboards. In 2nd grade, students should be introduced to keyboarding. The main keys include the alphanumeric, punctuation, enter, shift, backspace, and delete keys, as well as the space bar.	Clarifying Statement: Students should receive direct instruction in keyboarding beginning in 3rd grade. Instruction should focus on form over speed and accuracy.	Clarifying Statement: Students should continue to improve keyboarding skills, with a focus on increasing speed as well as accuracy.	Clarifying Statement: Students should demonstrate proficient keyboarding skills by the end of 12th grade.
For Example: Students use a keyboard to type a narrative written during writing workshop to create a class book of stories.	For Example: Students use a school-selected online keyboarding program to learn the fundamentals of keyboarding.	For Example: Students regularly type on keyboards as they use technology throughout the school day.	For Example: Students are able to type on a keyboard with enough automaticity that they can fluently and fluidly transfer thoughts to computer.

Digital Literacy

Digital Use

K-2	3-5	6-8	9-12
K-2.DL.2 **Communicate and work with others using digital tools to build knowledge and convey ideas.**	**3-5.DL.2** **Communicate and collaborate using digital tools to learn with others.**	**6-8.DL.2** **Communicate and collaborate with others using a variety of digital tools to create and revise a collaborative product.**	**9-12.DL.2** **Communicate and work collaboratively with others using digital tools to support individual learning and contribute to the learning of others.**
Clarifying Statement: The focus should be on teaching students that people use digital tools to share ideas and work together. Communication and collaboration should be under teacher supervision with school-approved audience(s).	Clarifying Statement: Students progress from understanding *that* people use digital tools to communicate and collaborate to *how* they use the tools. Communication and collaboration should be purposeful and, when possible and appropriate, with an authentic audience.	Clarifying Statement: Students connect with others (students, teachers, families, the community, and/or experts) to further their learning for a specific purpose, give and receive feedback, and created a shared product.	Clarifying Statement: Digital tools and methods should include both social and professional (those predominantly used in college and careers). Collaboration should occur in real time and asynchronously, and there should be opportunities for students to both seek and provide feedback on their thoughts and products.
For Example: Students collaboratively build a list of their favorite books, and the teacher posts the list on their class website.	For Example: Students use a school-approved digital tool to type a request to an expert (author, zoologist, museum curator), asking him or her to speak to their classroom; collaboratively generate a list of questions to ask; and connect with the expert over a digital conferencing tool.	For Example: Students communicate through digital conferencing tools with students from other countries about voting rights. Students collaboratively create an original product (report, presentation, podcast) based on the conversations, post to a shared site, and provide feedback to peers on their products.	For Example: Students identify a local issue of interest/concern, collaborate on a solution, collaboratively create a digital product, and give presentations to authentic audiences.

Digital Literacy

DIGITAL USE

K-2	3-5	6-8	9-12
K-2.DL.3 **Conduct basic searches based on keywords provided.**	**3-5.DL.3** **Conduct and refine advanced multi-criteria digital searches to locate content relevant to varied learning goals.**	**6-8.DL.3** **Compare types of search tools, choose a search tool for effectiveness and efficiency, and evaluate the quality of search tools based on returned results.**	*(mastery reached by grade 8)*
Clarifying Statement: The teacher will provide key words to help students conduct searches and sorting of objects, etc..	Clarifying Statement: Focus should be on the quality of results a search generates, and how to improve search results based on the task or purpose by defining multiple search criteria and using filters.	Clarifying Statement: Mastery of this standard implies an understanding of how different search tools work, why different search tools provide different results, and how and why some websites rise to the top of a search.	
For Example: Students use a key word to find appropriate picture(s) related to a search.	For Example: Students search for articles published after 2018 and pictures licensed under the Creative Commons Non-Commercial license to create a presentation on endangered ecosystems.	For Example: Students compare results when they search on multiple engines; conduct a search, clear their cache/cookies and then conduct a search again; and conduct a search on a mobile device versus a desktop.	

Digital Literacy

DIGITAL USE

K-2	3-5	6-8	9-12
K-2.DL.4 **Use a variety of digital tools and resources to create simple digital artifacts.**	**3-5.DL.4** **Use a variety of digital tools and resources to create and revise multimedia digital artifacts.**	**6-8.DL.4a** **Select and use digital tools to create, revise, and publish digital artifacts.**	**9-12.DL.4a** **Independently select advanced digital tools and resources to create, revise, and publish complex digital artifacts or collection of artifacts.**
Clarifying Statement: Different digital tools are used for different purposes, such as communicating, collaborating, researching, and creating original content. Students may work collaboratively or independently, under supervision.	Clarifying Statement: Multimedia artifacts include images, audio, video, animation, etc., though not necessarily all formats in one single artifact.	Clarifying Statement: Teachers should designate a school-approved location for students to publish artifacts for an audience to view. Advanced digital tools may refer to the tool itself (i.e. the tool is more advanced) or to utilization of more advanced features on a tool.	Clarifying Statement: Mastery of this standard implies an ability to choose and use the technology tool or resource best suited for a task or purpose.
For Example: By the end of second grade, students will have communicated with a school-approved audience, worked together, researched a topic, and created something, all using different tools. When introducing a new tool, the teacher thought aloud/modeled how to choose the right tool for the task.	For Example: Students create a digital story to demonstrate understanding of a concept, such as the branches of government.	For Example: In collaborative groups, students create anti-cyberbullying commercials and an accompanying infographic for parents on ways they can help kids spot and report cyberbullying.	For Example: For a project that allows students to represent learning in different/multiple ways, students choose the tools to use and write a justification why they were the best choices.

DRAFT NYS K-12 Computer Science and Digital Fluency Standards

Digital Literacy

Digital Use

K-2	3-5	6-8	9-12
		6-8.DL.4b **Transfer knowledge of technology operations in order to explore new technologies.**	**9-12.DL.4b** **Transfer knowledge of technology operations in order to use new and emerging technologies on multiple platforms.**
		Clarifying Statement: New technologies could include different tools for collaboration, creation, etc. that the student has not used before.	Clarifying Statement: New technologies could include different tools for collaboration, creation, etc. that the student has not used before. Platforms could include devices running different operating systems or could be emerging STEAM technologies. Digitally fluent individuals can move between platforms and can use that knowledge when encountering new technology.
		For Example: Students familiar with a desktop presentation software (PowerPoint/Keynote) use an online presentation tool to create a presentation.	For Example: Students choose an emerging technology and use it create a simulation of a principle of physics.

DRAFT NYS K-12 Computer Science and Digital Fluency Standards

Digital Literacy

Digital Citizenship

K-2	3-5	6-8	9-12
K-2.DL.5 **Provide examples of online information about real people, and identify ways that people put their own information into online spaces.**	**3-5.DL.5** **Describe persistence of digital information and explain how actions in online spaces can have consequences in the "real world."**	**6-8.DL.5** **Explain the connection between the persistence of data on the Internet, personal online identity, and personal privacy.**	**9-12.DL.5** **Actively manage digital presence and footprint to reflect an understanding of the permanence and potential consequences of actions in online spaces.**
Clarifying Statement: Concepts related to personal information sharing/privacy should be introduced.	Clarifying Statement: In order for students to be able to effectively manage their digital identities, it should be understood that online information doesn't "go away," and that information posted online can affect their "real lives," even years in the future.	Clarifying Statement: A focus should be on learning about privacy settings on social media accounts, exploring the concept of a positive online presence/identity, and identifying behaviors and information that could potentially affect them now and when they are ready to transition to college and careers.	Clarifying Statement: Active management implies an understanding of how intentional and unintentional actions can affect a digital presence.
For Example: The teacher leads a discussion about photos found online: how people post them, how they sometimes let other people see them, and sometimes they choose to keep them private, and how if the students are playing a game and the game wants to take their picture, they need to ask a responsible grown-up if it's ok.	For Example: Students use a tool that displays archived versions of websites (such as "Wayback Machine") to research how information is available even if it seems to be deleted.	For Example: Students create guides for an adult (family member, celebrity, fictional character) on how to manage online identity and actions that affect someone's digital footprint.	For Example: a. Students create diagrams / infographics that illustrate the myriad sites that might collect data on an individual, the accumulation of which is a digital footprint. b. Students create an online portfolio showcasing sample work and resume that could be shared with potential employers or college admissions boards.

Digital Literacy

DIGITAL CITIZENSHIP

K-2	3-5	6-8	9-12
K-2.DL.6 **Identify actions that promote good digital citizenship, and those that do not.**	**3-5.DL.6** **Identify actions in online spaces that could potentially be unsafe; describe cyberbullying and actions to take if cyberbullying is witnessed or experienced.**	**6-8.DL.6** **Describe safe, appropriate, positive, and responsible online behavior; identify types of cyberbullying, and identify strategies to combat cyberbullying/harassment.**	**9-12.DL.6** **Design and implement strategies that support safety and security of digital information, personal identity, property, and physical and mental health when operating in the digital world.**
Clarifying Statement: Good digital citizens practice safe, responsible, ethical, and positive behavior when they use technology and/or are in online spaces. Just like in “real-life,” good citizens know to follow the rules, be safe, and be respectful to one another.	Clarifying Statement: Potentially unsafe actions include – but are not limited to – sharing personal information, clicking on pop-ups/advertisements/phish-bait, allowing access to camera.	Clarifying Statement: Types of cyberbullying include – but are not limited to – harassment, trolling/flaming, excluding, outing, dissing, masquerading, and impersonation.	Clarifying Statement: Strategies that support positive mental health in the digital world include both ways to avoid or handle cyberbullying and ways to interact positively and constructively with others in connected spaces.
For Example: Students hold up red light/green light signs at teacher prompts about actions with technology/in online environments, such as “Share your password,” “Go to sites linked from our class webpage,” “Write something mean about someone,” etc. Actions could be added to a running list on a chart displayed in the classroom.	For Example: Students create PSAs on online safety and cyberbullying to include in district/school newsletters/newspaper or make posters to put up in the middle school.	For Example: Students work in collaborative groups to create action plans to decrease instances of cyberbullying among teens.	For Example: Students create an individual action plan on how they would prevent multiple types of cyberbullying and/or a compromise of their digital identity.