IOWA | Department of Education

DRAFT

IOWA ACADEMIC STANDARDS FOR

Computer Science, Artificial Intelligence and Data Science







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Introduction

In a world increasingly driven by computing and data, it is important for Iowa students to build a foundational understanding of these areas throughout their K-12 education. Learning the basics of computer science, artificial intelligence and data science helps set students up for whatever comes next in their postgraduation path, whether it is general everyday use of the concepts or pursuing careers in these specialized fields.

This document outlines standards across three interconnected areas: computer science, artificial intelligence (AI), and data science. Each of these areas includes elements of digital literacy, but these should not be considered a comprehensive list of digital literacy standards.

Computer Science is the understanding of how and why technologies work. It explores whether and how technology can solve real-life problems, investigates procedures, and involves creating solutions while learning about programming, data networks, security and their effects on society and individuals. Learning computer science means learning how to create new technologies rather than simply using them.

Computer Science Standards

Artificial Intelligence (AI) refers to machine-based systems capable of performing tasks that typically require human intelligence, such as learning, reasoning, problem-solving and decision making. AI utilizes large datasets and advanced algorithms to analyze information and generate predictions, recommendations or decisions. These systems rely on human-defined objectives and can influence both real and virtual environments.

AI builds on the foundations of computer science. Core AI standards that all students should learn are included within the computer science standards, while more specific AI standards are addressed in the AI section.

Artificial Intelligence Standards

Data Science combines math, statistics and technology to understand and use data. By analyzing different types of information, it helps uncover patterns, answer questions and turn data into meaningful insights. It plays a key role in AI systems and computer science but also stands as its own discipline.

Data science is an interdisciplinary field that combines scientific methods, algorithms, mathematics and statistics to extract and communicate actionable insights and knowledge from structured and unstructured data.

Data science is utilized heavily in the creation and functioning of artificial intelligence systems and, more broadly, in computer science. However, it is not limited to computer science alone. It stems from mathematics and is used in almost every other content area. Because data science functions as its own area, the data science standards exist in their own section of this document.

Data Science Standards

How to Read the Standards

The standards are organized by grade level (K–6) and banded at the middle and high school levels. High school standards include more specialized areas for deeper learning, continuing the pathway from elementary school and helping prepare students for college and careers, including those pursuing more focused fields.

The standards are designed to create a K–12 pathway that supports multiple exit points along students' computer science, AI and data science journeys. They ensure all students build a strong foundation while also preparing them to enter the workforce after high school or continue their education through community college or a four-year program.

Standards in each area are implemented across all grade levels to create a cohesive, comprehensive system of learning:

- **Elementary standards** — build a foundational understanding of key concepts.
- **Middle school standards** — deepen knowledge and increase rigor.
- **High school standards** — develop a more advanced understanding, enabling students to apply their learning in real-world contexts.

Each content area incorporates the universal constructs throughout both the standards and practices. As students progress, they expand their abilities in validate, complex communication, creativity, collaboration, flexibility and adaptability, and productivity and accountability. While these skills may not always be directly mentioned in the standards, the specific skills associated with them are evident throughout.

According to the Iowa Department of Education, these skills include:

Critical Thinking reflects:

- Thoughtful questioning that challenges assumptions, promotes higher-order thinking, leads to new insights and validates perceptions
- Metacognition that supports reflective practice
- Processes that analyze, select, use and evaluate various approaches to develop solutions
- Critical issues that develop innovative responses
- Analysis and synthesis of multiple sources and points of information
- Intentional use of disciplinary frameworks to analyze complex issues and information
- Suspension of judgement while collecting evidence to make determinations

Complex Communication reflects:

- Negotiation processes that generate mutually satisfactory solutions
- Managing and resolving conflicts
- Interacting effectively with people
- Selection and integration of various communication processes
- Integration of appropriate forms of informative communication technology
- Understanding the interactions among modes of communication
- Meaningful and engaging interactions
- Focus, energy and passion around the key message
- Navigation through nuances of effective communication

Creativity reflects:

- A disciplined process that includes skill, knowledge imagination, inspiration and evaluation
- Capturing or collecting new ideas for current or future use
- A combination of seemingly unrelated ideas into something new
- A respectful change of ideas
- Engagement in formal and informal learning experiences

- Divergent thinking
- Entrepreneurial thinking that encourages unique thoughts and applications
- A comfort level with open-ended challenges that reflect multiple approaches and results
- Reconfiguration of current thought within a new context pattern recognition across disciplines that results in an innovative outcome

Collaboration reflects:

- Non-hierarchical leadership based on individual skill sets
- Respect for a complex process that requires individuals to contribute and participate in meaningful interactions
- The belief that group synergy enhances productivity
- Understanding and application of effective group processes to solve problems
- Productive group interactions
- Respectful disagreement

Flexibility and Adaptability reflects:

- Engagement in innovation and creativity
- Intellectual agility
- Embracing change
- Expecting and accepting the emotions inherent in change while supporting those who are involved
- Respect for unique qualities of others and self
- Purposeful and thoughtful response to disruptions
- Acknowledging and responding to dissonance in productive ways
- The potential for positive and negative outcomes in risk-taking
- Proactive and reactive approaches to change
- Acknowledging ambiguity is inherent in a changing environment

Productivity and Accountability reflects:

- The ability to acquire new learning on one's own
- Application of appropriate processes and tools to facilitate task completion
- Self-sufficiency as required in a complex environment
- Identification of available opportunities
- Motivation and commitment to achieve
- Assuming leadership roles
- Building on prior learning and experience to apply knowledge and skills in a variety of contexts
- Self-confidence and self-respect

All standards areas are organized into main concept areas, which are further broken down into more specific sub-concepts. Within each concept and sub-concept, the standards are presented in a table that includes the Standard Code, Iowa Academic Standard and Standard Clarification. Below the standard table is the list of Content Connections to other content areas.

The **Standard Code** contains the grade level (EK), Concept area (ALG), Subconcept (PS) which is also noted below the standard code and the standard number in the grade level (04)

The **Iowa Academic Standard** is the standard itself. This is the level of learning students should attain.

The **Standard Clarification** specifies what the learning should look like in order for the students to meet the standard and provides example activities.

Standard Code	Iowa Academic Standard	Standard Clarification
EK-ALG-PS-01 Algorithmic Problem Solving	Carry out algorithms in daily activities	Students should demonstrate simple, step-by-step activities in the correct sequence for familiar classroom or home tasks. Following classroom routines (e.g., cleaning up or lining up) or completing personal tasks (e.g., eating snacks or washing hands) are appropriate. Teachers should explicitly teach the word algorithm in context. Students are not expected to carry out algorithms that include conditionals or iteration. Students are not required to write algorithms or use a programming language.

Content Connections suggest opportunities to integrate these standards into other subject areas. Integration serves two purposes: it helps teachers expand what they cover in the classroom without dedicating time to a single

ELA Connection

RF.K.1.A (EK-ALG-PS-01) Follow words from left to right, top to bottom, and page by page.

RL.K.2 With prompting and support, retell familiar stories, including key details.

Computer Science

Computer Science is the understanding of how and why technologies work. It involves exploring how technology can solve real-world problems, developing procedures, creating solutions and understanding computing systems, programming, networks and security, as well as their impact on individuals and society. It goes beyond using technology to understanding how to create it.

Today's students have never known a world that wasn't heavily influenced by computing, and that influence will only continue to grow. To prepare Iowa's students for future success, it is essential that all students are engaged and supported through computer science education. These standards are intended to provide all students with a foundational knowledge of computer science, helping them understand how current, emerging and future technologies work and how they impact and are impacted by people and society.

Iowa's computer science standards are influenced by the Computer Science Teacher Association Computer Science Standards. These research-based standards were written by experts from across the country and tailored by our committee to meet the needs of Iowa students.

The foundational K-12 computer science standards are divided into five concept areas:

- Algorithms & Design (ALG).
- Programming (PRO).
- Data & Analysis (DAT).
- Systems & Security (SYS).
- Computing & Society (SOC).

Each concept area is broken into smaller sub-concepts to help students form a more complete understanding.

In addition to these foundational areas, specialty standards are included for:

- Software Development.
- Cybersecurity.
- Physical Computing.
- Game Development.

These specialty standards support more advanced learning and help teachers design courses for students who want to go beyond foundational concepts and explore potential career pathways in computer science. Advanced specialty standards are also included within the AI and data science sections.

The computer science standards cover machine learning and other essential topics for creating and managing AI systems. These standards address the concepts from a computer science perspective and are different from the standards contained in the AI section.

The computer science standards contain standards related to data science that address data processing and analysis necessary for the programming and creation of computing systems. However, these are not intended to be comprehensive. Comprehensive data science standards are addressed in the Data Science section.

Computer Science Concepts & Subconcepts

Algorithms & Design (ALG)

An algorithm is a sequence of steps designed to accomplish a specific task. Algorithms are translated into programs, or code, to provide instructions for computing devices. In early grades, students learn about age-appropriate algorithms from the real world. As they progress, students learn about the development, combination, and decomposition of algorithms; the evaluation of competing algorithms; and the difference between traditional algorithms and artificial intelligence/ machine learning (AI/ML) algorithms. The Algorithms and Design standards and the Programming standards are complementary and should be considered in tandem. Algorithms & Design standards focus more on program planning and evaluation, while Programming standards focus more on program implementation.

Algorithmic Problem Solving (PS)

Designing algorithms, or step-by-step solutions to a task, are an essential component of CS. In early grades, students identify and create algorithms reflecting tasks in their daily lives. As students progress, they develop more complex algorithms and create visual representations of their solutions and evaluate the efficiency and accuracy of computational algorithms running under different conditions and use problem-solving skills to explore algorithms' underlying opaque systems.

Machine Learning (ML)

Machine learning is a subfield of artificial intelligence in which computers "learn" from data in order to make decisions without being explicitly programmed to do so. This subconcept includes content that is key for understanding foundational components of artificial intelligence and is placed within this concept to ensure students gain a basic understanding of artificial intelligence concepts. More detailed standards addressing how computing systems learn can be found in the Learning Concept in the Artificial Intelligence standards.

In early grades, students recognize patterns used by people and machines for decision-making. As they advance, students explore how AI models evolve with new training data, train AI models for classification or prediction, and analyze the relationship between training data properties and AI model output. By high school, students justify the selection of AI algorithms, evaluate training data for quality and bias, and develop AI models for specific tasks using appropriate data and tools.

Impacts of Algorithms & Design (IM)

In early grades, students begin by exploring how algorithms can lead to different results for themselves and others. As students progress, they learn to identify possible consequences of algorithmic decisions and they apply human-centered design principles to develop and refine computational algorithms. In later grades, students critically analyze the societal impacts of algorithms, and consider how algorithmic systems can shape real-world experiences.

Programming (PRO)

Programming controls all computing systems. The development process involves choosing which information to use and how to process and store it, decomposing problems, using and analyzing different solutions. While the Algorithms and Design standards focus more on program planning and evaluation, the Programming standards focus more on program creation and implementation. These two sets of standards are complementary and should be implemented together.

When implementing these standards, it is important to note that not all code is text-based or screen-based. The coding experience for students in the younger grades may include tangible systems. These standards were written with the intent that students utilize age-appropriate programming tools and systems.

Program Development (PD)

Students focus on reading and interpreting code, translating algorithms into code and understanding programming languages. As programming constructs repeat across this concept, the complexity increases as students advance through grade levels. Programming involves paying attention to the organization and structure of code. In early grades, students strengthen their understanding of how to create programs. As

students progress, they focus more on building on existing code, modularizing code, documenting code, and using AI tools to support their programming.

Variables & Data Storage (VD)

This subconcept focuses on data used while programming. Understanding how programs structure and store data is necessary for successful programming. In early grades, students focus on identifying and labeling data in their daily lives and in age-appropriate programming languages. As students progress, they learn about and manipulate more complex data types.

Reading & Documenting Code (RD)

In early grades students describe how code completes tasks including explaining code functionality, program development steps and how code segments contribute to a program's purpose. Also included is learning how to document programs for clarity and create embedded or external documentation for projects. Students evaluate AI-generated code for accuracy, reliability and usability.

Testing & Refining Code (TR)

In early grades, students focus on identifying and fixing errors in their programs. As students progress, they focus on more complex troubleshooting strategies, optimizing their code for efficiency and usability and assessing the accuracy and bias of AI-generated code.

Data & Analysis (DAT)

Computers collect and store data so it can be analyzed to better understand the world and make more accurate predictions. The standards in this concept area differ from the data science standards in that these standards are more specifically designed to address the needs of programming and more general computer science-related needs.

Data Collection and Preparation (DC)

In the early grades students learn about different types of data and how it is generated, collected and organized and how to use computational tools to manipulate data. As students progress, they get experience with larger and more varied datasets, learning about more advanced data types and organizational structures and data documentation and apply computational methods to automate data cleaning, identify and handle errors in data and prepare data for analysis.

Data Investigation (DI)

Data investigation is a multistep process beginning with posing data questions, using computational tools to collect and analyze data to creating data visualizations, generating insights and telling the story of the data. Students progress from asking simple questions that can be answered with small datasets to working with larger datasets, asking and answering more sophisticated questions that consider variability and relationships between multiple variables.

Impacts of Data Science (IM)

Students examine the benefits, risks and ethical considerations around data use from discussing how using data can help them make more informed decisions in their daily lives in the early grades to exploring issues related to bias in data, data privacy, AI and machine learning, and large-scale societal and environmental impacts of data science applications.

Systems & Security (SYS)

Systems and security include the broad categories of hardware and software, networks and cybersecurity. The physical components (hardware) and instructions (software) make up computing systems, and communicate and process information in digital form. Networks connect computing devices to share information and resources. An increasingly connected world necessitates more understanding of the security required to protect the information being transmitted.

Hardware and Software (HW)
As students progress through the hardware and software standards, they move from learning how systems use hardware and software to represent and process information to developing a deeper understanding of the interactions between hardware and software at multiple levels within computing systems.

Security (SE)
In the early grades students learn how to protect their personal information laying the foundation for learning about information transmission across devices, network design and how to protect networks from different types of threats as they progress through the standards.

Networks (NT)
Students learn that computing devices communicate with one another across networks to share information from learning how computers connect them to other people, places and things in the world in the early grades to gaining a deeper understanding of how information is sent and received across different types of networks.

Impacts of Computing Systems (IM)
In the early grades students examine the impacts of computing systems on individuals, learning that computing systems are created by humans with the intent of accomplishing tasks and solving problems and that while there are benefits, there are also new problems. As students progress, they learn about the impacts of computing systems on global society.

Computing & Society (SOC)

Computing shapes and is shaped by humans; individuals, communities and cultures form around the world. Computing transforms daily life, economies, governments and global systems providing great benefits and challenges. Students learn to critically and responsibly navigate these implications by examining the evolving relationship among computing, culture and society. In doing so, students are empowered to contribute thoroughly and responsibly to a digital future.

History of Computing (HI)
Students move from learning how computing is used in daily life and how technology has evolved over time in response to social, scientific and economic needs to evaluating how historical challenges led to computing innovations; the roles of individuals, communities, organizations and governments in those innovations and the societal impacts of those innovations in the middle grades. In high schools, students look at the main eras of computing history and understand policy and legislation related to computing technologies and analyze the historic impacts of technologies.

Emerging Technologies (ET)
This subconcept differs from the others in that it focuses on recently developed and developing technologies that have the potential to significantly impact society. In the early grades, students learn how computing aids their daily life, evaluating choices and consequences related to emerging technologies and identifying problems that these advances could address. In the middle grades, students evaluate how emerging technologies impact user experiences, and explain how emerging technologies can inspire innovation and help people accomplish tasks in new ways. In high school, students understand the core computational practices behind emerging technologies and compare the ethical considerations of emerging technologies.

Humans and Computing (HU)
Students learn that people are the fundamental creators of computing technologies and will differentiate between tasks suited for humans versus those for computing. Students will investigate how humans use computing to solve problems and examine the motivations behind designing and building computing systems.

Kindergarten Standards

Algorithms & Design

Standard Code	Iowa Academic Standard	Standard Clarification
EK-ALG-PS-01 Algorithmic Problem Solving	Carry out algorithms in daily activities.	Students should demonstrate simple, step-by-step activities in the correct sequence for familiar classroom or home tasks. Following classroom routines (e.g., cleaning up or lining up) or completing personal tasks (e.g., eating snacks or washing hands) are appropriate. Teachers should explicitly teach the word algorithm in context. Students are not expected to carry out algorithms that include conditionals or iteration. Students are not required to write algorithms or use a programming language.
EK-ALG-ML-02 Machine Learning	Recognize attributes of objects to notice patterns and make decisions.	Students should notice and identify that objects (e.g., people, animals, plants, other items) have specific characteristics (e.g., color, size, shape, texture) that can be used to classify them. For example, students might notice that a square and a triangle have different shapes, but recognize that they share the attribute of being red so they can be grouped together based on color. Students are not expected to recognize hidden attributes that cannot be seen or felt. Students are not required to work with more than one or two clear, observable attributes at a time to make a decision.
EK-ALG-IM-03 Impacts of Algorithms & Design	Describe how people create algorithms to solve problems.	Students should recognize that computers function according to algorithms created by people. They should describe, in simple terms, the human process of developing an algorithm (i.e., identifying a task, breaking it into smaller parts, and ordering steps to reach a goal). For example, students might describe how people design instructions for making a sandwich or sorting classroom supplies. Students are not expected to describe all aspects of computational thinking. Students are not required to understand how algorithms are translated into computer code.

AI Connection

EK-LN-MD-06 Identify simple rules that can be used to group objects into classes based on their features.

ELA Connection

L.K.5.A Sort common objects into categories (e.g., shapes, foods) to gain a sense of the concepts the categories represent.

W.K.8 With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question.

SL.K.4 Describe familiar people, places, things, and events and, with prompting and support, provide additional detail.

Mathematics Connection

K.MD.B.3 Classify objects into given categories count the numbers of objects in each category and sort the categories by count.

Science Connection

K-2-ETS1-1 Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

Programming

Standard Code	Iowa Academic Standard	Standard Clarification
EK-PRO-PD-04 Program Development	Create a sequence of commands to complete a simple task or express ideas.	Students should arrange a small set of commands in order (e.g., to help a character reach an object, tell a short story, follow a classroom routine). Using manipulatives, arrows, or simple digital programs is appropriate. Unplugged activities are appropriate. Students are not expected to write code or use control structures beyond sequencing. Students are not required to use computers.
EK-PRO-VD-05 Variables & Data Storage	Identify everyday gestures and symbols that represent information people use to make choices.	Students should recognize and explain common symbols, signs, and gestures they see in familiar environments such as home, school, or playgrounds. Students should be able to state what each symbol means or what action it signals. Symbols with clear, immediate meanings are appropriate (e.g., stop signs, traffic lights, a teacher's raised hand for quiet, thumbs up or down, pictures on classroom labels). Students are not expected to interpret abstract or unfamiliar symbols, read written words on signs, or analyze why specific symbols were chosen. Students are not required to understand cultural variations, complex decision-making, or digital icons requiring prior background knowledge.
EK-PRO-RD-06 Reading & Documenting	Describe how a sequence of commands completes a task.	Students should observe and describe, in their own words, what happens when simple code runs (e.g., "The robot moved three steps." "The character turned red."). Gestures or short phrases to express what happens are appropriate. Students are not expected to read text-based code, explain why it works, use technical vocabulary, or explain advanced programming concepts.
EK-PRO-TR-07 Testing & Refining	Identify steps in a sequence of commands that do not work as expected.	Students should recognize which step in a simple sequence is not working correctly or is causing a problem. Observing and identifying a block that led to an unexpected result in a block-based coding app or a command card that was incorrect in an unplugged activity are appropriate. Students are not expected to explain why the error occurred, analyze program logic, or use formal debugging strategies.

ELA Connection

SL.K.3 Ask and answer questions in order to seek help, get information, or clarify something that is not understood.

W.K.3 Use a combination of drawing, dictating, and writing to narrate a single event or several loosely linked events, tell about the events in the order in which they occurred, and provide a reaction to what happened.

Mathematics Connection

K.MD.B.3 Classify objects into given categories count the numbers of objects in each category and sort the categories by count.

K.CC.B.4 Understand the relationship between numbers and quantities connect counting to cardinality.

Science Connection

K-2-ETS1-1 Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

K-2-ETS1-2 Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

K-ESS3-3 Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.

Data & Analysis

Standard Code	Iowa Academic Standard	Standard Clarification
EK-DAT-DC-08 Data Collection & Preparation	Use collected data to help answer questions.	Students should collect data to answer a question about a grade-appropriate topic involving two to three variables. Having students wonder about the world to create questions to answer is appropriate. Collecting simple survey data or recording measurements and creating graphs as a class in order to answer a question are also appropriate. Students are not expected to work independently. Students are not required to use digital tools or collect large sets of data.
EK-DAT-DI-09 Data Investigation	Investigate a question that can be answered by collecting data in students' everyday environments.	Students should pose a simple, concrete question that can be answered by gathering data in familiar contexts. For example, "How many students ride the bus?" or "What is the most common favorite fruit in our class?" Then they should hold morning meetings to collect answers. Students are not required to use computational tools. Students are not expected to design experiments or other types of research studies, use statistics, or analyze large datasets.
EK-DAT-IM-10 Impacts of Data Science	Investigate how data can help a person make informed decisions in everyday life.	Students should explore everyday questions involving things they can count, observe, sort, and touch. Examples include household objects, classroom materials, and weather attributes. Students should compare quantities (e.g., less than, more than, equal to) and use patterns to make simple decisions based on data. Students are not expected to work with large datasets. Students are not required to use statistical concepts. Students should not make decisions that are subjective and not based on data.

Data Science Connection

EK-DR-ND-01 Identify that information can come from pictures, books, videos, sounds, and people.

EK-DR-ER-02 Explain how counting or collecting information can help make decisions.

EK-CC-DC-04 Ask a simple question that can be answered by counting or sorting.

ELA Connection

SL.K.3 Ask and answer questions in order to seek help, get information, or clarify something that is not understood.

SL.K.4 Describe familiar people, places, things, and events and, with prompting and support, provide additional detail.

Science Connection

K-2-ETS1-1 Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

Systems & Security

Standard Code	Iowa Academic Standard	Standard Clarification
EK-SYS-HW-11 Hardware & Software	Examine the use of tools to accomplish tasks or solve problems for different users.	Students should explore and talk about how everyday tools, both digital and non-digital, help people complete activities. Students should also recognize that different tools are designed to solve specific problems for different people. Age-appropriate examples include using a pencil or pen to write, using a paintbrush or drawing app to create a picture, using a magnifying glass to see small things, or using an app on a tablet or physical book to read a story. Students are not expected to explain technical details about how the tools work or compare them based on efficiency. Students do not need to develop knowledge of specialized hardware, software, or design processes.
EK-SYS-SE-12 Security	Differentiate between public and private information.	Students should focus on being able to describe the differences between information that can be safely made public (e.g., favorite food, favorite animal) and information that should be kept private (e.g., home address, family photos). Real-life scenarios, like deciding what is okay to share with a friend versus with a stranger, are appropriate. Students are not expected to use technical vocabulary like "confidential." Students do not need to understand detailed internet safety rules or the technical aspects of data privacy or cybersecurity. Connects to Social Studies
EK-SYS-IM-13 Impacts of Computing Systems	Identify responsible behavior when using computing systems and tools.	Students should be able to identify the responsible use of hardware and software in terms of tangible, classroom-level expectations, including caring for hardware (e.g., handling devices gently, keeping food and drink away from devices), making safe choices (e.g., asking permission before using a device, using only the app specified), and being a good citizen in a shared technology environment (e.g., not using someone else's account, using headphones instead of playing sound out loud). Students should focus on understanding that computing systems in schools are tools for learning and should be used appropriately, in the same way other tools are used in the classroom. Students are not expected to understand complex cybersecurity or digital citizenship topics.



Science Connection

K-2-ETS1-1 Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.



Social Studies Connection

D2.Civ.3.K-2 Explain the need for and purposes of rules in various settings inside and outside of school.

Computing & Society

Standard Code	Iowa Academic Standard	Standard Clarification
EK-SOC-HI-14 History of Computing	Identify computing technologies used in daily life that have changed over time.	Students should recognize and recall basic visual differences of computing technologies used in school or by their own family members that have changed from older versions. Identifying that the current family phone is smaller and flatter than an older phone a parent or grandparent used or that the family watches movies on a tablet now instead of using a TV are appropriate. Students are not expected to understand the internal technological advancements (e.g., faster processors, memory capacity) that caused the changes. Students are not required to know specific historical dates, names of inventors, or the technical functions of the different generations of devices.
EK-SOC-HU-15 Humans & Computing	Explain that people design and develop computing technologies.	Students should recognize and express that the computing technologies they use every day (e.g., tablets, apps, programmable toys) do not appear by magic, but are created by people to help solve problems or for entertainment. For example, during a classroom discussion about a favorite game, a student might explain that a person had to think of the rules, draw the characters, and program the game before they could play it. Students are not expected to understand the technical details of how technologies are built. Students are not required to build their own functioning electronic computing technologies.



AI Connection

EK-SI-BA-08 Identify how technology is created by humans.



Science Connection

K-2-ETS1-1 Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

First Grade Standards

Algorithms & Design

Standard Code	Iowa Academic Standard	Standard Clarification
E1-ALG-PS-01 Algorithmic Problem Solving	Decompose a problem or task into individual parts to develop an algorithm.	Students should be able to break down familiar, multistep tasks into smaller, ordered steps, focusing on sequencing and logical thinking. For example, decompose classroom routines, a game in physical education, or instrument maintenance in music into distinct, sequenced steps. Students are not expected to work with abstract problems or create algorithms involving conditional logic (if/then). Students are not required to use a programming language.
E1-ALG-ML-02 Machine Learning	Recognize that AI systems are a technology that uses patterns in data to make decisions or generate new things.	Students should be able to identify that AI systems are a technology created by people that looks for repeating patterns in information to make a choice or create something new. For example, students recognize and verbally express that an app knows which book they may want to read next because it has seen a pattern of the books they have read before. Students are not expected to understand the different types of machine learning (e.g., supervised, unsupervised).
E1-ALG-IM-03 Impacts of Algorithms & Design	Explain how changes to algorithms lead to different outcomes.	Students should express, through everyday activities or drawings, that changing the order of steps can produce different results. For example, when following two sets of instructions to build a block tower, one set might create a tall, stable tower, whereas another creates a shorter or weaker one. Students are not expected to write or modify computer code. Students are not required to understand complex algorithms used in digital tools.



AI Connection

E1-LN-MD-05 Describe how a computer uses a rule to decide which class a new object belongs to.



Data Science Connection

E1 DR-ER-02 Describe how choices in how data is collected or recorded can change the results or how we understand them.

Programming

Standard Code	Iowa Academic Standard	Standard Clarification
E1-PRO-PD-04 Program Development	Create code from an algorithm that includes sequence to complete a task or express ideas.	Students should translate algorithms with sequential steps into block-based code. Tasks such as translating an algorithm to move a character or navigate a maze are appropriate. Students are not expected to design the algorithm themselves or use selection or iteration.
E1-PRO-VD-05 Variables & Data Storage	Identify terms that refer to data values that change over time in everyday life.	Students should name real-world examples of information that changes, such as temperature, time, score, or age. For example, students can identify that the score of a game changes during the game, that the temperature outside changes throughout the day and night, and that their age changes each year. Students should recognize that some information changes while other information stays the same. Students are not expected to use the formal term variable or understand the programming concept of assignment.
E1-PRO-RD-06 Reading & Documenting	Explain the function of code that includes an event and sequence.	Students should explain what each step in a short program does and how an event triggers what happens next. Expressing what happens when a sequence of movement blocks runs or when a tap or collision event starts an animation are appropriate. Students are not expected to analyze advanced control structures (e.g., loops, conditionals), formal flow, syntax, or efficiency.
E1-PRO-TR-07 Testing & Refining	Debug programs that include a sequence.	Students should identify and fix simple errors in block-based programs they have developed or were provided by the teacher. Students should focus on identifying and correcting simple, visible mistakes. For example, if a character is supposed to move and then jump, but the code blocks are in the wrong order, the student should be able to identify the problem and reorder the blocks. Students are not expected to find complex logical errors or debug programs that include loops or conditionals.



ELA Connection

SL.1.4 Describe people, places, things, and events with relevant details, expressing ideas and feelings clearly.



Mathematics Connection

1.MD.C.4 Organize, represent, and interpret data with up to three categories: ask and answer questions about the total number of data points, how many in each category, and how many more or less are in one category than in another.



Science Connection

1-ESS1-1 Use observations of the sun, moon, and stars to describe patterns that can be predicted.

1-ESS1-2 Make observations at different times of year to relate the amount of daylight to the time of year.

Data & Analysis

Standard Code	Iowa Academic Standard	Standard Clarification
E1-DAT-DC-08 Data Collection & Preparation	Use multiple methods to collect both numeric and non-numeric data to help answer questions.	Students should use different ways (e.g., observation, measurement, surveys) to gather numbers and descriptive words to help answer questions. For example, students might ask their classmates about their favorite fruit (descriptive words) or measure the height of a bean plant in cubes or with a ruler (numeric data). Students are not expected to analyze or organize data into complex charts. Students are not required to use digital tools or formal statistical methods.
E1-DAT-DI-09 Data Investigation	Compare questions that can be answered with data investigations and questions that are answered through other means.	Students should distinguish between questions that require evidence gathered through counting or observing (data) and questions that are based on feelings, guesses, or creative ideas. For example, students should recognize that "How many students are wearing blue shirts today?" is a data question because we can count them and that "What is the best color in the world?" is a question of opinion that cannot be answered by counting. Students are not expected to come up with complicated questions or do math that is beyond first grade expectations. Students are not required to analyze qualitative data versus quantitative data. The focus is on identifying whether a question needs proof from the real world to be answered.
E1-DAT-IM-10 Impacts of Data Science	Examine a variety of data questions that address the needs of a person or community.	Students should examine data questions that are relevant to their lives (e.g., "How many students bring lunch versus buy lunch?" "What are the most common ways students get to school?"). Students should consider how a given data question might be relevant to or impact different people and communities and how minor changes to wording can affect how we interpret and answer the question (e.g., "How many first graders read at home?" vs. "How many first graders have books at home?"). Students are not expected to generate data questions or answer the questions being examined. Students are not required to collect or analyze data.



Data Science Connection

E1-VC-BS-14 Predict whether an object belongs in a group based on its characteristics and explain the reasoning.



Science Connection

K-2-ETS1-1 Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

Systems & Security

Standard Code	Iowa Academic Standard	Standard Clarification
E1-SYS-HW-11 Hardware and Software	Describe the purpose of basic hardware components of a computing system, using accurate terminology.	Students should use correct academic language to both identify the name and explain the basic function of external computing system hardware (e.g., laptop computer, tablet device, keyboard, mouse). Expressing that a laptop or tablet is used to run apps to complete school work or relating that headphones are used to hear sounds on a device is appropriate. Students are not expected to identify or describe the function of internal computer system hardware. Students do not need to determine whether peripherals serve as input or output for a computing system.
E1-SYS-SE-12 Security	Describe how to keep devices and online accounts safe from unauthorized access.	Students should focus on how authentication (e.g., passwords, QR codes for signing in) and good habits like signing out/logging off help keep their information protected online. Demonstrating how they sign out of devices and accounts and keep their authentication details secret from others is appropriate if students have online accounts that require authentication. Students are not expected to create their own passwords or other authentication methods or to describe more complex authentication methods (e.g., multifactor authentication, passkeys, biometrics). Students do not need to have online accounts that require authentication. They can learn and describe these concepts without online accounts.
E1-SYS-IM-13 Impacts of Computing Systems	Describe an individual's role in responsibly using computing systems and tools.	Students should be able to explain why rules for responsible use of computing systems and tools exist and why following them is important for themselves and their classroom community. They should describe their individual role in meeting these expectations and explain both individual and classroom consequences when expectations are not followed. For example, students could explain that careful handling of hardware (e.g., using devices gently, keeping food and drinks away) ensures devices remain available for everyone and that being a good digital citizen in a shared technology environment (e.g., not using someone else's account, using headphones instead of playing audio aloud) helps maintain a safe and respectful learning space. Students are not expected to describe complex digital citizenship topics. Students do not need to understand intellectual property (e.g., copyright), plagiarism, how to identify misinformation, or the nuances of a digital footprint.

ELA Connection

SL.1.4 Describe people, places, things, and events with relevant details, expressing ideas and feelings clearly.

W.1.2 Write informative/explanatory texts in which they name a topic, supply some facts about the topic, and provide some sense of closure.

Social Studies Connection

D2.Civ.3.K-2 Explain the need for and purposes of rules in various settings inside and outside of school.

Computing & Society

Standard Code	Iowa Academic Standard	Standard Clarification
E1-SOC-HI-14 History of Computing	Compare how an everyday activity changed after a specific computing technology was introduced.	Students should compare observable differences in how people completed a familiar task before and after a computing technology was introduced. Concrete, everyday examples, such as how people communicate (e.g., writing letters vs. sending text messages) or find information (e.g., using library books vs. searching online) are appropriate. Students are not expected to understand the technical details of how technologies work or their historical timelines. Students are not required to analyze societal shifts or economic impacts.
E1-SOC-HU-15 Humans and Computing	Differentiate between activities that humans do well and activities that computing technologies do well.	Students should categorize and explain simple, observable differences in what humans and computing technologies do best for various tasks. Examples of human strengths, such as creativity, understanding feelings, and solving new problems, are appropriate. Examples of computing technology strengths, such as repeating tasks without mistakes, calculating quickly, and remembering lots of information, are also appropriate. Students are not expected to understand the cognitive science behind human intelligence or the technical details of how computing technologies perform certain tasks. Students are not required to analyze ethical or societal consequences that arise from humans or machines performing specific tasks.



AI Connection

E1-NI-HA-03 Identify tasks that computers can help people with.

E1-LN-NL-04 Describe a specific difference between learning from personal experience and learning from a set of examples.



ELA Connection

RI.2.3 Describe the connection between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text.



Social Studies Connection

D2.Geo.5.K-2 Describe how human activities affect the cultural and environmental characteristics of places or regions.

Second Grade Standards

Algorithms & Design

Standard Code	Iowa Academic Standard	Standard Clarification
E2-ALG-PS-01 Algorithmic Problem Solving	Create an algorithm that includes sequence, events, and iteration to solve a problem or express ideas.	Students should create simple algorithms using a sequence of steps that respond to events (e.g., "Ready, set, go!" or tapping on a character) and include iteration (e.g., loops) to accomplish a task or express an idea. Appropriate activities include creating a storyboard for a story to be coded later, developing an algorithm to solve a math story problem, or designing an algorithm of the steps to complete a science experiment. Students may complete this work individually or with peers. Students are not expected to use complex or nested loops. Students are not required to create algorithms with conditional branches or variables.
E2-ALG-ML-02 Machine Learning	Examine how data is used to train machine learning models.	Students should explore simple examples of how a trained machine learning model identifies patterns in data and makes predictions or recommendations based on those patterns. Students should notice that models can make more mistakes for some kinds of examples than others, especially when the training examples were mostly of one kind. Students should focus on observing that machine learning models use patterns in data to make predictions or choices and that limited or unbalanced examples can lead to unfair or uneven results. For example, they might label images for a teacher-trained model and observe how well it classifies new pictures or use a drawing app that predicts what object they are sketching before they finish. Students are not expected to independently train machine learning models.
E2-ALG-IM-03 Impacts of Algorithms & Design	Describe how algorithms might impact peers in varied situations.	Students should evaluate how algorithms affect peers by determining if outcomes are fair or unfair and explaining their reasoning using simple criteria. Students should recognize that the same algorithm can affect different people in different ways depending on the situation. For instance, when a teacher draws names from a bucket to choose a line leader, students might evaluate whether this is fair by considering if everyone has an equal chance, if anyone is left out, or if the same person might be chosen multiple times while others never get a turn. Students are not expected to analyze technical details of how algorithms work, understand complex concepts like bias or discrimination, design solutions to fix unfair algorithms, or evaluate algorithms beyond determining basic fairness in concrete, familiar situations.

Programming

Standard Code	Iowa Academic Standard	Standard Clarification
E2-PRO-PD-04 Program Development	Create code from an algorithm that includes sequence, events, and iteration to complete a task or express ideas.	Students should translate a provided algorithm that begins with an event and includes sequential steps and iteration (e.g., loops) into a working program. Writing an animation in a block-based language from a storyboard or coding a robot in collaboration with a partner to dance from an algorithm of arrows are appropriate. Students are not expected to work with selection (e.g., conditionals [if/then statements]), variables, or nested loops. Teachers may provide the original algorithm, if desired.
E2-PRO-VD-05 Variables & Data Storage	Label different representations of information with a name and whether its value is constant or changes.	Students should give logical names to pieces of information they encounter in real life and determine whether the value of each piece of information changes or stays constant. Students should focus on describing information in meaningful, age-appropriate terms. Examples from digital contexts (e.g., score in a game) and nondigital contexts (e.g., temperature in an oven, day of the week) are appropriate. Students are not expected to use programming vocabulary or write code.
E2-PRO-RD-06 Reading & Documenting	Explain the steps taken to create a program.	Students should provide a simple step-by-step description of how they built their program and the specific function of the code blocks they used. Students should acknowledge which parts of the process and code were their own ideas and which parts were inspired or assisted by a peer or teacher. Students can explain verbally or in a written document. For example, a student could verbally express that they wanted a character to spin and first used a sequence of turn commands but they changed the code to a "forever" loop because a classmate helped them to make the spinning better. Teacher-provided graphic organizers or sentence starters are appropriate. Students are not expected to use advanced vocabulary, formal documentation, or written citations.
E2-PRO-TR-07 Testing & Refining	Debug programs that include sequence, events, and iteration.	Students should test a simple, block-based program that includes sequence, events, and iteration, identify one obvious bug, and correct it. Bugs may involve commands in the wrong order (sequence), an event not triggering the intended action, or a loop repeating too few or too many times (iteration). For example, if a robot does not respond when clicked, moves in the wrong order, or draws only three sides of a square instead of four, students should locate the issue and adjust the relevant block. Students are not expected to fix multiple or complex errors or explain problems using technical terms.



ELA Connection

SL.2.4 Tell a story or recount an experience with appropriate facts and relevant, descriptive details, speaking audibly in coherent sentences.

W.2.3 Write narratives in which they recount a well-elaborated event or short sequence of events, include details to describe actions, thoughts, and feelings, use temporal words to signal event order, and provide a sense of closure.

Data & Analysis

Standard Code	Iowa Academic Standard	Standard Clarification
E2-DAT-DC-08 Data Collection & Preparation	Compare numeric and non-numeric types of data in terms of how they are collected and what information they provide.	Students should compare how numeric (quantitative) data can be used for math and measurement and non-numeric (categorical) data can be used to sort, group, and describe. Having students identify the kinds of pets the class has (non-numeric data), count the total number of pets in each category (numeric data), and make simple comparisons (e.g., more students have cats vs dogs) is appropriate. Students are not expected to perform more sophisticated data transformations or analyses, nor are students expected to identify finer-grained data types (e.g., integers, characters). Students are not required to use technology to collect or compare different types of data.
E2-DAT-DI-09 Data Investigation	Develop a question that can be answered with data.	Students should brainstorm and refine a question that can be answered with data. Students must understand that the best way to answer some questions is not through data collection. For example, a student might start with a vague question like "What colors do kids like?" and refine it to "What is the most common favorite color in our class?" Students can develop questions related to counting and frequency, comparisons, interpretation of tally charts, bar graphs, pictographs, and making simple predictions and inferences. Students are not required to use computational tools for data collection or creation of data representations. Students are not required to use statistical concepts beyond grade level (e.g., mean, median, mode, probability). Students are not required to create or interpret graphs with complex scales or work with large datasets.
E2-DAT-IM-10 Impacts of Data Science	Distinguish between data collection approaches, including those that may lead to inaccurate or biased data.	Students should articulate how different ways of gathering data could affect different people or communities they are familiar with (e.g., classroom, family, school, neighborhood). Students should identify which communities might be unfairly represented or left out by specific data collection methods. Students should compare similar approaches to describe how they might produce different results. Students are not expected to analyze data at this stage. Students are not required to collect data.

Data Science Connection

E2-CC-OP-04 Identify the categories used to describe an object or event.

E2-CC-CD-08 Create a chart or table with data to help answer questions about data.

Mathematics Connection

2.MD.D.10 Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems using information presented in a bar graph.

Science Connection

K-2-ETS1-3 Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

Systems & Security

Standard Code	Iowa Academic Standard	Standard Clarification
E2-SYS-HW-11 Hardware & Software	Explain how the basic hardware components of a computing system work together to perform input and output (I/O) operations.	Students should use academic language to name components of a computing system, identify whether they are input or output components, and explain how the components work together to take in information from the real world and produce an action that can be seen or heard by people. Explaining input and output operations of components like keyboards, monitors/screens, microphones and sound sensors, headphones, speakers, webcams/cameras, printers, light sensors, sound sensors, and distance sensors is appropriate. Students are not expected to explain the technical details (e.g., I/O ports and buses, data digitization) of how inputs and outputs work. Students do not need to explain processing and storage.
E2-SYS-SE-12 Security	Explain how online actions have real-world consequences.	Students should focus on age-appropriate examples that connect how their online actions (e.g., sharing information, posting comments, using a device) can have effects in the real world (e.g., hurting someone's feelings, compromising personal safety). Writing a story or drawing a picture to show how a specific online behavior (e.g., sharing a picture without asking) can lead to a consequence (e.g., making a friend angry) is appropriate. Discussing the consequences of copying someone's work online is also appropriate. Students are not expected to identify specific laws (e.g., Children's Internet Protection Act, COPPA) or legal frameworks like copyright or intellectual property law. Students do not need to have online accounts. They can learn and describe these concepts without online accounts.
E2-SYS-IM-13 Impacts of Computing Systems	Describe the benefits and harms that arise from an individual's use of computing systems.	Students should describe benefits and harms in the context of their own personal experiences, feelings, and well-being. The concepts should be simple and concrete. Describing benefits such as learning new things (e.g., watching a video about animals), having fun (e.g., playing a creative game), and connecting with family and friends (e.g., video-calling a relative) are appropriate. Describing harms such as the physical effects of too much screen time (e.g., tired eyes, feeling grumpy), the emotional effects (e.g., feeling sad or left out by something they see, accidentally seeing something confusing or scary) are also appropriate. Students are not expected to describe complex or large-scale societal harms. Students do not need to understand issues like the digital divide, the spread of misinformation, or data privacy.



Science Connection

K-2-ETS1-2 Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.



Social Studies Connection

D2.Civ.3.K-2 Explain the need for and purposes of rules in various settings inside and outside of school.

D2.Eco.2.K-2 Identify the benefits and costs of making various personal decisions.

Computing & Society

Standard Code	Iowa Academic Standard	Standard Clarification
E2-SOC-HI-14 History of Computing	Analyze the ways that people have designed computing technologies to help them solve problems and express themselves.	Students should explore how computing technologies have emerged from people's efforts to meet specific needs and express ideas within their geographic, cultural, and historical contexts. Students are not expected to conduct detailed history on the evolution of computing as a whole. Students are not required to compare complex cultural or societal impacts of technology across time periods.
E2-SOC-HU-15 Humans & Computing	Investigate situations where humans have created computing technologies to solve problems.	Students should investigate familiar, concrete examples of how people have designed computing technologies to address everyday problems they can relate to. Technologies with clear, observable purposes are appropriate, such as traffic lights that help cars and pedestrians move safely, barcode scanners that help stores track inventory, automatic doors that help people enter buildings, weather apps that help families plan activities, or classroom timers that help manage transitions. Students might investigate how these technologies were created to solve specific problems, like "cars were crashing at intersections" or "it was hard to keep track of library books." Students are not expected to understand how computing technologies work internally or to explain programming, engineering, or data processes. Students are not required to analyze historical development, compare technologies, or address advanced issues such as data privacy, cybersecurity, artificial intelligence, or automation.

AI Connection

E2-SI-AS-12 Explain how technology is part of culture and daily life.

E2-NI-HA-04 Explain how people and AI systems work together to complete tasks.

ELA Connection

RI.2.3 Describe the connection between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text.

Science Connection

K-2-ETS1-1 Ask questions, make observations and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

Social Studies Connection

D2.Civ.14.K-2 Describe how people have tried to improve their communities over time.

D2.Geo.5.K-2 Describe how human activities affect the cultural and environmental characteristics of places or regions.

Third Grade Standards

Algorithms & Design

Standard Code	Iowa Academic Standard	Standard Clarification
E3-ALG-PS-01 Algorithmic Problem Solving	Create algorithms that include sequence, events, iteration, and selection to solve a problem or express ideas.	Students should focus on solving problems or expressing ideas that include sequences, responses to events, iteration (e.g., loops), and/or selection (e.g., conditionals, if/then statements). An appropriate activity is writing instructions for a game. Students may complete this work individually or with peers. Students are not expected to learn formal conditional logic. Students are not required to create one single algorithm that includes all control structures (i.e., sequencing, events, iteration, and selection). However, all control structures should be included throughout multiple algorithms.
E3-ALG-ML-02 Machine Learning	Investigate how machine learning models can change when new data is added to a training set.	Students should observe and describe what happens when a machine learning model receives additional training data. They should notice when adding missing or underrepresented examples helps the model make more accurate predictions. For example, students could use an image-recognition tool to identify animals, then add more pictures to see how the model's predictions change or improve. Students should focus on observing how new data affects outcomes. Students are not expected to train their own machine learning models or understand the technical or mathematical processes behind them. Students are not expected to analyze complex datasets or create models from scratch.
E3-ALG-IM-03 Impacts of Algorithms & Design	Compare how different algorithms may affect outcomes, situations, and people.	Students should evaluate examples of algorithms that produce different outcomes and discuss how those differences may help or harm people. Students should focus on comparing impacts, not on programming or implementation. For example, students might consider how a navigation app choosing the fastest route differs from one choosing the safest route. Students are not expected to analyze algorithms at a technical level or evaluate efficiency or performance trade-offs.

AI Connection

E3-LN-DS-06 Identify instances where a computer's accuracy improved after receiving more examples.

ELA Connection

RI.3.3 Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect.

Science Connection

3-5-ETS1-2 Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

Programming

Standard Code	Iowa Academic Standard	Standard Clarification
E3-PRO-PD-04 Program Development	Develop code from a student-created algorithm that includes sequence, events, iteration, and selection to solve a problem or express ideas.	Students should implement their own or a classmate's algorithm in a block-based environment using events, iteration (e.g., loops) for efficiency, and basic decisions (e.g., conditionals [if/then statements]). Students should also give credit to the algorithm author and implementer. For example, turning a storyboard for a game that includes a game character moving forward, jumping over obstacles repeatedly, and choosing different paths when encountering a fork in the road into a program using a block-based programming language is appropriate. Students are not expected to use text-based languages or design multilevel projects. Students are not required to implement a single program that includes every control structure.
E3-PRO-PD-05 Program Development	Use constructive feedback to improve programs.	Students should give and apply specific, helpful suggestions to improve the function or design of their programs. Incorporating feedback from peers, teachers, or users into a program is appropriate. Teacher-provided templates for giving constructive feedback are appropriate. Students are not expected to interpret complex error reports, use advanced tools, or overhaul program structure or design. Students are not required to defend against all critiques or implement all feedback.
E3-PRO-VD-06 Variables & Data Storage	Identify the variables being stored and manipulated in a program.	Students should read completed programs to find variables. Students should recognize that each variable has a unique name that must be spelled consistently. Identifying variables that track a game score, user input, or collected data is appropriate. Students are not expected to assign variables to specific data types (e.g., string, integer, Boolean) or write code themselves.
E3-PRO-RD-07 Reading & Documenting	Articulate how a specific segment of code contributes to the overall purpose of a program.	Students should use age-appropriate academic language to describe what a code segment does and how it supports the program's goal. For example, students sharing their understanding via annotated screenshots, prompted explanations, or brief presentations is appropriate. Students are not expected to conduct formal code reviews or be the original author of the code.
E3-PRO-TR-08 Testing & Refining	Debug programs that include sequence, events, iteration, and selection.	Students should locate and fix common logical or structural errors in programs using a combination of sequence, events, loops, and conditional choices. For example, debugging a block-based program in which commands in the wrong order (sequence), a character that does not move when clicked (event), a loop that runs too many times (iteration), or an "if" block triggers the wrong action (selection) are appropriate. Students are not expected to debug syntax errors in text-based languages or correct complex programs involving variables, functions, or nested conditions or loops. Students are not required to debug a single program that includes all control structures (i.e., sequence, events, iteration, and selection). However, across multiple debugging experiences, students should work with programs that collectively include all of these control structures.

Data & Analysis

Standard Code	Iowa Academic Standard	Standard Clarification
E3-DAT-DC-09 Data Collection & Preparation	Evaluate numeric and non-numeric data for accuracy and completeness.	Students should focus on checking for missing data and recognizing data that seems unreasonable (e.g., values that are much too large or much too small, data that is the wrong type). Students may use a survey to collect data that they record on a chart. Students may also use data supplied by the teacher. Students are not expected to create complex graphs or work with large datasets. Students are not required to use technology for collection, recording, or evaluation of data.
E3-DAT-DI-10 Data Investigation	Investigate a data question involving relationships between multiple attributes.	Students should investigate how two or more attributes in a dataset relate to each other. Investigating the relationship between sunlight and water on the height of a plant, where students collect data on all three attributes and examine how height changes with different combinations of sunlight and water, is appropriate. Students are not expected to perform statistical analysis. Students are not expected to work with more than two or three attributes. Students are not required to use digital equipment to collect or analyze data.
E3-DAT-IM-11 Impacts of Data Science	Design a data collection process that addresses the needs of multiple groups of people.	Students should consider different data collection plans and how they would affect accuracy and representation. Students' plans should include what data to gather, which tools to use, and which sources to access for an investigation. Tools like class surveys or tally charts marking observations are appropriate. Students should identify different groups and describe how they would be affected by different data collection strategies. Students can obtain consent by including an opt-out box for the survey a student is designing. Students should learn that they have a right to tell authority figures (e.g., teachers, website) that they don't want to share their information. Students are not required to use advanced data collection techniques or statistics. Students are not required to consider the ethics associated with data collection or design a process for more than two or three variables.



Data Science Connection

E3-DR-ND-01 Identify the differences between categorical and numerical data.

E3-DR-ER-03 Evaluate the strength of arguments that include data compared to those that do not.

E3-CC-OP-05 Examine a dataset to identify missing information.



Mathematics Connection

3.MD.B.3 Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories.



Science Connection

3-ESS2-1 Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.

3-5-ETS1-3 Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Systems & Security

Standard Code	Iowa Academic Standard	Standard Clarification
E3-SYS-HW-12 Hardware & Software	Describe the role of software in a computing system to accomplish tasks or solve problems.	Students should understand that software consists of programs and applications that tell hardware what to do and that different types of software serve different purposes (e.g., word processors for writing, web browsers for accessing information, games for entertainment, educational apps for learning). Students identify common software applications and describe how they process specific user inputs (e.g., typing, clicking) into meaningful outputs (e.g., a document, a game action) to complete tasks. Students do not need to learn about operating system structures, cloud storage administration, or version control systems.
E3-SYS-SE-13 Security	Evaluate how sharing information online might reveal personally identifiable information (PII) and other details.	Students should focus on developing skills to help them recognize risks in online situations and assess what information to share online and when to share it. Activities using age-appropriate real-world situations (e.g., sharing their favorite book with a classmate, providing their address in response to a pop-up on a website saying they won a prize) are appropriate. Students should practice identifying how seemingly harmless information shared in contexts like online gaming (e.g., screen names, team names, game schedules) can unintentionally reveal PII to unintended recipients. Students are not expected to evaluate all risky online situations, including things like catfishing and data breaches. Students do not need to participate in situations where they could reveal their personally identifiable information.
E3-SYS-NT-14 Networks	Explain how people access the internet to gain information and communicate with each other.	Students should be able to describe, in age-appropriate terms, how people use different devices to connect to the internet and communicate. Examples of devices that can be used to access the internet include computers, cell phones, and tablets. An example of accessing information is using a search engine to look up facts for a report. An example of communicating through technology is using video chat to talk with people across long distances. Students are not expected to describe technical infrastructure such as IP addressing, routing protocols, domain name systems, or data packet transmission. Students do not need to consider network configuration or errors.
E3-SYS-IM-15 Impacts of Computing Systems	Describe how widely used computing systems may impact an individual's life and community.	Students should be able to describe both benefits and harms (e.g., effects on safety, privacy, economy, culture) of computing systems in wide use. They should be able to reason about specific scenarios and identify which individuals or communities (e.g., themselves, their parents, children, elderly people, teachers) are impacted by a particular benefit or harm and describe the nature of the impacts. Students are not expected to describe the benefits and harms of computing systems or the impacts on communities without first learning about these technologies and communities. Students do not need to memorize a list of technologies and their impacts on specific communities.



ELA Connection

W.3.3 Write narratives to develop real or imagined experiences or events using effective technique, descriptive details, and clear event sequences.

Science Connection

3-5-ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

3-5-ETS1-2 Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

Computing & Society

Standard Code	Iowa Academic Standard	Standard Clarification
E3-SOC-HI-16 History of Computing	Examine how computing innovations have changed the ways people live, work, or communicate over time.	Students should explore and explain how computing innovations across different time periods have progressively changed daily life, work, or communication, focusing on concrete, observable changes in human behavior. Examining how finding information, communicating verbally and in writing, enjoying entertainment, shopping, doing tasks at school and work have evolved over time due to computing innovations are appropriate. Students are not expected to understand the technical details of how computing innovations work or to create timelines of all computing innovations. Students are not required to examine complex societal impacts of computing innovations.
E3-SOC-ET-17 Emerging Technologies	Describe how new technologies create both benefits and risks in personal and family life.	Students should describe how new technologies (both those they interact with on a daily basis and those they may have learned about in other ways) may not have an exclusively positive or negative impact on their personal or family life. They should consider examples of both benefits and risks. Examples such as video calls with relatives, online learning, AI technologies, or using smart devices at home are appropriate. Students are not expected to describe complex social or economic impacts nor complex new technologies (e.g., quantum computing).
E3-SOC-HU-18 Humans & Computing	Examine why people design and build computing technologies.	Students should explore the basic reasons computing technologies were created and communicate the needs or problems these technologies were likely intended to address, focusing on the human intent or goal. Examining how computing technologies, such as AI systems, are designed to meet needs, solve specific problems, make tasks easier, or provide entertainment is appropriate. Students are not expected to understand the technical details of how computing technologies work. Students are not required to compare multiple technologies to determine which best meets a particular need.

AI Connection

E3-SI-EA-12 Identify that people make decisions about how AI systems behave.

E3-SI-BA-13 Identify that AI systems rely on information provided by people.

ELA Connection

RI.3.3 Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect.

Science Connection

3-5-ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

Social Studies Connection

D2.His.2.3-5 Compare life in specific historical time periods to life today.

D2.His.3.3-5 Generate questions about individuals and groups who have shaped significant historical changes and continuities.

D2.His.14.3-5 Explain probable causes and effects of events and developments.

Fourth Grade Standards

Algorithms & Design

Standard Code	Iowa Academic Standard	Standard Clarification
E4-ALG-PS-01 Algorithmic Problem Solving	Create written representations of algorithms that incorporate a combination of sequence, events, iteration, and selection to solve a problem or express ideas.	Students should write step-by-step representations of an algorithm using grade-appropriate, everyday language that includes sequences, responses to events, iteration (e.g., loops), or selection (e.g., conditionals, if/then statements). Outlining a Choose Your Own Adventure story where readers make decisions that alter the path is appropriate. Students may complete this work individually or with peers. Students are not expected to create visual representations, flowcharts, or formal pseudocode. Students are not required to create a single representation that includes every program control structure (i.e., sequencing, events, iterations, and selection). However, all control structures should be included in multiple written representations.
E4-ALG-ML-02 Machine Learning	Analyze relationships between the properties of training data and a machine learning model's output.	Students should examine how characteristics of training data (e.g., amount, accuracy, labeling quality, representativeness) affect a machine learning model's performance. Students should connect unbalanced or poorly labeled data to inaccurate outputs and may learn the term bias to describe this pattern. Students should focus on making qualitative observations (e.g., "More data improves accuracy." "Labeling mistakes lead to incorrect predictions."). For example, students might observe that when too few images are used to train a classifier, the model often mislabels new images, leading them to conclude that data quantity and quality influence accuracy. Students are not expected to use statistical formulas, understand machine learning works mathematically, or define or correct specific bias types.
E4-ALG-IM-03 Impacts of Algorithms & Design	Evaluate how different algorithms for solving the same problem produce outcomes that may impact users differently.	Students should compare two or more algorithms that solve the same problem and explain how each affects people differently. Examples include different ways to sort items, plan routes, or schedule activities, noting potential differences. Students are not expected to design new algorithms or evaluate effectiveness.

AI Connection

E4-PC-PR-02 Analyze how multiple inputs influence AI system processing and outputs.

E4--SI-EA-12 Describe how rules or instructions influence how AI systems behave.

E4-SI-BA-13 Describe how differences in information can influence AI system outputs.

ELA Connection

W.4.2.D Use precise language and domain-specific vocabulary to inform about or explain the topic.

RI.4.3 Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text.

Science Connection

4-PS4-3 Generate and compare multiple solutions that use patterns to transfer information.

Programming

Standard Code	Iowa Academic Standard	Standard Clarification
E4-PRO-PD-04 Program Development	Compare different programming solutions to the same problem based on correctness and clarity.	Students should compare multiple short programs or code segments meant to solve the same task, noting which ones produce the correct result and which are easier to understand or follow. Examples that use short block-based or text-based code segments are appropriate. Students are not expected to create multiple versions themselves, evaluate efficiency, or conduct formal code reviews.
E4-PRO-PD-05 Program Development	Collaborate with a team by offering a meaningful contribution to creating a program.	Students should work in small groups to plan and create a simple program, contribute ideas or code segments, or test functionality while practicing respectful communication, active listening, and shared tasking. Adding a feature, fixing an error, improving a design element, or helping organize the code are appropriate. Students are not expected to use professional collaboration tools, manage large projects, or apply formal methodologies.
E4-PRO-VD-06 Variables & Data Storage	Trace how data flows and changes variable values in a program.	Students should follow short, age-appropriate programs to observe how variable values change as a program runs and be able to explain observable changes to variable values. For example, they might trace how a score counter increases with each correct answer or how a temperature tracker updates as new readings are added. Students are not expected to design variable-driven programs, work with multiple data types, or understand memory allocation, scope, or data structures.
E4-PRO-RD-07 Reading & Documenting	Document a program to clarify its functionality.	Students should use simple documentation (e.g., brief comments, labeled diagrams, short descriptions) to explain what their program does and how it works. The goal is to make the program easier for others to understand or modify. Students are not expected to produce professional design documents or complex explanations of code structure, use version control, or write industry-style technical prose.
E4-PRO-TR-08 Testing & Refining	Debug programs incrementally and repeatedly as they are developed.	Students should test and fix their code as they develop programs rather than completing all coding and then testing. For example, students can add a short sequence of blocks and then run the code to confirm that it does what is expected. If the code does not behave as expected, students can find, reproduce, and fix the error easily in the code they added incrementally. Students can use tracing skills to identify where code does not behave as expected. Debugging programs that include a combination of sequence, events, iteration, and selection are appropriate. Students are not expected to debug programs involving procedures or nested structures. Students are not required to debug one single program that includes all control structures (sequencing, events, iteration, and selection); however, all control structures should be included throughout programs that students debug.



Science Connection

3-5-ETS1-3 Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.



Social Studies Connection

D2.Civ.7.3-5 Apply civic virtues and democratic principles in school settings.

Data & Analysis

Standard Code	Iowa Academic Standard	Standard Clarification
E4-DAT-DC-09 Data Collection & Preparation	Organize collected data into tables using digital tools, with rows representing records and columns.	Students should practice organizing small sets of collected or provided data into simple tables, ensuring that each row represents one record (e.g., a survey respondent, a pet) and each column represents an attribute (e.g., age, favorite color, type of animal). Students may use paper-based tables and templates prior to using digital tools for this work. Students are not expected to design complex databases, manage large datasets, or use advanced spreadsheet functions. Students do not need to understand relational databases, formulas, or data visualization techniques.
E4-DAT-DI-10 Data Investigation	Create an explanation that includes at least one data visualization to report the process and results of a data investigation, using computing tools.	Students should use age-appropriate, accessible digital tools (e.g., spreadsheets, presentation software, data visualization applications) to create a short written report, slide presentation, or other digital document that includes a data visualization to describe a data investigation and its results. The explanation should include a brief narrative that describes how they collected data and what the data shows, paired with an appropriate chart or graph (e.g., bar chart, line graph, pictograph). For example, students could investigate whether the class is meeting recycling goals and create a short presentation that includes how they weighed the recycling bins, a bar graph showing the weight of the bins over time, and a conclusion on whether the class is meeting its recycling goals based on the visual evidence. Students are not expected to produce statistical analyses, interactive dashboards, or complex data visualizations. Students are not required to have knowledge of data visualization design principles beyond choosing a graph type that is appropriate for the data being presented.
E4-DAT-IM-11 Impacts of Data Science	Investigate how data collected about people may affect individuals and groups.	Students should investigate simple scenarios to identify who is affected by data collection and what the effect is, including concerns about privacy and fairness. Students should ask clarifying questions (e.g., "Who is collecting this information?" "What information are they collecting?" "Why do they need it?"). Students should identify who is affected, distinguishing between individuals and groups (e.g., the whole class). Students should describe what the effect is for the individuals and groups using simple, descriptive terms (e.g., "helpful," "harmful," "unfair"). Gathering facts and identifying clear effects rather than weighing pros and cons is appropriate. Students are not expected to conduct formal research projects or make evaluative judgments about whether the data collection is overall good or bad. Students are not expected to understand the technical aspects of how data is collected online.



Data Science Connection

E4-VC-BS-21Ask questions about where the data came from and how it was collected to determine the validity of the data.



Mathematics Connection

4.MD.B.4 Make a line plot to display a data set of measurements in fractions of a unit (1/2, 1/4, 1/8). Solve problems involving addition and subtraction of fractions by using information presented in line plots.

Systems & Security

Standard Code	Iowa Academic Standard	Standard Clarification
E4-SYS-HW-12 Hardware & Software	Apply basic troubleshooting processes to identify and fix common hardware and software issues.	Students should focus on following a consistent set of steps (e.g., define, plan, try, reflect) to address common hardware and software issues such as a device not responding, no network access, or an app crashing. Students should apply basic troubleshooting strategies such as restarting the device, checking connections, or closing and reopening applications. Students are not expected to solve all hardware and software issues they encounter. Students do not need to open devices to diagnose or troubleshoot internal hardware problems.
E4-SYS-SE-13 Security	Distinguish between authentication and authorization in protecting devices and private information.	Students should focus on authentication and authorization as two distinct but related concepts for protecting private information and devices. Using an analogy of a house is appropriate: authentication is proving you have the key to get in the door, whereas authorization is a parent telling you which rooms in the house you're allowed to enter once you're inside. Students are not expected to learn about different types of authentication (e.g., biometrics, multifactor authentication) or technical details of how authentication and authorization work. Students do not need to use a variety of authentication methods.
E4-SYS-NT-14 Networks	Compare wired and wireless methods that computing devices use to connect to the internet.	Students should focus on comparing the advantages and disadvantages of different ways of connecting to the internet. Important factors include distance, speed, convenience, and safety considerations (e.g., connecting to trusted networks at home or school vs. unknown public networks). Tasks in which students determine when it is advantageous to have either a wired connection or a wireless connection are appropriate. Students are not expected to explore other ways of connecting between devices to share information (e.g., Bluetooth) or the protocols used to connect devices (e.g., TCP/IP). Students do not need direct access to routers or hubs.
E4-SYS-IM-15 Impacts of Computing Systems	Investigate the impacts of widely used computing systems on natural resources and the environment.	Students should investigate the environmental effects of widely used computing systems (e.g., artificial intelligence, computers, tablets, monitors). T. Students can consider large sources of impact (e.g., not disposing of e-waste properly, burning fossil fuels for power, mining of materials, modeling of solutions using technology, conserving energy with "smart" systems) and individual sources of impact (e.g., water and energy usage, frequent device upgrades, recycling/reuse of computing systems and components, information availability about the environment, reduction in paper usage). Students are not expected to investigate the impacts of computing systems that are not in wide use (e.g., quantum computing). Students do not need specialized equipment or knowledge of science concepts beyond what is grade-level appropriate.



Science Connection

5-ESS3-1 Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.



Social Studies Connection

D2.Eco.3.3-5 Identify examples of the variety of resources (human capital, physical capital, and natural resources) that are used to produce goods and services.

Computing & Society

Standard Code	Iowa Academic Standard	Standard Clarification
E4-SOC-HI-16 History of Computing	Investigate the contributions of individuals and communities in the history of computing.	Students should explore stories and achievements of individuals and communities whose contributions to computing are important. Students are not required to memorize a comprehensive list of every historical figure.
E4-SOC-ET-17 Emerging Technologies	Analyze how the limitations of existing technologies can lead to emerging technologies.	Students should be able to identify a limitation in an older or existing technology (e.g., a weakness, something that doesn't work well, a problem) and logically explain how overcoming that limitation could motivate the creation of a new, emerging technology, focusing on cause-and-effect reasoning in innovation. Analyzing both past (e.g., mainframe computers to laptops, older mobile phones to smartphones) and more current emerging technologies (e.g., auto-complete to generative AI, older model cars to self-driving cars) is appropriate. Students are not expected to research the actual motivations for the creation of technologies.
E4-SOC-HU-18 Humans & Computing	Distinguish between human learning and machine learning processes.	Students should compare and contrast basic characteristics of human learning and machine learning using simple, observable examples. For example, humans learn by making sense of experiences and drawing on prior knowledge, and AI systems use patterns or correlations in data to make decisions or generate new things. Students are not expected to understand mathematical modeling, neural networks, or algorithmic training processes in technical detail nor are they expected to understand human cognition in detail. Students are not required to use or code actual AI models or apply formal data training procedures.



AI Connection

E4-PN-HA-04 Explain what people bring to a task that AI systems cannot.



Science Connection

4-LS1-2 Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.



Social Studies Connection

D2.His.2.3-5 Compare life in specific historical time periods to life today.

D2.His.3.3-5 Generate questions about individuals and groups who have shaped significant historical changes and continuities.

Fifth Grade Standards

Algorithms & Design

Standard Code	Iowa Academic Standard	Standard Clarification
E5-ALG-PS-01 Algorithmic Problem Solving	Create visual representations of algorithms that include variables and incorporate a combination of sequence, events, iteration, and selection to solve a problem or express an idea.	Students should create visual representations (e.g., physical coding blocks, mind maps, annotated diagrams) showing algorithms that use variables and combinations of the following control structures: sequence, events, iteration, and selection. Illustrating an algorithm as a drawing on index cards showing the sequence of events from start to finish on a horizontal line with branches for selection is appropriate. Students may complete this work individually or with peers. Students are not expected to include complex data structures (e.g., arrays, lists), procedures, or more than one level of nested iteration or selection. Students are not required to use formal flowchart notation or a single comprehensive diagram showing all control structures in a single representation.
E5-ALG-ML-02 Machine Learning	Train a machine learning model to make a classification or prediction.	Students should upload a labeled dataset (e.g., text, numbers, images, sounds, poses) to train a machine learning model that classifies, predicts, or recommends. Students should reflect on results that do not match expectations (e.g., who is missing from the training data, how adding more examples might make results more accurate). Students should focus on recognizing that training data influences model accuracy. For example, students might create a labeled dataset of animal sounds to train a machine learning model, test its accuracy on new examples, and reflect on outputs that differ from their expectations. Students are not expected to understand the mathematical processes behind training a machine learning model to make predictions. Students are not required to use specific tools or specialized hardware.
E5-ALG-IM-03 Impacts of Algorithms & Design	Articulate how human-centered design principles are incorporated into the development of computing technologies.	Students should identify familiar examples of computing technologies (e.g., websites, voice assistants, video games, recommendation systems) and explain how human-centered design considerations can be incorporated into their development. They should also recognize that computing technologies are created by people. Students are not expected to understand the technical details of computing technologies.

AI Connection

E5-LN-DS-07 Describe how AI systems use examples instead of explicit instructions to solve problems.

Science Connection

3-5-ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

3-5-ETS1-2 Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

Programming

Standard Code	Iowa Academic Standard	Standard Clarification
E5-PRO-PD-04 Program Development	Create a novel program by modifying or combining elements of existing programs.	Students should make purposeful changes to a program by incorporating teacher-created, peer-created, or other code segments to create a unique variation of the original program, giving appropriate credit for code segments used. Remixing or adapting existing code to add new features, levels, or outcomes, including credit for code reuse through comments in code or in external documentation, is appropriate. Students are not expected to write entirely original, complex programs from scratch or manage large-scale integrations of multiple projects. Students are not required to incorporate AI-generated code.
E5-PRO-PD-05 Program Development	Construct individual components of a program that are collaboratively assembled into a programming project.	Students should individually build small code components and integrate them with teammates into a complete functional program. For example, in a block-based environment, one student might construct the code component for a scoring system using variables and selection, while another constructs the player movement component. They then integrate and test these pieces to ensure the final project works. Students are not expected to use version control or design full system architecture.
E5-PRO-VD-06 Variables & Data Storage	Use variables to store, compare, and modify data within a program.	Students should use variables in block-based or beginner text-based environments to store, compare, and update data that affects program behavior. Examples include tracking a player's score, comparing time values to trigger an event, or updating health or points after an action. Students are not expected to manage complex data types, arrays, or mathematical formulas involving multiple variables. Students are not required to understand variable scope.
E5-PRO-RD-07 Reading & Documenting	Create embedded or external documentation for a programming project.	Students should produce documentation common to their programming language environment (e.g., in-code comments, project notes) describing its purpose in detail. Comments, virtual sticky notes, program descriptions or an external document are all appropriate options. Students are not expected to follow professional templates or produce formal documentation sets. Teachers may opt to introduce guidelines or templates, but students are not required to follow any specific guidelines for documentation.
E5-PRO-TR-08 Testing & Refining	Debug programs using systematic strategies.	Students should apply more than one systematic debugging strategy. Strategies such as reproducing the problem, reading error messages, tracing code, changing one element at a time, or adding temporary outputs (e.g., sounds, text, other alerts) to locate issues are appropriate. Students should focus on using clear, repeatable methods to find and fix syntax, logic, or runtime errors. Students are not expected to use professional debugging tools or automated testing frameworks.



ELA Connection

W.5.2 Write informative/explanatory texts to examine a topic and convey ideas and information clearly.

Science Connection

3-5-ETS1-2 Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

3-5-ETS1-3 Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Social Studies Connection

D2.Civ.9.3-5 Use deliberative processes when making decisions or reaching judgments as a group.

Data & Analysis

Standard Code	Iowa Academic Standard	Standard Clarification
E5-DAT-DC-09 Data Collection & Preparation	Use digital tools to collect and organize different types of data.	Students should demonstrate their ability to use digital tools to collect (e.g., surveys, sensors) and organize (e.g., spreadsheets) data. Students should collect and distinguish between quantitative (numeric) and qualitative (descriptive and non-numeric) data. When organizing the data, students should use a computational tool to efficiently sort and group similar data (e.g., sort from highest to lowest temperature, sort non-numeric responses alphabetically). Students are not expected to create their own data collection tools from scratch. Students are not required to create data visualizations or to analyze or interpret the data collected.
E5-DAT-DI-10 Data Investigation	Analyze a dataset to identify the nature and possible sources of variability in the data.	Students should identify patterns and variability in a dataset and distinguish between typical values and outliers. Students should look for trends or regularities in data and identify relationships between different variables. Understanding that data can vary from one observation to another is appropriate. For example, students could create a dataset using a timer to record multiple instances of how long it takes a marble to travel two meters and recognize that the times are not all the same, attributing the differences to possible error in clicking Start and Stop, differences in how the marble traveled (e.g., marble bumped the side of the track), and possible recording errors. Students are not required to calculate statistical measures (e.g., mean, median, standard deviation) or perform statistical tests.
E5-DAT-IM-11 Impacts of Data Science	Analyze the benefits and risks of computing technology that uses collected data.	Students should examine everyday technologies that rely on collected data (e.g., weather apps, fitness trackers, AI tools like voice assistants or recommendation systems) and identify both benefits (e.g., convenience, personalization, improved predictions) and risks (e.g., privacy concerns, inaccurate results,). Students are not expected to understand technical details of algorithms, machine learning model training, or data storage infrastructure. Students are not required to evaluate statistical methods, encryption, or policy frameworks.

Data Science Connection

E5-AM-VD-14 Determine whether a data point is reasonable based on dataset characteristics and context.

E5-IPR-GA-19 Identify possible human or technological sources of error in data collection and analysis.

Systems & Security

Standard Code	Iowa Academic Standard	Standard Clarification
E5-SYS-HW-12 Hardware & Software	Explain how hardware and software components of a computing system work together to perform input and output (I/O), processing, and storage.	Students should focus on everyday examples of how hardware and software interact to complete a task (e.g., pressing a key on a keyboard sends input to the computer, which is stored in memory and processed with software to display a letter on the screen as output). Age-appropriate models, such as flow diagrams, role-play activities (e.g., students acting as a computer with input, processor, memory, and output), and physical computing projects that use sensors are appropriate. Students are not expected to design or analyze actual logic gate diagrams, understand machine-level binary representations, or study complex computer architecture. Students do not need to develop knowledge of circuitry or number base systems.
E5-SYS-SE-13 Security	Describe the concepts of the CIA (Confidentiality, Integrity, Availability) Triad and how each part is important in protecting information.	Students should be able to explain the CIA Triad at a conceptual level and describe how each element (confidentiality, integrity, and availability) helps protect information. For example, students might describe confidentiality as keeping a password secret and not sharing personally identifiable information online. They might describe integrity as ensuring that data is accurate and unchanged (e.g., checking whether a photo is real or AI-generated, ensuring that grades in a gradebook haven't been improperly changed). They might describe availability as ensuring that they can access their accounts, devices, apps, or gaming systems when they need them (e.g., the system isn't down or blocked). Students are not expected to implement technical security measures such as encryption or access control lists. Students do not need to understand cybersecurity systems or networks beyond how they affect students' daily lives.
E5-SYS-NT-14 Networks	Distinguish between the components of wired and wireless networks.	Students should explore and describe the basic components of networks, such as devices (e.g., computers, tablets, phones), connecting hardware (e.g., routers, switches, cables), and wireless connections (Wi-Fi signals). Students are not expected to understand detailed networking protocols, IP addressing, or the technical differences between LANs, WANs, and the internet. Students do not need to understand packet structures, routing tables, or advanced network design.
E5-SYS-IM-15 Impacts of Computing Systems	Examine how computing systems impact culture and the ways people live and work.	Students should examine the cultural impact of existing and emerging computing systems that both help and hinder societal needs. Examples of appropriate topics include the different roles social media plays in our culture and society and how generative AI is changing the way people work. Students are not expected to identify or reference specific ethical frameworks or sociological concepts). Students do not need to access or use the technologies being discussed.



Mathematics Connection

5.G.B.4 Classify two-dimensional figures in a hierarchy based on properties.

Science Connection

5-ESS3-1 Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Social Studies Connection

D2.Geo.6.3-5 Describe how environmental and cultural characteristics influence population distribution in specific places or regions.

Computing & Society

Standard Code	Iowa Academic Standard	Standard Clarification
E5-SOC-HI-16 History of Computing	Analyze how the inclusion or exclusion of individuals and communities has shaped the design, development, and societal impact of computing technologies.	Students should analyze historical and contemporary examples of computing innovations. Analyzing the development of early programming languages or accessibility tools is appropriate. Students are not expected to conduct independent historical research or examine complex sociopolitical movements in depth. Students are not required to know specific dates, laws, or named individuals beyond those directly connected to major computing milestones.
E5-SOC-ET-17 Emerging Technologies	Examine how people decide whether or not to use emerging technologies.	Students should analyze the factors people consider when making personal decisions about using, avoiding, or rejecting emerging technologies, including personal needs and values, benefits, concerns, and accessibility. For example, students might examine why a person would choose to use or reject a smart watch or voice assistant at home by considering convenience, cost, privacy concerns, and accessibility for family members with varying abilities. Students are not expected to do research studies or understand the technical aspects of how the emerging technologies work. Students are not required to make value judgments about whether people's decisions are "right" or "wrong."
E5-SOC-HU-18 Humans & Computing	Evaluate when it is appropriate to use or not use computing technologies to solve a problem.	Students should evaluate and justify whether computing technologies are the best tools for solving a specific problem by considering the context, potential benefits, and potential drawbacks. These potential benefits and drawbacks can include technical, ethical, privacy, or environmental considerations. Students should focus on analyzing the feasibility of whether the solution requires computing. Deciding that AI is helpful for quickly translating a simple sentence but is not appropriate or helpful for deciding who should receive the last slice of pizza, which requires human judgment and social skills, is appropriate. Students are not expected to understand ethical frameworks, legal implications, or technical performance metrics (e.g., error rates, training data bias) used by professional engineers to make these decisions. Students are not required to solve the problem.



Science Connection

3-5-ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.



Social Studies Connection

D2.His.14.3-5 Explain probable causes and effects of events and developments.

Middle School Standards

Algorithms & Design

Standard Code	Iowa Academic Standard	Standard Clarification
MS-ALG-PS-01 Algorithmic Problem Solving	Design an algorithm that includes variables of multiple data types to solve a problem or express ideas.	Students should design and explain an algorithm that uses multiple variables with different data types (e.g., integers, string, Boolean) to solve a problem or express an idea. The algorithm should show how variables are created, updated, and used (e.g., tracking a score, storing a name, checking a true/false condition, responding to user input, calculating a result). Representations may be verbal, visual, physical, pseudocode, or block-based and should emphasize the logic and data changes rather than producing executable code. Students are not expected to write executable programs, manage memory, use or implement data structures (e.g., lists/arrays, dictionaries/maps, objects), or analyze efficiency.
MS-ALG-PS-02 Algorithmic Problem Solving	Model a given algorithm with a flowchart or pseudocode that includes a combination of control structures and procedures.	Students should model a teacher- or peer-provided algorithm using either a flowchart or clearly structured pseudocode that shows how the algorithm runs. The model should include a combination of control structures (i.e., sequence, iteration, and selection) and should represent at least one procedure (a named, reusable set of steps) being used within the algorithm. Models may include variables and other supporting details only as needed to accurately represent the algorithm's logic. Teacher-provided templates or agreed-upon formats are appropriate. Students are not expected to design or optimize the algorithm, justify efficiency, refactor for readability, or apply formal software engineering practices. Students are also not expected to use professional programming syntax or convert pseudocode into executable code.
MS-ALG-PS-03 Algorithmic Problem Solving	Verify the accuracy of an algorithm for given inputs.	Students should test whether a given algorithm produces expected outputs for specific inputs by tracing steps or running the algorithm. For example, students could check whether a sorting algorithm correctly orders numbers or whether a set of instructions builds a shape as intended. Students are not expected to perform formal proofs of correctness, analyze efficiency, or optimize algorithms. Students are not required to use mathematical notation or comparison of multiple algorithms for performance.
MS-ALG-PS-04 *Algorithmic Problem Solving*	Justify whether a problem is best solved using procedural instructions, rule-based logic, data-driven methods, or a combination of these approaches.	Students should justify whether a problem is best solved using explicit step-by-step instructions, pattern-based rules, data-driven approaches, or a combination of these. Examples may include explaining why a procedural approach fits a fixed and predictable task (e.g., calculating a total score), why rule-based logic supports responsive or conditional behavior (e.g., enforcing game rules), or why a data-driven approach is appropriate when patterns are identified from collected data (e.g., recommending a song based on listening history). Students may also justify combining approaches when a solution requires both defined procedures and conditional or data-based decision-making. The emphasis is on evaluating and explaining the reasoning behind the chosen approach. Students are not expected to use formal logic notation, compare imperative and declarative paradigms, or design/implement machine learning models.

Standard Code	Iowa Academic Standard	Standard Clarification
MS-ALG-PS-05 Algorithmic Problem Solving	Use AI tools to generate outputs that assist in solving a computational problem.	Students should use age-appropriate AI tools or prebuilt models to generate outputs that support solving a computational problem. Examples include generating text to brainstorm ideas, using image recognition to classify objects, or asking a chatbot for troubleshooting help. Students should focus on interpreting and assessing AI outputs, not building or programming AI systems. Students can validate teacher generated output without generating outputs themselves if students are prohibited from using generative AI. Students are not expected to train AI models or explain underlying algorithms.
MS-ALG-ML-06 Machine Learning	Hypothesize how a machine learning model generates classifications or predictions.	Students should develop a hypothesis about how a machine learning model might be processing information based on the observed inputs and outputs of the model. Students should focus on forming credible, evidence-based inferences from experimentation and observation. For example, students might test an image classification tool by submitting several pictures of animals and, after noticing that it consistently labels striped animals as "tiger," hypothesize that the model is prioritizing visible patterns like stripes over other features such as size or habitat. Students are not expected to explain exactly how machine learning models work internally.
MS-ALG-ML-07 Machine Learning	Investigate ways to improve the accuracy and fairness of a machine learning model by refining the quality of examples and nonexamples in the training data.	Students should test a machine learning model to evaluate the outputs, identify overrepresented or missing examples in the training data, and suggest improvements to increase accuracy and fairness. Students should focus on testing, interpreting results, and suggesting refinements based on evidence. For example, students might notice that a model misidentifies certain objects and propose adding more examples, then retest to see if performance improves. Students are not expected to create machine learning models or understand the technical mechanics of training. Students are not expected to make changes to machine learning models; this can be a conceptual discussion.
MS-ALG-ML-08 Machine Learning	Evaluate the features and limitations of a machine learning model.	Students should examine machine learning model documentation, including model cards, to determine the model's features and limitations. Students should review information about the machine model, including (a) datasets used for training, including potential sources of bias; (b) the contexts or scenarios in which the model should or should not be used; (c) the computing power or time required for operation; and (d) potential risks, ethical concerns, privacy considerations, and recommendations for fair and responsible use. Students should evaluate the observable inputs and outputs of a machine learning model for utility and reliability. Students should focus on reviewing documentation and analysis, not implementation or debugging. Students are not expected to build a machine learning model or access proprietary training data.
MS-ALG-IM-09 Impacts of Algorithms & Design	Evaluate which human-centered design principles are present or missing in existing computing technologies.	Students should analyze familiar computing technologies (e.g., websites, mobile apps, video games, school platforms, recommendation systems) to determine how human-centered design principles are reflected in their features. Students should consider how different users might experience the technology differently and evaluate the potential impacts of design choices. Students may suggest improvements to the computing technologies examined. Students are not expected to design or implement full computing technologies. Students are not required to conduct formal user research, perform usability testing

Standard Code	Iowa Academic Standard	Standard Clarification
MS-ALG-IM-10 Impacts of Algorithms & Design	Examine evidence of beneficial and harmful impacts, ethical issues, of algorithms encountered in daily life.	Students should identify and describe common ethical issues in AI systems using familiar examples). They should evaluate whether the outcomes of these systems seem fair and explain why in simple, concrete terms. Students are not expected to program or modify AI tools, understand neural networks, or study global AI policy.
MS-ALG-IM-11 Impacts of Algorithms & Design	Modify an algorithm to address a specific societal impact or issue.	Students should design modifications to an existing algorithm, verbally or through diagrams or flowcharts, to make its outcomes fairer. Students should focus on creating more balanced and representative results through simple, conceptual modifications. For example, they might suggest adjusting a music playlist generator to include more artists. Students should explain how their modification helps create more balanced and representative results. Students are not expected to design complex algorithms from scratch or apply statistical fairness techniques.



AI Connection

MS-LN-MD-15 Analyze how changing parameters in a simple model affects its accuracy.



ELA Connection

RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.



Mathematics Connection

7.SP.C.5 Understand that the probability of a chance event is a number between 0 and 1 that expresses the likelihood of the event occurring.

8.F.A.1 Understand that a function is a rule that assigns to each input exactly one output.



Science Connection

MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

MS-ETS1-3 Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

Programming

Standard Code	Iowa Academic Standard	Standard Clarification
MS-PRO-PD-12 Program Development	Use procedures to structure code for clarity and reusability.	Students should use procedures to make code easier to read and reuse by grouping a set of steps under a clear, descriptive name and calling the procedure in one or more places in the program. Students recognize an opportunity for a procedure (e.g., repeated or logically grouped steps), create the procedure, replace repeated code with procedure calls, and describe how this improves clarity and reusability (e.g., reduces duplication, makes updates easier, helps organize the program). Procedures may be teacher-provided, student-created, or developed from starter code. Students are not expected to write procedures with parameters or return values, to design large modular systems, or to manage many interacting procedures, modules, or objects.
MS-PRO-PD-13 Program Development	Use reference documentation in program development.	Students should use reliable documentation that helps write, debug, and refine their programs. They should use teacher-provided or self-selected documentation to understand functions or blocks and search for common error messages to identify causes and solutions. Students are not expected to read professional-level documentation or apply coding concepts beyond their grade level.
MS-PRO-PD-14 Program Development	Justify the importance of attribution and intellectual property when developing computing technologies.	Students should define intellectual property and explain why giving credit to original creators matters. They should recognize that programming and computing technologies make use of multiple artifacts (e.g., code, images, music, text), and understand the difference between learning from others' code and plagiarizing it. Identifying whether code is open source, free to use, or proprietary and providing basic attribution in their own work are appropriate. Students should focus on ethical awareness and responsible use of others' work. Students are not expected to study copyright law, fair use, or licensing in depth or to license their own code.
MS-PRO-PD-15 Program Development	Develop a program utilizing collaborative practices that support meaningful participation.	Students should actively share ideas during planning, provide and receive constructive feedback in all stages of program development, and collaborate effectively on shared digital tools. Students should focus on productive teamwork and communication. Practicing equal participation, clear communication, and respect for others' contributions is appropriate. Students are not expected to use formal collaboration methods, like Agile or Scrum, or professional project management software.
MS-PRO-VD-16 Variables & Data Storage	Use variables of multiple data types to store, access, and manipulate data within a program.	Students should create programs that use variables of multiple data types (e.g., integers, strings, Booleans) to store, access, and change data during execution. Students should be able to update individual values, use selection to make decisions based on variable values, and use iteration to repeat a process over time (e.g., repeated input/updates, repeated calculations, repeated checks) without requiring collections. Students should perform basic manipulations such as incrementing and decrementing, accumulating a running total, tracking a maximum or minimum, counting occurrences, and transforming values (e.g., converting between types or combining text). Students are not expected to use or implement data structures (e.g., lists/arrays, dictionaries/maps, objects) or use professional or industry-specific syntax and conventions beyond what their programming environment requires.

Standard Code	Iowa Academic Standard	Standard Clarification
MS-PRO-RD-17 Reading & Documenting	Analyze the roles of iteration, selection, variables, and procedures in a segment of code.	Students should demonstrate how a segment of code works. Tracing the execution of a code segment and the value of variables through sequences of code (e.g., step-by-step in order), iteration (e.g., repeated sections of code), selection, and procedures (e.g., separate modules of code) are appropriate. Students are not expected to debug or test the code or analyze procedures with parameters or return values.
MS-PRO-RD-18 Reading & Documenting	Analyze AI-generated code for accuracy and usability in a programming project.	Students should be provided with simple AI-generated code and evaluate whether any functions used actually exist, identify flaws in logic, and describe their opinion of the level of complexity and readability of the code. Students should also make suggestions for improvements to the code. Students are not expected to evaluate code beyond their current level of understanding or generate code with AI themselves.
MS-PRO-TR-19 Testing & Refining	Use systematic strategies to test, refine, and document changes to a computing technology to meet the intended purpose.	Students should select and implement a variety of techniques to find and fix errors, explain code, refine a user interface, and give and receive constructive feedback during code review. Appropriate techniques might include testing input and output, using watchers, testing individual procedures, or using AI to make suggestions for alignment with design specifications. Students are not expected to use debugging software, unit testing frameworks, or version control systems or to follow documentation standards beyond basic commenting practices.
MS-PRO-TR-20 Testing & Refining	Refine a computing technology based on user feedback to improve its usability.	Students should discuss user feedback with peers, consider the needs of all potential users, and identify which suggestions would most improve a computing technology's usability. Students should focus on developing awareness of others' needs and incremental improvement. Students are not expected to perform formal audits or implement complex frameworks.



ELA Connection

W.7.2.D Use precise language and domain-specific vocabulary to inform about or explain the topic.



Science Connection

MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

MS-ETS1-3 Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

MS-ETS1-4 Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.



Social Studies Connection

D2.Civ.9.6-8 Compare deliberative processes used by a wide variety of groups in various settings.

Data & Analysis

Standard Code	Iowa Academic Standard	Standard Clarification
MS-DAT-DC-21 Data Collection & Preparation	Evaluate how different levels of precision and granularity in data collection affect accuracy, storage, and analysis.	Students should explain the difference between precision and granularity in data collection and evaluate how these choices affect data accuracy, storage requirements, and interpretation. Students should identify and explain situations in which higher precision or granularity might be more important. For example, students might compare tracking daily step counts (lower granularity, less storage) versus tracking steps every minute (higher granularity, more storage) or recording ages in years (lower precision) versus years and months (higher precision). Comparing medical monitoring data (requiring high precision and granularity for patient safety) with casual fitness tracking data (where lower precision and granularity are sufficient) is appropriate. Students are not expected to collect data at varying precision or granularity levels. Students are not expected to understand the technical details of data collection processes.
MS-DAT-DC-22 Data Collection & Preparation	Explain how data and its associated metadata can be used to answer questions.	Students should be able to explain how data and metadata serve different but complementary purposes when answering questions. Students should understand that metadata is data about data (i.e., it provides context that helps interpret the primary data content). For example, a photo's image data shows what was captured, whereas its metadata (e.g., timestamp, location, camera settings) provides context about when, where, and how the photo was taken. Students should be able to use computational tools to view metadata (e.g., viewing file properties, examining web page source code). Students should recognize that metadata can be collected automatically without their explicit knowledge (e.g., their phone adding location and time data to photos). Students are not expected to understand technical standards for metadata formats or structures. Students are not required to focus on any particular metadata tool or to manually create or edit metadata fields. Students are not expected to provide exhaustive lists of all possible metadata types for different file formats.
MS-DAT-DC-23 Data Collection & Preparation	Use a digital tool to sort, filter, group, and summarize structured data.	Students should use a spreadsheet or other age-appropriate digital tool to apply basic operations such as sorting, filtering, grouping, and calculating simple summaries (e.g., counts, averages) on a structured dataset. Students can work with a pre-existing data set of a grade-level-appropriate size. Students should explain why they are using each operation and how it helps answer their data question (e.g., "I am filtering the data to show only results from 2023 so I can analyze recent trends," "I am grouping by product type and calculating total sales to find our best-selling category.") Students do not need to collect data to fulfill this standard. Students are not expected to clean messy datasets, correct inconsistencies, restructure text fields, or prepare unstructured data for analysis. Students do not need to master any computational programs or software to transform data.

Standard Code	Iowa Academic Standard	Standard Clarification
MS-DAT-DC-24 Data Collection & Preparation	Analyze options to address data quality issues.	Students should be able to identify common data quality issues, such as missing data and incorrect formatting, as well as investigate their causes. Students should also be able to develop multiple approaches for addressing data quality issues, such as deleting records with a lot of missing attributes, reformatting data that doesn't conform to expected values, or leaving the data as is. Students should evaluate the outcomes of each approach to addressing data quality and consider how removing data can introduce bias into a data set. Students should be focused on the human oversight of errors in data to prepare them to understand how decisions made by humans in the development of automation tools can impact others. Students can be provided with a data set to analyze. Students are not expected to choose a "correct" approach for addressing data quality. Students should be focused on analyzing and evaluating solutions. Students are not expected to work with large, complex datasets, nor do they need to generate their own data with errors to analyze. Students are not expected to use automation tools to identify errors.
MS-DAT-DI-25 Data Investigation	Use computational tools to identify relationships among variables in a dataset and make classifications or predictions.	Students should use spreadsheets or programming tools to identify relationships between different variables in a large dataset. Once a relationship is identified, it can be used to make a prediction. Students should critically analyze their predictions to see if they make sense for unknown conditions or input. Students should recognize that many artificial intelligence systems work by identifying relationships and making predictions. Students are not required to understand statistics beyond what is covered in sixth grade math standards.
MS-DAT-DI-26 Data Investigation	Create data visualizations to show how different design choices can impact the interpretation of the same data.	Students should generate multiple visualizations for the same data to highlight a key insight they discovered. Students should critically analyze whether the different visualizations are equally clear and accurate, visually appealing. Students should also critically analyze the visualizations to see if they convey the same message despite different design choices. Students can use representations other than visual to communicate insights from data. Students can work with pre-existing data. Students are not required to use computational tools, though they may be helpful.
MS-DAT-DI-27 Data Investigation	Summarize a data investigation process, including potential limitations, and supporting evidence.	Students should describe a data investigation, including the original question, how the data was collected and analyzed, and the key decisions made during the process. They can describe an investigation they completed individually or with a team or they can interview someone else and report on that person's process. Students should explain the motivation for the investigation, evaluate whether the results were expected or satisfactory, and identify potential sources of bias and limitations. They should clearly connect their conclusions to the evidence gathered during the investigation. Students are not expected to collect actual data, but rather reflect on a process that is already completed. Students are not required to use computational tools, but they may find them helpful.

Standard Code	Iowa Academic Standard	Standard Clarification
MS-DAT-IM-28 Impacts of Data Science	Explain the benefits and risks of allowing personal data and metadata to be collected and used in datasets, including issues of data ownership, privacy, and sovereignty.	Students should be able to explain the benefits and risks of allowing personal data and metadata to be collected by websites, apps, and other computing technologies. Students should understand that benefits may include personalized recommendations, improved services based on user data, or free access to platforms in exchange for data collection. Students should recognize risks including loss of privacy (e.g., location tracking, browsing history collection), unauthorized sale or sharing of personal data, and reduced control over how information is used (data ownership). Students should also understand basic concepts of data sovereignty, such as how data collected in one country may be stored or governed under another country's laws. Students are not expected to understand technical data protection methods (e.g., encryption, secure protocols) or analyze specific legal frameworks (e.g., General Data Protection Regulation [GDPR], the Children's Online Privacy Protection Act [COPPA]). Students are not required to create technical explanations of cybersecurity systems or evaluate the technical adequacy of privacy policies.
MS-DAT-IM-29 Impacts of Data Science	Analyze how decisions made at different stages of working with data can lead to biased data, misleading conclusions, and compromised AI models.	Students should be able to recognize that decisions made during data collection, data processing, data analysis, and data presentation all involve human choices and that those choices can, often unintentionally, introduce bias or distort results. Students should examine simple examples to identify how limitations or assumptions at different stages can affect interpretations and conclusions and how those same limitations may influence the performance of AI models trained on the data. Students should be able to explain how these limitations shape conclusions and outcomes. Students are not required to learn advanced statistical methods, the technical details of AI training algorithms, or programming-level solutions Students are not required to have deep knowledge of machine learning mathematics or data science processes.



Data Science Connection

E6-DR-ND-01 Make sense of the variability of data through an iterative process of refinement by questioning.

MS-DR-ID03 Modify conclusions when new data becomes available and support revised claims with evidence.

MS-CC-MD-06 Consider when and where data were collected and its precision to understand its limitations.

MS-CC-PR-09 Utilize graphs (e.g., bar graphs, line graphs) to describe patterns and identify trends, similarities, and differences within data.

MS-VC-DS-19 Create explanations of data visualizations to tell their story.



Mathematics Connection

6.SP.B.4 Display numerical data in plots on a number line, including dot plots, histograms, and box plots.

6.SP.B.5.C Summarize numerical data sets in relation to their context, such as by: Giving quantitative measures of center (median and/or mean) and variability (interquartile range and/or mean absolute deviation), as well as describing any overall pattern and any striking deviations from the overall pattern with reference to the context in which the data were gathered.

7.RP.A.2 Recognize and represent proportional relationships between quantities.

8.SP.A.1 Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities.

Systems & Security

Standard Code	Iowa Academic Standard	Standard Clarification
MS-SYS-HW-30 Hardware & Software	Examine differences between computing systems based on user needs, system requirements, and potential societal, environmental, and ethical impacts.	Students should compare multiple computing systems based on features and system requirements (e.g., storage capacity, connectivity, accessibility features). Students should identify user needs (e.g., portability, cost, battery life) and provide reasoning for system choices. Students should connect at least one societal, environmental, or ethical impact to system choice. Students are not expected to explain detailed technical specifications (e.g., processor clock speeds, low-level architecture).
MS-SYS-HW-31 Hardware & Software	Describe computing devices used in various industries, their basic functions, and how they are used to accomplish tasks or solve problems.	Students should learn about computing devices used in various industries and describe their basic functions. Devices might include robots, electronic control units in vehicles, medical imaging devices, automated manufacturing equipment, and agricultural sensors. Students should identify how these devices use input, output, processing, storage, and (when applicable) mechanical interactions to accomplish specific tasks or solve problems within industries such as medicine, agriculture, or manufacturing. Students should have agency in selecting industries and devices to study. Students are not expected to build or program devices. Students do not need to demonstrate advanced technical fluency in hardware or software integration.
MS-SYS-SE-32 Security	Explain the effects of not using the CIA Triad when working with data.	Students should recognize and explain what happens when each element of the CIA Triad is not maintained. When confidentiality is compromised, sensitive data is exposed (e.g., leaked passwords, shared personal information). When integrity is compromised, data becomes corrupted or altered (e.g., incorrect grades in a school database). When availability is compromised, systems become inaccessible (e.g., a denial-of-service attack blocking a website). Students should apply the CIA Triad to age-appropriate, relatable contexts (e.g., school accounts, social media, online gaming), demonstrating understanding of how failures connect to real-world impacts. Students are not expected to conduct professional-level security audits or develop deep cryptography knowledge.
MS-SYS-SE-33	Evaluate common types of cyber attacks and preventions.	Students should identify and describe common types of cyber attacks, such as phishing, malware, ransomware, and social engineering. They should be able to evaluate how these attacks exploit human behavior and system vulnerabilities. Students could also explore real-world examples of cyber incidents and their consequences. Students should learn to apply basic prevention strategies, such as using strong passwords, enabling multifactor authentication, and recognizing suspicious activity. Students are not expected to investigate complex cyber attacks or use professional security tools. They do not need to break into systems, test network defenses, or analyze how malware is built. Students are also not expected to configure advanced security settings or understand technical protocols used in industry.
MS-SYS-NT-34 Networks	Model how information in a network is broken down into packets, transmitted between devices, and reassembled.	Students should be able to model how data is split into packets, encoded into binary, transmitted independently across a network, and reassembled at the destination. Students should also identify common issues such as packet loss, explain possible causes (e.g., congestion, interference, faulty hardware), and describe basic strategies to reduce or prevent packet loss. Students are not expected to explore networking protocols in detail (e.g., TCP/IP) or to configure real-world networking hardware (routers, switches, servers).

Standard Code	Iowa Academic Standard	Standard Clarification
MS-SYS-NT-35 Networks	Explain how the resilience of the internet depends on interconnected devices and their roles and functions within the network.	Students should be able to explain how the internet is made up of interconnected devices that each serve specific roles. For example, routers direct traffic between networks, servers host information, clients (e.g., laptops, phones) request and use data, and switches connect devices within a local network. Students should also describe how redundancy (multiple pathways between devices) supports resilience, allowing communication to continue even if some devices or connections fail. Students are not expected to demonstrate technical knowledge of networking protocols (e.g., TCP/IP) or to configure or analyze real-world enterprise-level networking systems.
MS-SYS-IM-36 Impacts of Computing Systems	Collaborate to improve the design of a computing system to meet the needs of all potential users.	Students should recognize that computing systems need to be designed so they can be better used by people with different needs, abilities, and ways of thinking... Students may conduct simple peer testing to evaluate design improvements. Students are not expected to design hardware from scratch or write complex code for accessibility features. Students do not need to perform professional-level usability testing.
MS-SYS-IM-37 Impacts of Computing Systems	Examine how access to computing systems can vary based on personal and social factors.	Students should investigate how access to computing systems varies across groups and regions. For example, students may compare access to broadband internet in urban versus rural areas or explore how adaptive technologies support people with disabilities. Students are not expected to perform statistical analyses of large national datasets, but they may use pre-curated datasets, maps, or local surveys. Students do not need to perform advanced policy evaluation.



Science Connection

MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

Computing & Society

Standard Code	Iowa Academic Standard	Standard Clarification
MS-SOC-HI-38 History of Computing	Compare the roles of individuals, communities, organizations, and governments in shaping computing technologies across major eras in computing history.	Students should identify and describe examples of historical and contemporary individuals, communities, organizations, and governments that have influenced the development of computing technologies. Students explain the motivations of these individuals and groups in advancing computing. Students also recognize how these different actors have interacted with one another. Students compare the different roles these groups have played (e.g., designing, funding, regulating, using technologies) and recognize that these actors sometimes work together or influence one another. Students are not expected to memorize timelines, technologies, or related facts. They are not expected to conduct deep ethical or social analyses. Students are also not expected to evaluate or rank individuals or groups by their relative importance.
MS-SOC-HI-39 History of Computing	Analyze intended and unintended impacts of historical computing technologies on society and the environment.	Students should distinguish between the intended purpose of a computing technology and its unintended consequences. Students identify and describe clear societal and environmental impacts, such as changes in communication, employment, privacy, e-waste, and energy consumption. They make simple cause-and-effect connections between computing technologies and their outcomes. Students are not expected to conduct cost-benefit analyses or perform complex calculations to determine environmental impacts. They are also not expected to make detailed predictions about future technologies or develop solutions to the unintended effects they identify.
MS-SOC-ET-40 Emerging Technologies	Evaluate when it is appropriate to use AI and other emerging technologies to solve a problem based on their capabilities, limitations, and environmental impacts.	Students should be able to identify what emerging technologies (e.g., AI, robotics, virtual reality, quantum computing) can and cannot currently do and determine whether they are appropriate for addressing a specific problem. They should consider factors such as technical capabilities, reliability, infrastructure requirements, environmental impacts, and the maturity or readiness of the technology. Students are not expected to understand the underlying mechanics of these technologies, predict future breakthroughs, or design functioning prototypes. They are also not expected to engage in ethical debates about regulation or human rights implications.
MS-SOC-ET-41 Emerging Technologies	Evaluate how design decisions in emerging technologies influence user experiences differently.	Students should be able to identify and evaluate examples of how design decisions in new and emerging technologies influence user experiences. They analyze how selected design choices can create benefits or barriers for different groups of users. Students may focus on one or more of these factors rather than addressing all dimensions simultaneously. Students are not expected to conduct usability studies, apply design frameworks, or create prototypes.
MS-SOC-ET-42 Emerging Technologies	Debate ways an emerging technology impacts local communities.	Students should be able to assess the potential or current impact of emerging technologies to address local community needs. Focusing on a specific emerging technology, students should be able to construct arguments with references for a debate on positive and negative impacts of that technology. Students could either debate which applications of an emerging technology have the greatest or least impact or argue for or against a particular application. Students should pay attention to who is impacted and how they are impacted as well as to costs and harms to the community and environment. Students are not expected to understand all the technical details of emerging technologies.

Standard Code	Iowa Academic Standard	Standard Clarification
MS-SOC-HU-43 Humans & Computing	Analyze how the decisions humans make when using computing technologies have ethical and social consequences.	Students should analyze how human choices in the design and use of computing technologies influence fairness, privacy, and social well-being. They should investigate how decisions such as what data to collect, which algorithms to use, or how results are interpreted can lead to different outcomes for individuals and communities. Students should explain how intentional human decisions, rather than the technologies alone, shape these ethical and social impacts and propose ways to use computing more responsibly. Students are not expected to design or program full computing systems, perform advanced algorithmic audits, or resolve complex ethical dilemmas. Students are not required to take positions on philosophical questions about artificial intelligence, consciousness, or rights.



AI Connection

MS-SI-EA-25 Analyze how different perspectives influence decisions about designing or using AI systems.

MS-SI-EA-26 Analyze how ethical decisions influence how AI systems affect people.

MS-SI-AS-29 Evaluate how AI systems influence culture, media, and access to information.



ELA Connection

WHST.6-8.1 Write arguments focused on discipline-specific content.



Science Connection

MS-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

Foundational High School Standards

Algorithms & Design

Standard Code	Iowa Academic Standard	Standard Clarification
HS-ALG-PS-01 Algorithmic Problem Solving	Design an algorithm using appropriate data structures to solve a problem or express ideas.	Students should create a logical plan for a program that selects a specific way to organize data (e.g., using a list to store a collection of items, using an object to represent a single complex entity) to effectively solve a specific challenge. For example, a student might design a leaderboard system for a game by choosing a list to store player scores and designing a sorting algorithm to arrange them from highest to lowest. Students are not expected to implement complex data structures (e.g., manual memory management for linked lists). The focus is on the selection and application of existing high-level structures available in modern programming languages to support the algorithm's goal.
HS-ALG-PS-02 Algorithmic Problem Solving	Optimize the design of an algorithm using procedural abstraction and control structures.	Students should evaluate existing algorithms to identify redundancies, inefficiencies, or unclear logic, and then refine them using procedural abstraction (e.g., defining functions or methods that encapsulate repeated steps). They should also apply control structures, including iteration and selection, to streamline processes and improve the algorithm's clarity, efficiency, and reusability. For example, a long, repetitive script for calculating student grades could be optimized by creating a "calculateGPA" procedure and using a loop to process a list of scores. Students are not expected to perform formal Big-O complexity analysis or optimize at the assembly/hardware level. This standard does not require the use of advanced dynamic programming or complex recursive optimizations, as the focus is on the structural improvement of the logic using fundamental programming constructs.
HS-ALG-PS-03 Algorithmic Problem Solving	Evaluate algorithms for efficiency, correctness, and clarity, using metrics or test cases.	Students should analyze algorithms for efficiency (time or memory use), correctness of outputs, and clarity (human readability), using simple metrics or test cases. For example, they could compare two algorithms for finding the largest number in a list by testing runtime when using different sized lists. Metrics may be qualitative or comparative (not formal analysis). Students are not expected to apply formal mathematical proofs or Big O notation. Students are not required to analyze all possible inputs.
HS-ALG-PS-04 Algorithmic Problem Solving	Describe the differences between deterministic and probabilistic algorithms.	Students should be able to explain that deterministic algorithms always produce the same output from a specific input and follow the same sequence of states, whereas probabilistic (randomized) algorithms use a source of randomness as part of their logic, which may result in different outputs or runtimes across different executions. For example, students could describe how a deterministic search algorithm always checks a list in a fixed order, whereas a probabilistic approach might pick elements at random to find a target more quickly in certain datasets. Students are not expected to calculate formal probability distributions or perform complex mathematical proofs.
HS-ALG-PS-05 Algorithmic Problem Solving	Evaluate AI-generated output to assess accuracy, and potential harms.	Students should analyze and critique AI-generated content (e.g., text, images, code) for accuracy, and potential harms. Students should focus on critical evaluation of outputs rather than technical implementation. Students are not expected to build or debug AI models or understand their internal mathematical algorithms.

Standard Code	Iowa Academic Standard	Standard Clarification
HS-ALG-ML-06 Machine Learning	Justify the selection of a type of AI algorithm to accomplish a task.	Students should support the selection of an AI algorithm for a specific task by evaluating its strengths and limitations relative to the problem requirements. This justification may consider data size and type, human interpretability, and desired outcomes. Students should focus on evaluating appropriateness, not technical construction. For example, students might explain that a Decision Tree is suitable for classifying spam emails because its logic is transparent and easy to explain, even if less accurate than other models. Students are not expected to understand or implement the underlying mathematics or statistics of these algorithms.
HS-ALG-ML-07 Machine Learning	Evaluate training data by examining its source, quality, representativeness, potential biases, and privacy implications.	Students should critically evaluate datasets before use by examining their origin, purpose, accuracy, completeness, representativeness, and privacy implications. For example, when using crime statistics, students might check where the data originated (e.g., police reports, surveys), assess its quality, and identify potential biases or privacy concerns. Students are not expected to conduct advanced statistical analyses to prove representativeness or to apply formal correctional techniques.
HS-ALG-ML-08 Machine Learning	Develop a machine learning model for a chosen task using appropriate data and tools.	Students should develop a machine learning model for a defined task by selecting suitable tools and data, training the model, and testing its performance against task requirements. Students should focus on applying available tools to create and evaluate functional models, not on mastering the mathematics that underlie them. For example, a student could use a block-based platform or a simple Python library to create a model that recognizes handwritten digits or classifies objects. Students are not expected to write algorithms from scratch or use advanced programming languages.
HS-ALG-IM-09 Impacts of Algorithms & Design	Design computing technologies using human-centered design principles.	Students should design computing technologies by following a human-centered design process. This includes researching user needs, exploring design options, and anticipating the impacts of their design. For example, when creating a website, students might ensure sufficient color contrast, keyboard navigation, and clear language for users with differing abilities. Students should also identify laws that set requirements for accessibility (e.g., ADA, IDEA, Section 508). Students are not expected to conduct large-scale user studies or meet every criterion of formal accessibility standards (e.g., Web Content Accessibility Guidelines, WCAG).
HS-ALG-IM-10 Impacts of Algorithms & Design	Evaluate the potential limitations and unintended consequences of rule-based and data-driven algorithms.	Students should evaluate how rule-based and data-driven algorithms can have limitations of unintended consequences. They should identify potential sources of incomplete information. Students should provide recommendations on how algorithms can be refined. Students' analyses should remain conceptual, focusing on observable impacts and ethical reasoning. Students are not expected to audit proprietary systems or use advanced statistical methods.
HS-ALG-IM-11 Impacts of Algorithms & Design	Articulate the values embedded in the design of algorithmic systems.	Students should identify and explain the values reflected in the design of algorithmic systems, recognizing that every design choice involves prioritizing certain outcomes or perspectives. Students should focus on identifying underlying priorities (e.g., efficiency, privacy, fairness, transparency) that shape algorithmic behavior. For example, students might examine a social media platform's recommendation system and discuss how its design favors engagement and attention over accuracy or civility. Students are not expected to deconstruct proprietary systems or analyze full business models.

Programming

Standard Code	Iowa Academic Standard	Standard Clarification
HS-PRO-PD-12 Program Development	Create a modular program that uses procedures, external libraries, or objects to improve reusability and readability.	Students should decompose a complex problem into smaller, manageable parts and implement each part as a distinct procedure, external library, or object. Students should focus on creating clear, reusable, and well-organized code. For example, a game program might separate player movement and scoring. Students are not expected to use advanced software design patterns or deep inheritance structures.
HS-PRO-PD-13 Program Development	Use documentation, libraries, Application Programming Interfaces (APIs), and other tools in program development.	Students should locate and use external resources to support program development, including built-in documentation, common libraries, simple APIs, and features of an Integrated Development Environment (IDE) (e.g., debuggers, syntax highlighting). Students should focus on effectively using available resources to enhance programs. For example, using a math library instead of writing a trigonometric function from scratch is appropriate. Students are not expected to create APIs or advanced development tools.
HS-PRO-PD-14 Program Development	Apply appropriate attribution and respect intellectual property when developing computing technologies.	Students should apply intellectual property principles by giving accurate credit for any code or digital media created by others. They should demonstrate ethical practice by documenting sources according to their terms of use or license. For example, a student creating a game might include a "Credits" section listing each asset's creator, source, and license. Students are not expected to master copyright law.
HS-PRO-PD-15 Program Development	Collaborate on a programming project using a defined workflow that includes design documentation and clear task roles.	Students should use collaborative workflows to organize group projects (e.g., assigning roles, maintaining shared design documents, using basic version control tools to manage changes). Students should focus on learning structured teamwork practices with accessible, classroom-ready tools. For example, a group of students might use a project management tool to assign tasks or a collaborative document for design specifications. Students are not expected to use professional-grade tools or manage large-scale projects.
HS-PRO-VD-16 Variables & Data Storage	Create a program that uses appropriate data structures to store, access, and manipulate data.	Students should design and implement programs that use data structures such as arrays, lists, or dictionaries to organize, access, and modify data effectively. Students should focus on selecting and applying suitable structures to manage data efficiently. For example, students might create a program that stores and retrieves information about daily tasks, chores, or student names and grades. Students are not expected to implement advanced data structures like linked lists, stacks, queues, trees, or graphs.
HS-PRO-RD-17 Reading & Documenting	Analyze how a segment of code works, including the role of parameters, return values, and data structures.	Students should read existing code and explain how its components interact to achieve the program's purpose. This includes explaining the roles of elements learned in prior years (i.e., sequence, iteration, selection, variables, and procedures) as well as elements learned in high school (i.e., parameters, return values, and data structures) and how these elements work together within a segment of code. For example, students could analyze a segment of code for a simple guessing game and explain how a variable stores the secret number, how a while loop continues until the correct number is guessed, and how an if/else statement provides feedback on whether the guess was too high or too low. Students are not expected to analyze complex algorithms or systems with many interconnected data structures.

Standard Code	Iowa Academic Standard	Standard Clarification
HS-PRO-RD-18 Reading & Documenting	Evaluate AI-generated code for accuracy, reliability, and alignment with program requirements.	Students should evaluate AI-generated code by testing it against predetermined requirements and verifying that it produces correct and reliable results. They should analyze whether the code meets its intended purpose, handles a variety of inputs appropriately, and follows any given design constraints (e.g., using a specific data structure or algorithm). Students should focus on evaluating the quality and reliability of the output. For example, a student using an AI tool to generate a function that calculates an average should test edge cases (e.g., empty lists, single values, mixed positive and negative numbers) and confirm that outputs are accurate and consistent with the task description. Students are not expected to understand the underlying machine learning models or algorithms that power the AI tools.
HS-PRO-TR-19 Testing & Refining	Evaluate a computing technology's alignment with design specifications and responsible design values, including its correctness, effectiveness, and user experience.	Students should systematically evaluate a computing technology that they or someone else created to determine whether it functions correctly, aligns with original design specifications, and reflects responsible design values. For example, a student might test a range of inputs to verify accuracy and reliability, examine edge cases, and assess usability, accessibility, clarity, and overall user experience. Students should compare the completed project to the intended features and purpose to confirm alignment. Students are not expected to use formal verification methods or master industry-specific tools.
HS-PRO-TR-20 Testing & Refining	Refine a computing technology based on user feedback, testing results, and responsible design values to improve its effectiveness and impact.	Students should use testing results and user feedback to make meaningful refinements to a computing technology's functionality, usability, accessibility, accuracy, and efficiency, but not necessarily all at the same time. For example, a student might add a help command, simplify instructions, or adjust text size and contrast to improve readability and accessibility. Students are not expected to correct every functional or user-related issue or achieve full optimization.

Data & Analysis

Standard Code	Iowa Academic Standard	Standard Clarification
HS-DAT-DC-21 Data Collection & Preparation	Use a digital tool to generate simulated data that fits certain parameters for use in simulations.	Students should be able to generate simulated data using a digital tool. Students should be able to write a simple program or use a spreadsheet function to create a dataset that meets specific criteria (e.g., generate a set number of data points within a specific range of values, create a certain distribution). For example, students could generate random initial velocities and launch angles within specified ranges to serve as inputs for a projectile motion simulation. Students should focus on creating data that can be used by a pre-existing simulation or model. Students are not expected to build a simulation. Students are not expected to use advanced statistical methods or write complex algorithms to generate the data.
HS-DAT-DC-22 Data Collection & Preparation	Create a data dictionary that describes the names and types of attributes, allowable values/ranges for each attribute, and logical relationships between variables in a dataset.	Students should be able to create a data dictionary for a dataset, including the names of all attributes (variables), their data types, and the range of acceptable values for each. The data dictionary should also describe the logical connections between variables, such as how a particular response on a survey question might lead to missing responses on other questions due to survey skip logic. For example, students could analyze a dataset of anonymized survey responses from a school and then create a data dictionary that lists each question as an attribute, defines the response format (e.g., integer, text string), and specifies the valid range of responses (e.g., a rating scale might allow the numbers 1–5 and "No Response" if the question was skipped). Students are not expected to create the dataset or handle extremely large, complex datasets that require specialized tools or databases.
HS-DAT-DC-23	Use a digital tool to clean and organize text-based data.	inconsistencies (e.g., variations in capitalization, inconsistencies in spacing), correcting errors (e.g., misspellings, invalid entries), and structuring the data appropriately (e.g., separating combined fields, standardizing formats). Students should identify when regular expressions can be used for pattern matching in text. Using a spreadsheet program or a simple programming script to convert inconsistent date formats, remove duplicate entries, or separate a single text column into multiple columns (e.g., first name and last name) within a dataset of survey responses is appropriate. Students are not expected to build cleaning tools from scratch. Students are not required to handle large-scale, unstructured data like social media feeds.
HS-DAT-DC-24 Data Collection & Preparation	Evaluate different approaches to verifying consistency and compliance with expected data types, values, and ranges.	Students should be able to identify and evaluate different methods for ensuring that data is clean, accurate, and ready for use. This includes examining data for expected formats, values, and ranges. For example, students could evaluate different approaches for validating a dataset of customer birthdates to ensure all entries are in the correct format (e.g., MM/DD/YYYY) and fall within a reasonable range of years. Students are not expected to write or implement scripts or use statistical models to perform data validation.

Standard Code	Iowa Academic Standard	Standard Clarification
HS-DAT-DI-25 Data Investigation	Use computational tools to create data visualizations of multivariate data sets to answer a question, classify, or make predictions.	Students should be able to use computational tools (e.g., spreadsheets, data analysis and visualization tools) to create data visualizations (e.g., scatter plots, line graphs, stacked bar charts, heat maps) that represent the results of their data investigations. For example, to represent the school's recycling habits, students could create a stacked bar chart showing the distribution of recycling material type (paper, plastic, metal) by school location (cafeteria, gym, classrooms) or time of day. Students are not expected to use text-based programming or implement an algorithm or model to generate their visualization or make predictions. Students are also not required to conduct statistical analyses.
HS-DAT-DI-26 Data Investigation	Evaluate data simulations and data visualizations to answer data questions, inform decision-making, and identify potential limitations.	Students should be able to evaluate the results presented in data visualizations and data simulations to determine their validity and usefulness in answering a question. Students should be able to identify misleading representations, and limitations in the data or the model that could lead to different conclusions. For example, students could inspect a line graph showing daily air quality index values and identify whether the Y-axis starts at 0 or at a higher value, which could exaggerate changes in air quality. Students should focus on evaluating existing data products rather than creating them. Students are not expected to create their own complex data simulations. Students are not required to rewrite or debug the code that generated the data visualizations or simulations.
HS-DAT-IM-27 Impacts of Data Science	Evaluate the societal, environmental, and ethical implications of large-scale data collection and processing, including AI applications.	Students should be able to analyze and articulate the societal, environmental, and ethical trade-offs associated with large-scale data collection and processing. This includes evaluating issues such as individual privacy and consent, data sovereignty, the spread of misinformation, and the environmental impact of data centers. For example, students could evaluate a social media platform's data collection policy and discuss the ethical implications of using that data for targeted advertising. Students are not expected to perform a formal legal or economic analysis of data policies or otherwise focus on the technical or legal specifics.
HS-DAT-IM-28 Impacts of Data Science	Debate the efficacy of policies and regulations to ensure responsible data use.	Students should be able to analyze and evaluate the effectiveness of existing data policies and regulations. This could look like students researching a specific data privacy issue and preparing arguments for a classroom debate on whether a new law is needed to protect consumer data. Students should include the efficacy of social approaches aimed at shaping the design and use of computing systems. Students are not expected to read the text of laws.

Systems & Security

Standard Code	Iowa Academic Standard	Standard Clarification
HS-SYS-HW-29 Hardware & Software	Differentiate operating systems (OS) as a special type of software that manages both the hardware and other software components of a computing system, including handling memory and peripherals.	Students should be able to differentiate an operating system from other types of software by identifying its role in managing hardware and software resources. For example, students might describe a computer's operating system, explaining that the operating system manages the computer's basic functions (e.g., allocating memory, connecting to peripherals). Students are not expected to understand the intricacies of how an operating system is coded or to perform advanced tasks like configuring system drivers.
HS-SYS-HW-30 Hardware & Software	Demonstrate the capabilities and limitations of a physical or simulated computing device to address a task or problem.	Students should be able to select and use a computing device to solve a practical problem. For example, a student could use a device to manage project deadlines and task assignments for a group project, using its apps and cloud synchronization features to coordinate with team members while also identifying limitations, such as battery life or screen size. Students are not expected to build their own computing device, understand the internal architecture of the device, or write code that directly controls the device's hardware components.
HS-SYS-SE-31 Security	Identify different types of cybersecurity and physical security measures and the trade-offs for users, data, and devices.	Students should be able to identify and describe different types of cybersecurity and physical security measures, as well as their associated trade-offs. They should be able to articulate how a security measure may benefit one aspect (e.g., data protection) while posing a challenge to another (e.g., user convenience, cost). For example, students could identify how multifactor authentication enhances security for a user's account, but makes it less convenient for the user to access. Students should focus on conceptual understanding of security principles and their practical implementation. Students are not expected to implement these security measures or demonstrate technical expertise.
HS-SYS-SE-32 Security	Classify the causes and impacts of security breaches and social engineering attacks for individuals, industries, communities, and governments.	Students should be able to research and categorize the consequences of a security breach or social engineering attack, differentiating between the effects on various stakeholders. The classification should go beyond a simple list of impacts and demonstrate an understanding of how the same breach can have different types of consequences (e.g., financial, reputational, legal, operational) for different groups. For example, a student could classify the impacts of a data breach at a hospital, analyzing the effects on patients (individuals), the hospital (industry), the local healthcare system (community), and regulations (government). Students should focus on understanding the broad, interconnected impacts of an attack. Students are not expected to conduct a forensic investigation of a real-world breach or to use professional cybersecurity tools for their analysis. Students do not need to focus on the technical details of the attack itself.

Standard Code	Iowa Academic Standard	Standard Clarification
HS-SYS-SE-33 Security	Formulate a solution to a security flaw in a given system.	Students should be able to analyze a simulated or described scenario involving a security flaw and propose a high-level solution. The proposed solution should explain the identified vulnerability, the potential consequences, and the recommended steps for mitigation. For example, a student could be given a case study of a school's network being compromised by a phishing attack and be asked to propose a solution that includes both technical measures (e.g., email filtering that detects suspicious links, multifactor authentication) and nontechnical measures (e.g., user training, security policies) to prevent future attacks. Students are not expected to implement the solution.
HS-SYS-NT-34 Networks	Diagram a network of computing systems, including hardware and software.	Students should be able to create a diagram of a computing systems network that includes both hardware (e.g., servers, routers, storage, user devices) and software (e.g., operating systems, applications). Students should focus on recognizing and representing the concept of a network and the role of each component in the network. Students should show how these components connect and interact to process information, accomplish tasks, or solve problems. Students are not expected to build a network using hardware or software.
HS-SYS-NT-35 Networks	Analyze how the internet functions as a network of networks and how it differs from other types of networks.	Students should be able to conceptually analyze the internet's layered structure and its role as a global network connecting smaller, local networks. They analyze its layered structure, key components (e.g., routers), core protocols (e.g., TCP/IP), and the client/server model. For example, a student could compare a simple LAN in a classroom to the global structure of the internet in terms of structure, scalability, addressing, and data transfer. Students should focus on developing a high-level, conceptual understanding of networking principles. Students are not expected to implement specific networks, configure or troubleshoot professional-grade networking equipment, write network protocols, or perform packet analysis.
HS-SYS-IM-36 Impacts of Computing Systems	Evaluate the rationales behind laws and policies governing the design and use of computing systems.	Students should be able to analyze and articulate the reasoning (technical, legal, and social) behind various policies related to the design and use of computing systems. Students should consider the rationale for technical approaches (e.g., responsible design practices, policies requiring two-factor authentication for sensitive data), legal approaches (e.g., COPPA) and social approaches to shaping the design and use of computing systems. Students should focus on understanding why these policies exist, the problems they aim to solve, and their intended and unintended consequences. Students do not need to read and interpret the text of laws or other legal texts.
HS-SYS-IM-37 Impacts of Computing Systems	Investigate how computing systems and infrastructure impact society and the environment, identifying who is affected and why.	Students should research, analyze, and articulate the societal and environmental impacts of computing systems, including the lifecycle of physical components. Students are not expected to propose novel technical solutions to these large-scale problems, but rather to analyze and communicate the problems themselves.

Computing & Society

Standard Code	Iowa Academic Standard	Standard Clarification
HS-SOC-HI-38 History of Computing	Analyze the historical trajectory of specific computing technologies and how their development is linked to societal and environmental factors.	Students should be able to investigate a computing technology (e.g., the internet, a social media platform, a specific type of integrated sensor technology) from its inception to its current state, identifying key moments where nontechnical forces directly influenced its design, adoption, or ethical challenges. They should use reliable secondary sources to draw and support their analytical conclusions. For example, high school students could research the rise of mobile computing, analyzing how shifts in economic factors and social trends drove its rapid adoption and evolution. Students are not expected to conduct or synthesize research on the primary source documents of these technologies, nor are they required to master economic models or complex legal frameworks related to technology regulation.
HS-SOC-HI-39 Emerging Technologies	Propose modifications to existing policies and legislation that encourage ethical innovation and minimize societal risks associated with technology.	Students should be able to articulate the rationale behind policies and legislation that guide technological development. This includes explaining how specific laws, like data privacy regulations and rules about algorithmic transparency, are designed to address societal concerns such as discrimination, a loss of privacy, or job displacement. Students should focus on understanding the reason behind technology policy rather than on the process of lawmaking. Students are not expected to draft legal documents, interpret complex legal jargon, or have a deep understanding of the legislative process itself.
HS-SOC-ET-40 Emerging Technologies	Evaluate the fundamental technological differences between an emerging technology and established technologies and how those differences influence computing.	Students should be able to evaluate the technological advances that distinguish an emerging technology from existing technologies and how they enable features or address limitations in current systems. For example, quantum computing uses superposition and entanglement to represent and manipulate information more compactly than classical systems. This allows certain data structures and computations to be expressed with fewer physical resources. The degree to which students are introduced to a technical concept is dependent on the technology and the backgrounds of the students. For example, quantum operations would be reasonable, but not necessary, to introduce, but the introduction of the quantum mechanics underlying superposition and entanglement is not expected.
HS-SOC-ET-41 Emerging Technologies	Evaluate the societal and environmental impacts of emerging technologies.	Students should be able to critically analyze an emerging technology by identifying and assessing its potential positive and negative effects on society and the environment. Students should focus on developing a well-reasoned, conceptual argument about an emerging technology's broader impacts. For example, a student could evaluate the use of generative AI in education. They would identify not only the potential positive impacts, like providing personalized tutoring, but also the negative ones, such as the potential for academic dishonesty and the risk of widening the digital divide for students without access to these tools. Students are not expected to conduct a formal, data-driven sociological or environmental study.

Standard Code	Iowa Academic Standard	Standard Clarification
HS-SOC-ET-42 Emerging Technologies	Design a conceptual solution to a real-world problem using an emerging technology, analyzing its potential benefits and harms.	Students should be able to design a conceptual or tangible solution to a real-world problem by applying an emerging technology. This process must be supported by credible research on both the problem and the technology's capabilities. The solution should also be mindful of ethical implications, with students analyzing the potential benefits and harms to different groups of people and the environment. For example, a student could create a design document for a system that uses AI to analyze satellite imagery to help track deforestation, addressing a real-world environmental problem. Their work would include research to support their claim and a discussion of the ethical considerations, such as the potential for misuse of the data. Students are not expected to build a fully functional, production-ready version of their solution. Students are not expected to engage in complex engineering.
HS-SOC-HU-43 Humans & Computing	Evaluate how human choices in using, designing, deploying, and regulating computing technologies have risks, benefits, and long-term impacts.	Students should evaluate the ethical and societal implications of computing technologies by examining how choices made by developers, users, and regulators shape their outcomes. Students are not expected to train a complex machine learning model from scratch or perform a deep mathematical analysis of different AI algorithms (e.g., backpropagation in neural networks). Students should not focus on the underlying code or mathematics.
HS-SOC-HU-44 Humans & Computing	Debate perspectives on differences between human and artificial intelligence and their implications for consciousness, ethics, and human responsibility.	Students should debate philosophical and ethical differences between human intelligence and artificial intelligence, including questions about consciousness, agency, and responsibility. Discussions may include perspectives on whether AI systems could demonstrate human-like intelligence (e.g., artificial general intelligence) and the ethical or societal implications that might follow. Students should analyze and articulate arguments about the roles and responsibilities of humans in designing, deploying, and governing AI systems, including issues such as accountability, fairness, and decision-making authority. Students are not expected to analyze the neurological or biological mechanisms of human consciousness or the mathematical details of complex AI models (e.g., specific neural network architectures).

Computer Science Specialty Standards

Cybersecurity

S1: Network Theory & Design

Standard Code	Iowa Academic Standard	Standard Clarification
S1-CYB-ND-01	Analyze the role of network services and protocols in secure communication and their potential vulnerabilities.	Students should analyze security trade-offs in common network services and protocols based on context, including when plaintext communication may be acceptable and when encryption is required. Analysis should include: (a) comparison of insecure versus secure protocol pairs (e.g., HTTP/HTTPS, Telnet/SSH), (b) examination of common vulnerabilities, and (c) contextualizing of risks to users and communities if those vulnerabilities are exploited. Students may demonstrate understanding through simulated environments, packet capture analysis, case studies, or instructor-provided demonstrations. Students are not expected to exploit live networks, configure enterprise infrastructure, or analyze advanced routing protocols. Hands-on Man-in-the-Middle (MitM) simulations are not required and should only be conducted in safe, isolated environments where permitted.
S1-CYB-ND-02	Examine the concepts of the Open Systems Interconnection (OSI) model and their role in network communication.	Students should trace the path of a data packet through the OSI model, articulating how data is encapsulated and processed at each layer during transmission. Students should use the OSI model as a tool for reasoning, troubleshooting, and security analysis, not rote memorization. Students should identify which layers support key security functions, such as encryption, authentication, or error detection. Students should demonstrate a functional understanding of how layered systems support connectivity and security. Students are not expected to memorize all protocol-layer mappings or perform low-level debugging. Students are not expected to recall the exact sequence of all seven layers or associate every protocol with its specific layer.
S1-CYB-ND-03	Distinguish between networks based on their protocols, topologies, and addressing schemes.	Students should distinguish between common network architectures (wired, wireless, hybrid) and articulate how topologies, segmentation and addressing schemes, and protocols interact in real-world systems. Students should analyze how modern networks: (a) combine multiple topologies (e.g., hybrid, mesh), (b) use multiple protocols simultaneously, and (c) employ IPv4 and IPv6 addressing. Students are not expected to rigidly classify networks into single categories. For example, students are not expected to classify networks into legacy addressing classes (e.g., Class A, Class B, Class C), but rather to describe how addressing is structured and used within a network. Students are not expected to design complex addressing plans or configure production networks.
S1-CYB-ND-04	S1-CYB-ND-04 Examine security risks in digital systems and corresponding mitigation strategies.	Students should analyze cybersecurity risks by identifying threats, vulnerabilities, exploits, and potential impacts using a simple risk framework that considers likelihood and impact. Students may analyze case studies or simulated scenarios to: (a) identify risks (including AI-enhanced threats, such as automated phishing, deepfakes, prompt injection and data poisoning), (b) propose appropriate mitigation strategies, and (c) evaluate societal impacts, including effects on trust or access to services. Hands-on investigation may occur in isolated virtual environments, such as a cyber range, or through instructor-provided artifacts. Students are not expected to conduct penetration testing or deploy enterprise security tools. Students are not expected to access physical hardware or live networks.

S1: Network Operations

Standard Code	Iowa Academic Standard	Standard Clarification
S1-CYB-NO-05	Apply diagnostic tools and techniques to resolve network connectivity issues.	Students should use basic network diagnostic tools to document connectivity and performance issues and to investigate whether those issues may indicate misconfiguration, failure, or potential security concerns. At a minimum, students should: (a) use command-line or equivalent diagnostic tools (e.g., ping, traceroute, netstat, simulated equivalents), (b) connect observed behavior to relevant OSI layers to isolate where a problem may be occurring, and (c) document whether issues are due to routine network issues (e.g., latency, packet loss, routing failures) or whether they may indicate security-related events, such as denial-of-service activity or on-path interference. Students should focus on systematic troubleshooting, evidence-based reasoning, and understanding the security implications of network behavior. Students are not expected to have access to system-level permissions or live network monitoring tools. Students are not expected to write diagnostic scripts, perform penetration testing, deploy monitoring infrastructure, or respond to live attacks. Students are not expected to perform operational remediation.
S1-CYB-NO-06	Analyze system processes and network activity using command-line tools to identify potential security concerns.	Students should analyze system or network activity to identify potential security concerns, using a defensive and ethical perspective. At a minimum, students should: (a) explain why systems generate logs (e.g., accountability, troubleshooting, security), (b) identify common indicators of concern in logs or monitoring outputs (e.g., repeated failed logins, unusual process activity, unexpected network connections), and (c) propose appropriate mitigation or response strategies based on observed behavior. Students may examine instructor-provided logs, command outputs, packet summaries, screenshots, or scripted scenarios rather than executing tools directly. When command-line tools (e.g., process listing, system status, network discovery utilities) are used, they should be limited to safe, read-only, defensive contexts within virtualized or sandboxed environments where permitted. Students are not expected to perform vulnerability scanning, penetration testing, password attacks, exploit development, or unauthorized network scanning. Students are not expected to execute powerful tools (e.g., network scanners) on live or unauthorized networks.

S1: Threats & Security Measures

Standard Code	Iowa Academic Standard	Standard Clarification
S1-CYB-TS-07	Analyze how common cyber threats related to network activity exploit system vulnerabilities.	Students should analyze how common cyber threats exploit vulnerabilities in digital systems, with particular attention to network-related examples, and distinguish clearly between threats, vulnerabilities, exploits, and attacks. Students should analyze examples such as spoofing, interception, denial-of-service, or misuse of insecure protocols to articulate: (a) what the threat is, (b) what vulnerability is being targeted, and (c) what impact the attack could have on users or communities. Students should focus on developing conceptual understanding, classification, and explanation. Students are not expected to perform attacks, exploit systems, or simulate adversarial behavior. Students are not expected to use offensive security tools or reproduce attack techniques in any environment.
S1-CYB-TS-08	Evaluate a security threat using the CIA triad, states of data, and types of control.	Students should evaluate common cybersecurity threats based on their impact on the confidentiality, integrity, and availability properties of an information system. Students should evaluate specific, common threat examples (e.g., ransomware, malware, denial-of-service attacks, on-path attacks) using the CIA model and assess: (a) which CIA properties are affected, (b) which data states are impacted (data at rest, in transit, or in use), and (c) which types of security controls (preventive, detective, or corrective) are most relevant. Students should focus on structured reasoning, classification, and explanation. Students are not expected to design security systems, implement controls, or analyze advanced threat models. Students are not expected to select or deploy specific security products or technologies.
S1-CYB-TS-09	Analyze how encryption methods in network communication protect privacy and security.	Students should analyze how symmetric and asymmetric encryption methods support confidentiality, integrity, authentication, and nonrepudiation in digital systems and articulate when encryption is necessary based on context. Students should evaluate established, trusted cryptographic algorithms and libraries. Students should analyze trade-offs associated with encryption, including: (a) performance and computational overhead, (b) key management complexity, and (c) situations where plaintext communication may be acceptable or preferable. Students should understand at a conceptual level that encryption strength varies and that some methods require significantly more computational effort to break than others. Students are not expected to implement cryptographic algorithms, break encryption, or evaluate algorithmic strength mathematically. Students are not expected to analyze the mathematical foundations of cryptographic hardness or assess how advances in computing (e.g., quantum computing) may impact specific algorithms.
S1-CYB-TS-10	Evaluate security measures as part of a layered defense strategy to protect sensitive information.	Students should evaluate common security controls by categorizing them as preventive, detective, or corrective and assessing their use as part of a layered defense strategy. Students should consider security controls across multiple domains (e.g., network security such as firewalls and filtering, application security such as input validation and authentication, device and system security such as updates and access controls, and physical security such as locks and secured locations). Students should understand that no single control is sufficient on its own and that effective cybersecurity relies on multiple, overlapping layers of defense (defense-in-depth). Students should also evaluate trade-offs and constraints associated with security controls, such as ease of use versus strength of protection, cost and complexity, and impact on productivity or accessibility. Students are not expected to configure security tools, deploy AI systems, or implement enterprise-grade defenses. Students are not expected to select or configure specific commercial security products.

S1: Cybersecurity Policies

Standard Code	Iowa Academic Standard	Standard Clarification
S1-CYB-CP-11	Explain the importance of cybersecurity policies in protecting organizational assets and mitigating risks.	Students should explain the purpose of cybersecurity policies and how they translate legal, ethical, and organizational requirements into clear, actionable rules that guide user behavior and protect systems, data, and people. Students should understand the history of cybersecurity policies at a high level, including why formal security policies emerged as computing systems became networked and widely used, how early failures, breaches, and misuse highlighted the need for governance alongside technical controls, and why policy is an essential but often overlooked component of cybersecurity practice. Students should analyze common categories of organizational cybersecurity policies (e.g., acceptable use policies, data classification and handling policies, access control and password policies, incident reporting policies). Students are not expected to draft comprehensive policies or interpret statutes. Students are not expected to evaluate whether specific organizations are in compliance with laws or regulations.
S1-CYB-CP-12	Explain key components of effective security policies.	Students should explain the key components of organizational cybersecurity policies (e.g., purpose and scope, roles and responsibilities, acceptable and unacceptable behaviors, enforcement mechanisms, consequences for violations). Students should describe how these components work together to shape user behavior, organizational security, and accountability. Students should demonstrate understanding of policy structure, its social impact, and ethical trade-offs. Students are not expected to draft full organizational policies or assess legal compliance. Students are not expected to evaluate whether a specific policy meets regulatory requirements or industry standards. Students are not expected to demonstrate legal or administrative expertise.

S1: Professional Practice

Standard Code	Iowa Academic Standard	Standard Clarification
S1-CYB-PP-13	Analyze the potential consequences of cybersecurity decisions on individuals, organizations, and society.	Students should analyze how cybersecurity decisions involve trade-offs between technical effectiveness, human judgment, and societal impact. Students should examine sociotechnical decision-making scenarios in which technical solutions interact with human behavior, organizational values, and ethical considerations (e.g., automated security responses vs. human-in-the-loop decision-making, predictive threat modeling systems that prioritize certain alerts or users, monitoring systems that improve security but raise privacy or surveillance concerns). Students should demonstrate reasoned analysis, ethical evaluation, and understanding of consequences. Students are not expected to build AI systems, deploy automated defenses, or perform real-time security operations.
S1-CYB-PP-14	Analyze social engineering techniques and how they exploit human cognitive biases and organizational weaknesses.	Students should analyze and deconstruct common social engineering techniques used to manipulate individuals into revealing information or performing unsafe actions. Students should examine concrete examples of social engineering (e.g., phishing messages, pretexting scenarios, impersonation attempts), identify persuasion techniques used (e.g., urgency, authority, trust, fear), and explain how these techniques exploit human behavior rather than technical flaws. Students should focus on analysis, recognition, and prevention. Students are not expected to conduct real phishing campaigns, create deceptive content, or exploit others. Students are not expected to design or deploy social engineering techniques.
S1-CYB-PP-15	Translate cybersecurity concepts, risks, and solutions clearly to both technical and nontechnical audiences.	Students should translate technical cybersecurity information into clear, accurate, and actionable communication for nontechnical audiences. Students should identify the intended audience (e.g., executives, users, community members), distill complex technical findings (e.g., vulnerabilities, risks, incidents) into plain language explanations, and highlight implications, recommendations, and next steps appropriate to the audience's role and level of technical knowledge. Students are not expected to produce communications for real external stakeholders or organizations. Students should not rely exclusively on AI-generated text.

S2: Network Theory & Design

Standard Code	Iowa Academic Standard	Standard Clarification
S2-CYB-ND-01	Integrate security features in networking hardware and software.	Students should integrate and configure security features found in networking hardware (e.g., routers, firewalls, access points) and software (e.g., host-based firewalls, intrusion detection systems, server configurations) to establish defense-in-depth. Configuration tasks may include setting up a VPN tunnel on a router, configuring access control lists on a simulated switch or router, and integrating a host-based firewall on a server. For example, students could use virtual network labs or simulation tools to configure firewall policies that allow access to a server only from a specified subnet and require encrypted communication or authentication protocols. Students are not expected to physically manipulate hardware, write custom firmware for network devices, or deploy security solutions on networks with real-time production traffic.
S2-CYB-ND-02	Design a secure network, including servers, switches, routers, endpoints, and firewalls.	Students should plan security features within a network design to detect, analyze, and respond to suspicious or malicious activity, using a defense-in-depth approach. Students may demonstrate this through scaffolded design exercises, such as configuring traffic monitoring or logging mechanisms and articulating the indicators that might signal abnormal behavior, choosing security controls at multiple layers (e.g., network, endpoint, application), and conceptually designing automated responses (e.g., alerting, blocking traffic, isolating compromised components). Students should configure security features appropriately, reason about trade-offs, and explain how design choices improve security rather than pursuing exhaustive implementation. Students are not expected to build fully automated security operations centers, tune AI models, or manage real-time threat response.
S2-CYB-ND-03	Evaluate the security implications of different network topologies.	Students should assess how network topologies affect security, reliability, and resilience, including risks such as single points of failure, redundancy, traffic exposure, and scalability trade-offs. Students should identify potential vulnerabilities in different topologies and justify mitigation strategies, such as segmentation, redundancy, monitoring, and access control, distinguishing between what is inherent to the topology and what is addressed through design. Demonstrations may include diagrams, simulations, case studies, or design documentation. Students are not expected to configure enterprise networks, deploy live AI systems, or perform real-time network management. Students are not expected to implement or test network designs on production infrastructure.

S2: Network Operations

Standard Code	Iowa Academic Standard	Standard Clarification
S2-CYB-NO-04	Analyze network traffic patterns to distinguish between normal and potentially malicious behavior.	Students should analyze network traffic or log data to distinguish normal from potentially malicious behavior using baselines, pattern recognition, and basic threat-analysis frameworks. Students should establish a baseline of typical activity (e.g., protocols, frequency, destinations), compare new data to identify anomalies, and explain how these may indicate threats such as scanning, denial-of-service, or data exfiltration. Students should use high-level threat-analysis frameworks that categorize attacker tactics, techniques, and behaviors to reason about attacks, without requiring deep expertise in any single framework. Students should also articulate how AI tools support analysis (e.g., anomaly detection, behavioral modeling, alert prioritization). Students may use provided datasets, simulations, visualizations, or case studies. Students are not expected to build or train machine learning models, conduct live threat hunting, operate security operations centers, or debate regulatory or legal accountability frameworks in depth.
S2-CYB-NO-05	Analyze cybersecurity tasks to improve efficiency and reliability.	Students should analyze cybersecurity tasks to improve their efficiency and reliability, with an emphasis on secure automation practices (e.g., input validation, error handling, misuse prevention). Students may use approaches such as applying command-line tools with safe parameters to automate routine tasks (e.g., log filtering, system checks), developing simple automation scripts, or analyzing existing scripts and workflows to identify risks such as command injection, unsafe input handling, or excessive permissions. When scripting is used, students should demonstrate secure practices, including validating or constraining user input, handling errors safely, and avoiding hard-coded credentials or unsafe command execution. Students are not expected to write complex programs, build production-grade automation pipelines, perform penetration testing, or assume that scripting languages themselves are "secure." Students are not expected to develop or maintain automation systems for use in operational environments.

S2: Threats & Security Measures

Standard Code	Iowa Academic Standard	Standard Clarification
S2-CYB-TS-06	Design access controls to protect sensitive information.	Students should design authentication and authorization mechanisms that control access to systems, services, and resources and evaluate their effectiveness in different contexts. Students should address common access control approaches (e.g., password-based authentication, multifactor authentication, role-based or attribute-based authorization). Students should consider how access control design choices affect different users, recognizing that some approaches (e.g., multifactor authentication requiring a smartphone) may create barriers for users with different resources, abilities, or contexts. Students are not expected to build biometric systems, deploy enterprise identity platforms, or implement production-grade AI models. Students are not expected to manage real identity infrastructure or administer access control systems for operational environments.
S2-CYB-TS-07	Evaluate security risks to determine appropriate risk management strategies.	Students should evaluate cybersecurity risks and justify appropriate risk management strategies based on likelihood, impact, and context. Students should understand the four primary risk response strategies: risk acceptance (acknowledging and tolerating risk), risk avoidance (eliminating the activity that introduces risk), risk transfer (shifting risk through mechanisms such as insurance or outsourcing), and risk mitigation (reducing likelihood or impact through controls). Students should analyze scenarios to determine which strategy or combination of strategies is most appropriate and explain the trade-offs involved. Students should consider how risk management strategies affect users, recognizing controls that conflict with how people naturally work (e.g., overly complex password policies) may introduce new risks rather than reducing them. Students are not expected to build machine learning models, perform quantitative risk calculations, or deploy enterprise risk platforms. Students are not expected to use formal statistical methods or professional risk assessment tools.
S2-CYB-TS-08	Examine incident response plans and processes for real-world scenarios	Students should examine cybersecurity incidents and apply the phases of the incident response lifecycle (e.g., preparation, detection and analysis, containment, eradication, recovery, post-incident review). Students may demonstrate this by analyzing an existing incident response plan, examining how an organization would respond to a given incident scenario, or modifying a simplified incident response plan appropriate to a defined context. Students are not expected to operate security operations centers, deploy automated response systems, or execute live incident handling. Students are not expected to manage real-time incident response or coordinate across organizational teams during active security events.

S2: Cybersecurity Policies

Standard Code	Iowa Academic Standard	Standard Clarification
S2-CYB-CP-09	Debate how various regulations impact organizational security policies, procedures, and compliance.	Students should evaluate and debate how cybersecurity regulations influence organizational policies, technical practices, and individual rights. This could include critique of different types of security regulations and standards, such as prescriptive, technically specific frameworks (e.g., those that mandate particular controls or technologies) and principles-based or rights-focused regulations that emphasize outcomes and protections rather than specific implementations. Students should assess how organizations interpret and implement these requirements, including compliance trade-offs related to cost, complexity, and operational impact and differences in how regulations apply across industries and data types (e.g., financial, healthcare, public sector). Students are not expected to interpret legal text, ensure compliance, or draft regulatory guidance. Students are not expected to analyze the full text of specific laws or regulations.

S2: Professional Practice

Standard Code	Iowa Academic Standard	Standard Clarification
S2-CYB-PP-10	Analyze the benefits, risks, and ethical implications of AI in cybersecurity.	Students should analyze the dual-use nature of artificial intelligence in cybersecurity, recognizing that the same AI techniques may be used to enhance security defenses or enable more effective attacks. Students should examine issues such as how AI can support defensive applications (e.g., threat detection, anomaly identification, automated response), how AI can also be leveraged maliciously (e.g., attack automation, evasion, deception), and the responsibility of cybersecurity professionals to anticipate misuse, apply safeguards, and make ethical decisions about deployment. Students should compare trade-offs and responsibilities associated with AI use in cybersecurity, including power versus accountability, automation versus human oversight, and innovation versus harm. Students are not expected to build AI systems or conduct offensive cyber operations. Students are not expected to train, fine-tune, or deploy AI models for security applications.
S2-CYB-PP-11	Analyze cybersecurity vulnerabilities and incidents to inform responsible disclosure practices.	Students should examine incidents and vulnerabilities to inform disclosure practices, including coordinated disclosure processes that balance public safety, organizational responsibility, and ethical considerations. Students should examine the purpose and structure of responsible disclosure and coordinated vulnerability disclosure, the role of bug bounty programs in the cybersecurity ecosystem, and common failure modes such as premature disclosure, failure to address reported vulnerabilities, and the legal or ethical consequences of improper handling. Students are not expected to exploit real systems, bypass safeguards, or test vulnerabilities on live infrastructure. Students are not expected to participate in actual bug bounty programs or submit vulnerability reports to real organizations.
S2-CYB-PP-12	Create documentation of cybersecurity processes and decisions that supports team coordination and accountability.	Students should create and maintain clear cybersecurity documentation that supports accountability, team coordination, and informed decision-making during security operations. Documentation may include artifacts such as incident response playbooks, security decision logs, risk assessment summaries, and change management or post-incident reports. Students are not expected to operate live security systems, manage enterprise documentation platforms, or respond to real cyber incidents. Students are not expected to produce documentation for use in actual operational environments.

Game Development

S1: Design & Development

Standard Code	Iowa Academic Standard	Standard Clarification
S1-GMD-DD-01	Analyze the fundamental components of games, including players, rules, game mechanics, and outcomes.	Students should analyze the core components of simple games, including player roles, available actions, game rules that govern play, win/loss conditions, and how game state changes based on player actions. Students should represent these components using appropriate models (e.g., state diagrams, flowcharts, rule tables). For example, students analyzing a simple card game could document the initial setup, the legal moves on each turn, how card plays affect game state, and the conditions that end the game. Students are not expected to analyze complex games with extensive rule sets, probabilistic elements, or real-time mechanics that would require sophisticated implementation techniques.
S1-GMD-DD-02	Create a storyboard to plan and communicate game narratives and interactive experiences.	Students should create storyboards that visually outline the narrative flow and interactive elements of a game. Their storyboards should illustrate key scenes, player choices, decision points, and how the game responds to those choices. Storyboards should use simple sketches and annotations to clarify on-screen actions, intended player interactions, and the emotions or reactions the designer wants to evoke. Students should focus on using storyboards as a planning and communication tool. Basic, low-fidelity sketches that clearly convey the game's structure and interactivity are sufficient. Students are not expected to create polished or artistically detailed drawings or depict every possible branching path.
S1-GMD-DD-03	Develop an interactive experience to support gameplay.	Students should develop interactive functions that combine to create a playable gameplay experience, such as responding to player input, updating game state, providing feedback, or determining outcomes. At a minimum, the gameplay experience should include: (a) player input that affects the system (e.g., movement, selection, timing), (b) programmatic responses to that input (e.g., state changes, scoring, feedback), and (c) clear conditions that influence progression or outcomes (e.g., win/lose states, level changes, time-based events). Students should design interactions that give players meaningful feedback and a sense of agency over outcomes. Students should demonstrate how individual interactive functions work together to produce gameplay, rather than existing as isolated features. Students are not expected to create complete commercial games, advanced user interfaces, complex narratives, or polished visual assets. Students are not expected to produce production-quality output.
S1-GMD-DD-04	Adapt rule-based logic to improve control of game agents or systems.	Students should evaluate and adapt existing rule-based logic that governs the behavior of an in-game agent or system, such as a character, an object, the environment, or a game mechanic. Adaptations should focus on increasing conditional complexity, such as adding additional decision branches, combining conditions, or refining thresholds that affect behavior. Students should validate how changes to conditional logic impact game behavior, challenge, or player experience. For example, students might adapt the logic controlling a moving obstacle, scoring system, interactive object, or nonplayer character by adding new conditions that respond to player actions, game state, or time. Students are not expected to design artificial intelligence systems, implement learning or adaptive algorithms, or formally evaluate algorithmic efficiency.

S1: Player Experience

Standard Code	Iowa Academic Standard	Standard Clarification
S1-GMD-PX-05	Create a user-friendly interface for a game, considering usability, and aesthetics.	Students should design a user interface and gameplay presentation that supports usability, accessibility, and aesthetic coherence within a game or interactive experience. Design decisions should address a small, clear set of criteria, such as: (a) readability (e.g., legible text, clear visual hierarchy), (b) consistency (e.g., icons, controls, feedback behaving predictably), (c) color contrast or visual clarity, and (d) at least one accessibility consideration (e.g., adjustable text size, alternative input options, remappable controls, simplified interaction modes). Examples of accessibility features are illustrative, not exhaustive, and students may select options appropriate to their game type, audience, and toolset. Students are not expected to implement comprehensive accessibility compliance standards, conduct formal usability audits, or design professional-grade interfaces.
S1-GMD-PX-06	Optimize basic game usability through user testing and identifying actionable design revisions.	Students should optimize game usability by conducting basic user tests. They should collect observable usability data by watching users interact with a game or an interactive system and identifying how design choices affect user experience. At a minimum, evidence of usability testing should include: (a) observation of at least two users interacting with the system, (b) two to three key user flows or interactions (e.g., starting the game, completing a task, responding to feedback), and (c) a short list of observed friction points, such as confusion, errors, delays, or unintended behavior. Students should use their observations to suggest or implement simple design improvements based on identified issues. Students are not expected to conduct formal usability studies, collect large datasets, apply statistical analysis, or use professional testing tools.

S1: Architecture

Standard Code	Iowa Academic Standard	Standard Clarification
S1-GMD-AR-07	Examine the key architectural features of computing hardware and their implications for game development.	Students should examine how major computing system components influence game performance and player experience, including processing, graphics, input, audio, memory, and networking at a conceptual level. Students should examine how different hardware and software components contribute to gameplay outcomes, such as frame rate, responsiveness, visual quality, and input latency. Graphics processing units (GPUs) may be introduced as one example of specialized hardware that supports parallel processing for rendering, but they are not the sole focus. Students are not expected to analyze low-level hardware specifications, compare specific devices, optimize code for particular platforms, or work with high-end or professional gaming hardware. Students are not expected to demonstrate detailed technical knowledge of hardware internals.

S1: Professional Practice

Standard Code	Iowa Academic Standard	Standard Clarification
S1-GMD-PP-08	Analyze the ethical implications of copyright and intellectual property in game development.	Students should analyze ethical considerations related to intellectual property, attribution, accessibility, and user well-being in game development by applying a clear, concrete framework. At a minimum, students should: (a) select and apply an appropriate license or usage model (e.g., Creative Commons, public domain, original work), (b) properly attribute assets or code used in their project, and (c) articulate how their choices respect creators' rights and player communities. Students might also examine at a conceptual level how distribution platforms, marketplaces, or publishing environments can impact creator rights, ownership, or control. Students are not expected to provide legal analysis or interpret copyright law.
S1-GMD-PP-09	Develop game projects collaboratively within teams.	Students should develop game projects collaboratively. They should effectively collaborate on a game project by communicating design ideas, sharing responsibilities, and reflecting on how design choices may affect different player communities. Students should use appropriate tools and methods (e.g., shared documents, version tracking, task boards) to organize tasks and coordinate contributions across the team. Students should engage in guided discussion or reflection on how historical or contemporary game design practices have impacted game popularity and play. Students are not expected to control team composition or resolve complex social issues.

S2: Design & Development

Standard Code	Iowa Academic Standard	Standard Clarification
S2-GMD-DD-01	Justify the use of responsible design principles in developing engaging, meaningful game experiences.	Students should, in the context of a game development project, apply and justify at least two responsible design choices. Students justify each design choice by explaining how it affects player experience, behavior, and demonstrate how these choices are integrated into the gameplay or interaction design rather than added as afterthoughts. For example, students might design a game for a specific audience that includes adjustable difficulty and visual accessibility settings and assess how those features support player engagement and fairness. Students are not expected to conduct formal user research studies, implement every category of responsible design, or build professional-grade analytics, monetization, or production pipelines.
S2-GMD-DD-02	Develop systems that programmatically control 2D or 3D animation states based on game logic and player interactions.	Students should develop systems to programmatically control existing animation states in a 2D or 3D game environment to reflect character actions, game events, or system states. This includes triggering, switching, or blending between predefined animations based on conditions, input, or game state. At a minimum, students should develop and demonstrate: (a) two or more animation states (e.g., Idle, Run, Jump, Attack), and (b) explicit logic or conditions that control transitions between those states. For 2D games, animation control may involve frame-based sequences or sprite states. For 3D games, animation control may involve state machines, animation blending, or parameter-driven transitions. Students are not expected to design original animations, apply artistic animation principles (e.g., squash and stretch, anticipation), or use professional animation tools.
S2-GMD-DD-03	Construct in-game artificial intelligence to control NPC behavior.	Students should construct rule-based in-game intelligence to control NPC behavior, using explicit logic structures rather than learning or adaptive algorithms. At a minimum, the constructed behavior should include: (a) two or more distinct states or behaviors (e.g., idle, patrol, chase, evade), and (b) at least one explicit transition condition that determines when the NPC changes from one state or behavior to another (e.g., player proximity, health level, timer, game state). Students should articulate how states, transitions, and conditions work together to produce responsive and believable NPC behavior and demonstrate how changes to logic affect gameplay or player experience. Students are not expected to implement machine learning, neural networks, pathfinding optimization, probabilistic reasoning, or adaptive systems that learn from player behavior. Students are not expected to go beyond deterministic, rule-based decision-making.

S2: Player Experience

Standard Code	Iowa Academic Standard	Standard Clarification
S2-GMD-PX-04	Evaluate game interactions using diverse input devices to enhance immersion and player experience.	Students should evaluate player immersion by analyzing how specific design elements influence player attention, feedback, and engagement within a game experience. Evaluation should reference at least two concrete immersion factors, such as: (a) consistency of game rules and mechanics (e.g., predictable cause-and-effect), (b) responsiveness and feedback (e.g., timely visual, audio, score-based responses), (c) alignment between player actions and system outcomes, (d) clarity of goals, progress indicators, or challenge pacing, or (e) how different input devices (e.g., keyboard and mouse, game controller, motion controls) affect player comfort and accuracy. Students should support their evaluation using observable evidence, such as gameplay scenarios, comparisons of design alternatives, playtesting observations, or documented design revisions. Students are not expected to conduct formal user experience research, apply psychological immersion models, or quantify engagement using analytics platforms. Students are not expected to evaluate every possible input device or build custom input hardware.
S2-GMD-PX-05	Evaluate two versions of a game using defined metrics to determine which performs better.	Students should use comparative usability methods to evaluate and refine game designs by critiquing two or more design alternatives that differ in a specific, intentional way (e.g., control scheme, feedback style, difficulty pacing, interface layout). Evaluation should build on prior usability testing concepts and be grounded in qualitative or simple quantitative evidence, such as: (a) observed user behavior during gameplay, (b) structured user feedback or reflection, (c) counts of successful or unsuccessful interactions (e.g., level completion, errors, retries), or (d) documented friction points or player confusion. Students should justify which version better supports the intended player experience based on this evidence and explain how the findings informed design revisions. Students are not expected to conduct formal experiments, apply statistical analysis, or implement industry-specific testing techniques such as full A/B testing pipelines. Students are not expected to use professional analytics tools or recruit participants beyond their peer group.

S2: Architecture

Standard Code	Iowa Academic Standard	Standard Clarification
S2-GMD-AR-06	Analyze game system architectures that support scalability, maintainability, and performance.	Students should analyze architectural design principles of game systems to examine issues of scalability, maintainability, and performance. This includes reasoning about modular design, separation of concerns, interfaces between systems, and dependency management within a game. Students should analyze how architectural decisions affect: (a) system complexity, (b) ease of iteration or expansion, (c) performance across platforms (e.g., desktop, mobile, web), and (d) player experience. Examples may include separating input handling from gameplay logic, organizing rendering, audio, and networking systems, or designing game components that can be reused or extended. Students may examine hardware considerations (e.g., GPUs or cloud-based execution) as they relate to architectural trade-offs. Students are not expected to implement changes to improve scalability, maintainability, or performance. Students do not need to consider engine-level optimizations, manage distributed infrastructure, or perform detailed performance benchmarking. Students are not expected to implement hardware-specific optimizations or treat hardware considerations as implementation requirements.

S2: Professional Practice

Standard Code	Iowa Academic Standard	Standard Clarification
S2-GMD-PP-07	Create games utilizing ethical principles in the design and development process.	Students should create a game project or prototype using ethical design principles and building on foundational ethical awareness. Students should select a focused subset of ethical considerations and articulate how those principles informed specific design decisions. Students should integrate ethical reasoning into their design process rather than treating it as a standalone add-on. The project may be a prototype, vertical slice, or partial implementation, depending on instructional context. Students should provide written or verbal justification explaining how their design choices address the selected ethical principles. Students are not expected to implement every ethical domain, build fully polished games, or conduct formal ethics audits.
S2-GMD-PP-08	Collaborate effectively in a project team by defining and executing assigned roles, communicating clearly, and managing shared resources to deliver a game project.	Students should develop a game project in a collaborative team environment by communicating effectively, managing their assigned roles and responsibilities, and contributing to shared decision-making. Students should listen to and integrate teammates' ideas, work through disagreements constructively, and be willing to contribute outside their primary expertise when it benefits the team. For example, a student who prefers coding might help brainstorm art concepts with a teammate who is more visually inclined, demonstrating willingness to engage with different aspects of game development to support the team's goals. Students are not expected to use formal project management methodologies or maintain perfect team dynamics throughout the project.

Physical Computing

S1: Hardware & Circuit Design

Standard Code	Iowa Academic Standard	Standard Clarification
S1-PHY-HC-01	Construct an electrical circuit to power and control physical computing devices.	Students should create and troubleshoot a simple electrical circuit that powers and controls physical computing devices, with the aid of schematic diagrams. For example, students could build a circuit with a microcontroller, a resistor, and an LED, use a multimeter to check voltage and current, draw a corresponding schematic diagram, and troubleshoot if the LED doesn't light as expected by checking for loose connections or incorrect component orientation. Students are not expected to design circuits with multiple integrated circuits or design and etch custom-printed circuit boards.

S1: Inputs & Outputs

Standard Code	Iowa Academic Standard	Standard Clarification
S1-PHY-IO-02	Integrate sensors, actuators, and peripherals into physical computing systems.	Students should select, connect, and program sensors and outputs to enable physical computing systems to respond to real-world data. Outputs may include lights, sound, displays, wearables, environmental indicators, or simple mechanical motion. Students are not expected to integrate large numbers of components, use industrial-grade hardware, manage complex wiring or power requirements, or build systems for mission-critical use.

S1: Design & Development

Standard Code	Iowa Academic Standard	Standard Clarification
S1-PHY-DD-03	Develop software to control physical devices using iterative design processes.	Students should iteratively design and develop programs that directly control physical system behavior, such as reading sensor input, activating outputs, or changing system states. Programming may be implemented using block-based, hybrid, or text-based environments, with emphasis on the observable connection between code and physical behavior. Students are not expected to fabricate hardware, implement complex algorithms, or use professional embedded development environments.

S1: Connectivity & Internet of Things

Standard Code	Iowa Academic Standard	Standard Clarification
S1-PHY-CI-04	Use IoT devices to collect sensor data and transmit it locally using device-to-device or device-to-gateway communication.	Students should use IoT devices to collect and transmit sensor data wirelessly using local communication methods, such as device-to-device or device-to-gateway communication. Evidence of learning should demonstrate meaningful use of transmitted data, such as visualization, logging, or influencing system behavior, not merely establishing a connection. Students are not expected to configure cloud services, manage servers, rely on school Wi-Fi access, or implement custom communication protocols.
S1-PHY-CI-05	Implement IoT communication by connecting physical devices with protocols, applying security practices.	Students should deploy multiple connected devices to share data or actions within a system. Communication methods may include serial, radio, Bluetooth, Wi-Fi, or low-power wide-area networking (e.g., LoRa-type systems) where available. Students should investigate basic trade-offs, such as range, data size, latency, or power use. Students are not expected to design networking infrastructure, optimize performance, or deploy large-scale IoT systems.

S1: Professional Practice

Standard Code	Iowa Academic Standard	Standard Clarification
S1-PHY-PP-06	Use a version control system to coordinate development in physical computing projects.	Students should use a version control system to manage and coordinate code development when collaborating on physical computing projects. Students should create branches for different features or components, commit changes with descriptive messages, merge contributions from team members, and resolve basic merge conflicts. Students should understand how source control enables collaborative work by tracking who made what changes and allowing team members to work on different parts of the project simultaneously. For example, a team building a weather station could use a source control system to manage separate branches for sensor data collection code and display control code, with each team member committing their work and the team merging contributions into a main branch to create the integrated system. Students are not expected to set up and administer repository servers or hosting platforms. Students are not expected to resolve complex merge conflicts involving extensive code changes across many files. Students are not expected to use advanced features like rebasing, cherry-picking, or managing complex branching strategies.
S1-PHY-PP-07	Evaluate social, technical, and sociotechnical impacts of physical computing projects.	Students should assess ethical or social impacts) of a physical computing system. Evaluation should be grounded in a specific system and should reference design decisions. Students are not expected to conduct comprehensive global impact analyses, perform policy evaluations, or address all ethical dimensions simultaneously. Broader global or systemic impacts may be introduced as aspirational extensions, not required outcomes.
S1-PHY-PP-08	Evaluate the security implications of physical computing projects, including data privacy, unauthorized access, and potential vulnerabilities.	Students should evaluate security threats and vulnerabilities specific to physical computing devices. Students should assess how physical access to a device can lead to security breaches and how to protect against them. For example, students might evaluate security measures like strong authentication (e.g., using a keypad and unique PIN), data encryption for communication between device and servers, and physical safeguards to prevent tampering. Students are not expected to perform penetration testing or conduct systematic security audits.

S2: Hardware & Circuit Design

Standard Code	Iowa Academic Standard	Standard Clarification
S2-PHY-HC-01	Develop an electromechanical system using CAD tools for design and testing.	Students should design and refine complex physical computing systems using Computer Aided Design (CAD) software. Complex systems integrate multiple inputs, outputs, and behaviors to meet defined goals. For example, students could design and build a system that integrates mechanical components (e.g., motors, actuators, structural elements) with electrical components. They could use CAD software to model and refine their designs. Students could design a robotic arm that picks up and moves objects, using CAD software to design and simulate the arm's mechanical structure before building it. Students are not expected to master advanced electronics theory or industrial automation practices.

S2: Inputs & Outputs

Standard Code	Iowa Academic Standard	Standard Clarification
S2-PHY-IO-02	Design a closed-loop feedback control system to meet a desired outcome using varying sensor types.	Students should develop a closed-loop system selecting from various sensor options to implement system behavior meeting a desired outcome. Closed-loop feedback may be conceptual, simulated, or partially implemented, depending on instructional context. Students should assess trade-offs (accuracy, responsiveness, cost, and constraints) during design. Students are not expected to design or deploy fully optimized control systems, implement complex control algorithms, perform exhaustive quantitative analyses across multiple sensor dimensions, or build systems requiring specialized hardware, industrial-grade components, or mission-critical reliability.

S2: Design & Development

Standard Code	Iowa Academic Standard	Standard Clarification
S2-PHY-DD-03	Develop an application that extends functionality and user engagement with physical devices.	Students should develop applications that extend how users interact with physical systems, such as configuration options, feedback displays, data-informed behavior, or app-connected interaction. Students should focus on clarity of design, user interaction, and purposeful extension of functionality. Students are not expected to implement fully autonomous systems, advanced control algorithms, multilayer feedback architectures, or professional-grade embedded software pipelines.

S2: Connectivity & Internet of Things

Standard Code	Iowa Academic Standard	Standard Clarification
S2-PHY-CI-04	Develop IoT systems to manage the collection and transmission of data and enable remote monitoring and control of physical systems.	Students should develop IoT systems that transmit, receive, and use data across connected physical devices, using communication structures appropriate to the application. Connectivity may be local or extended, and students should justify communication choices based on range, latency, data size, power use, or reliability. Systems may be conceptual, simulated, or implemented, depending on instructional context. Students are not expected to deploy enterprise-scale IoT platforms or manage persistent cloud infrastructure.
S2-PHY-CI-05	Develop an embedded network, evaluating trade-offs among network protocols, security measures, and scalability.	Students should coordinate data from multiple physical devices using centralized or distributed approaches. Central coordination might be implemented using a local computer, single-board device, or simple script. Students might design simple communication protocols and reason about message structure and flow. Communication might be simulated or implemented, depending on instructional context. Students should connect networking and security concepts to physical system behavior. Students are not required to use cloud servers or web services. Students are not expected to implement advanced cryptographic protocols, perform detailed packet-level analysis, configure enterprise security systems, or master low-level networking theory.

S2: Professional Practice

Standard Code	Iowa Academic Standard	Standard Clarification
S2-PHY-PP-06	Apply project management methodologies to design, develop, and test physical computing projects collaboratively.	Students should apply project management methodologies (e.g., agile frameworks) to collaboratively manage a physical computing project from conception through delivery. They should share responsibilities, resolve conflicts equitably, and communicate progress and outcomes. For example, students might use a Kanban board to track tasks (e.g., prototyping, circuit design, programming the microcontroller, user testing) and hold regular stand-up meetings to discuss progress and resolve issues. Students are not expected to use professional project management software or lead projects with multiple teams and external stakeholders.
S2-PHY-PP-07	Evaluate how physical computing technologies affect social processes, communities, power, and people's experience in global society.	Students should evaluate how physical computing systems shape social, technical, and human outcomes through specific design decisions in their projects. Students might conduct small-scale, local research (e.g., surveys, interviews, observations) to identify relevant problems. Evaluation should focus on one or two impact dimensions and include a clear viability criterion such as cost, usability, or maintenance. Students are not expected to conduct formal sociological studies or global policy analysis.
S2-PHY-PP-08	Develop physical computing solutions for all potential users using the engineering design process.	Students should develop physical computing solutions using the engineering design process to plan, build, test, and refine a physical computing project. The process should be evidenced through design sketches, written plans, testing notes, and reflections tied directly to technical decisions. Students should demonstrate an awareness of the needs of all potential users and address them in the design process. Students are not expected to follow formal project management frameworks or use professional version control systems.

Software Development

S1: Design & Development

Standard Code	Iowa Academic Standard	Standard Clarification
S1-SWD-DD-01	Implement linear data structures to organize and access collections of data when solving computational problems.	Students should select appropriate linear data structures to store and manage data to solve a computational problem. Students should use arrays for fixed-size collections accessed by position, dynamic arrays (lists) for collections that grow or shrink, linked lists for efficient insertion and deletion, stacks for last-in-first-out access, and queues for first-in-first-out access. For example, students could use a dynamic array to store temperature readings collected over time, a stack to implement an undo feature in an application, or a queue to manage print jobs in the order they were submitted. Students should use built-in APIs or libraries and their associated methods. Students are not expected to implement these data structures or their operations (e.g., insert, delete, search) from scratch. Students are not expected to use dictionaries, trees, graphs, or heaps.
S1-SWD-DD-02	Design software that accounts for complexity through abstraction.	Students should apply design principles that promote maintainable and extensible software. Students should make intentional decisions about program structure, data organization, and relationships between components. They should consider how their software will handle growth (e.g., more users, more data, more features) and apply abstraction (e.g., data abstractions, procedural abstraction, recursion, object-oriented abstraction) to manage complexity. For example, students could design a social media application that organizes data efficiently to support adding more users and posts without rewriting core functionality. Students are not expected to handle scalability challenges requiring specialized infrastructure (e.g., multiple servers, distributed databases). Students are not expected to perform algorithm complexity analysis or optimize code for speed and memory usage.
S1-SWD-DD-03	Use integrated development environment (IDE) features to streamline software development, including code editing, debugging, version control, and project management.	Students should use the core features of an IDE to increase their efficiency and effectiveness in developing software. This includes utilizing the IDE's built-in tools for syntax highlighting, autocomplete, and real-time error detection while writing code. Students should use the integrated debugger to set breakpoints, step through code, and inspect variables to diagnose and fix logical errors. Students should also be able to interact with a version control system directly within the IDE to manage changes to their code, commit new versions, and collaborate on projects. Students should also use the IDE's project management features, such as organizing files and folders and managing dependencies, to maintain a structured project. Students are not expected to deeply understand the underlying mechanisms of these tools (e.g., how the debugger works at a machine level), set up complex IDE configurations from scratch, or configure custom build processes.

S1: User Experience

Standard Code	Iowa Academic Standard	Standard Clarification
S1-SWD-UX-04	Refine a user interface design using accessibility and responsive design tools.	Students should evaluate the effectiveness of user interface design choices in a digital product based on established principles such as contrast, alignment, proximity, and readability. For example, students could analyze a mobile app's user interface using an accessibility design tool and provide a written critique of how element alignment and color contrast affect readability for users with low vision. Students are not expected to design graphics, nor are they expected to create design systems that specify detailed guidelines for all visual and interaction elements across a product.
S1-SWD-UX-05	Create software that serves intended users and contexts using human-centered design principles.	Students should conduct heuristic reviews (i.e., systematic evaluations against established design criteria such as usability, consistency, accessibility, and user control) to assess how well the software serves all potential users, including variations in ability, language, and cultural context. Students should use these evaluations to inform design decisions and recommendations. Students are not expected to conduct user testing or collect feedback from actual users. Students are not expected to create accessibility solutions beyond applying established guidelines (e.g., Web Content Accessibility Guidelines [WCAG]).

S1: Testing & Refining

Standard Code	Iowa Academic Standard	Standard Clarification
S1-SWD-TR-06	Use AI-assisted IDE tools or features to understand unfamiliar code and identify errors during debugging.	Students should use AI-assisted IDE tools or features for code comprehension and debugging tasks. This includes generating code summaries and documentation to understand unfamiliar or legacy code and using intelligent code completion, error detection, and refactoring suggestions during debugging. For example, students could use AI assistance to generate a summary explaining an unfamiliar function's purpose, inputs, and outputs before fixing a bug. Students should apply existing, commercially available, or open-source AI IDE features. Students are not expected to manually configure or fine-tune the underlying machine learning models within the IDE (e.g., modifying the weights or architecture of the code-generation transformer model), integrate external non-IDE-based AI tools, or develop custom AI extensions for their IDE.
S1-SWD-TR-07	Design a test plan that exercises program functionality, including edge cases, error conditions, and varied user inputs	Students should create thorough and systematic test cases from both human and AI-generated sources. The plan should include a variety of test case types, such as unit tests and integration tests. Tests should cover valid input, edge cases, error conditions, user inputs, and other scenarios based on software use cases. Students should apply test cases systematically to a software project involving multiple functions and data structures. Students are not expected to implement automated testing frameworks or manage quality assurance processes for large systems, nor to perform adversarial security testing (e.g., penetration testing). They are also not expected to design, train, or modify any underlying machine learning models used to generate AI test case recommendations.

S1: Professional Practice

Standard Code	Iowa Academic Standard	Standard Clarification
S1-SWD-PP-08	Collaborate to develop software that reflects a range of perspectives.	Students should work in teams on a shared software project, with team members contributing to different components. They should use version control tools to manage workflows, including branching, reviewing code, resolving merge conflicts, and integrating work through pull requests. Teams should establish norms that actively incorporate a range of perspectives on code design, user experience, and ethical considerations, including respecting intellectual property through appropriate attribution, licensing, and responsible reuse of code and media. For example, students might develop a multi-module program using version control, where pull requests are reviewed not only for technical quality but also for usability and ethical implications, ensuring that insights drawn from varied areas of expertise (e.g., user communities, UI design, accessibility, data privacy) inform final decisions. Students are not expected to administer version control servers, manage repository security policies, or integrate version control with continuous integration/continuous deployment pipelines.

S2: Design & Development

Standard Code	Iowa Academic Standard	Standard Clarification
S2-SWD-DD-01	Apply associative and hierarchical data structures to solve computational problems.	Students should select and apply appropriate associative and hierarchical data structures including dictionaries (hash tables), trees, graphs, and heaps to solve computational problems. Students should use built-in or library implementations and their associated methods. Students should use dictionaries for efficient key-value lookups, trees for hierarchical data or ordered collections, graphs for modeling networks and relationships, and heaps for priority-based access. Students should explain relative efficiency trade-offs in practical terms (e.g., which operations are faster, which use less memory). For example, students might use a graph structure to find the shortest path in a navigation app, a dictionary to quickly look up student records by ID, or a tree to organize a file system hierarchy. Students are not expected to implement these data structures or their operations from scratch. Students are not expected to use Big O notation to express time and space complexity.
S2-SWD-DD-02	Develop a prototype using multiple user personas and user journey maps to guide design decisions.	Students should create user personas and user journey maps to guide ideation and prototyping and justify design decisions. User personas represent different types of users and their characteristics, needs, and goals. User journey maps visualize how users interact with a product from initial contact through achieving their goals, highlighting pain points and opportunities for improvement. For example, when designing an educational app, students might create personas representing different user types (e.g., a student with a learning disability, a highly motivated student, a parent) and develop user journey maps for each persona to ensure the design addresses all potential needs. Students are not expected to conduct market research to validate personas or produce fully functional applications.
S2-SWD-DD-03	Develop a project in iterative cycles, documenting changes and the rationale for each cycle.	Students should develop a software project using an iterative process. This includes breaking the project into multiple distinct cycles of planning, implementation, testing, review, and documentation that continuously refine and build project features. Students should document each cycle with a clear record of changes made and the reasoning behind them (e.g., bug fix, new feature, response to user feedback). For example, in one cycle a student might build a basic user login system, in the next cycle add a user profile feature, and in a third cycle implement a search function. Students are not expected to use formal, complex project management methodologies like Agile or Scrum and their specific ceremonies (e.g., daily stand-ups, sprint retrospectives).
S2-SWD-DD-04	Modify an existing algorithm to improve efficiency, considering factors such as data structures and algorithmic paradigms.	Students should identify opportunities to improve efficiency in terms of time or space complexity in algorithms. This involves understanding how different data structures (e.g., arrays, dictionaries, trees) impact performance and selecting a more suitable one. Students should apply algorithmic paradigms (e.g., divide and conquer) to break a problem into smaller subproblems. Students should use this information to modify and optimize existing solutions, measuring performance. For example, a student might improve a linear search algorithm for a large, sorted dataset by using a more efficient data structure and applying binary search. Students are not expected to invent new algorithmic paradigms.

S2: User Experience

Standard Code	Iowa Academic Standard	Standard Clarification
S2-SWD-UX-05	Evaluate the user experience to improve usability.	Students should conduct usability evaluations on digital interfaces by observing user interactions, collecting qualitative and quantitative feedback, and documenting findings in a structured format. For example, students could create a user survey or think-aloud protocol to test a peer's program or a real-world app and compile a report outlining specific usability issues (e.g., confusing navigation, inaccessible features). Students are not expected to obtain research ethics approval, recruit participants from outside of their peer group, or use specialized usability testing tools (e.g., eye-tracking software). Students are not expected to perform statistical analysis beyond calculating basic descriptive statistics for survey questions (e.g., average ratings, distribution of responses to Likert-type items).
S2-SWD-UX-06	Create user-friendly, accessible, and responsively designed interfaces.	Students should create user interfaces for digital products that are usable, accessible, and responsive across different devices and screen sizes by applying UI design principles and tools. For example, students could develop a web application that adapts its layout and functionality to be effective on smartphones, tablets, and desktop computers, ensuring that elements are navigable and legible for users with different needs. Students are not expected to create applications that function on every possible device and operating system or master responsive design frameworks.

S2: Testing & Refining

Standard Code	Iowa Academic Standard	Standard Clarification
S2-SWD-TR-07	Use IDE tools to test and refine complex software projects.	Students should use IDE tools and features, including AI-assistive tools, to enhance the testing and refinement phases of a complex software project. This includes features for automated test generation (e.g., unit test boilerplate, test cases), identifying redundant or inefficient tests and receiving real-time suggestions for code optimization and performance improvements during the refinement phase. Students could write a new class, use an AI tool to generate a basic suite of unit tests for it, review and critique the generated tests for test coverage, and then accept the IDE's AI-driven recommendation to refactor a slow loop into a more performant structure. Students are not expected to perform deep-dive performance profiling, interpret low-level hardware performance counters, or manually implement complex statistical analysis of test results derived from large-scale, enterprise-level performance testing tools. The "complex software project" should remain within the scope of advanced high school application development (e.g., multi-module, multifile application with external libraries).
S2-SWD-TR-08	Debug complex software projects to identify, isolate, and fix errors.	Students should systematically apply formal debugging methodologies (e.g., divide and conquer, binary search, backtracking) to software projects involving multiple files, libraries, and external dependencies. This includes using advanced IDE debugger tools and features such as AI-assisted debuggers, setting conditional breakpoints, inspecting the call stack and watch window for complex data structures, and remote debugging. For example, students could debug a multi-module program with a subtle bug by reproducing the error, isolating the fault by tracing state changes across functions, and then implementing a fix. Students should focus on logical program errors. Students are not expected to debug at the operating system level, such as analyzing assembly code, directly manipulating memory registers, or performing post-mortem memory dump analysis for errors in production operating systems or hardware drivers.

S2: Professional Practice

Standard Code	Iowa Academic Standard	Standard Clarification
S2-SWD-PP-09	Apply industry-standard software development processes to plan and deliver projects while prioritizing responsible outcomes.	Students should select and apply an industry-standard software development process (e.g., Agile Scrum, Kanban, Waterfall) to a medium- to large-scale project. Students should effectively use project-management tools to manage tasks, track progress, and communicate with team members. Students should demonstrate that responsible outcomes take priority over technical or budgetary pressures and articulate and justify project modifications . For example, a student team could adjust a project timeline and scope to prioritize features that improve accessibility for users with disabilities or mitigate algorithmic bias, even if it delays the release or requires refactoring complex code. Students should engage in development projects of appropriate complexity for high school, with a focus on applying sound processes and prioritizing ethical considerations. Students are not expected to manage the budget or financial resources of the project, use advanced proprietary or enterprise-level project management software, or manage external stakeholders beyond their classroom or school environment.

Artificial Intelligence

Artificial Intelligence (AI) refers to machine-based systems capable of performing tasks that typically require human intelligence, such as learning, reasoning, problem-solving and decision-making. AI utilizes large datasets and advanced algorithms to analyze information and generate predictions, recommendations or decisions. These systems rely on human-defined objectives and can influence both real and virtual environments. While they can act on their own, they're still guided by goals and objectives defined by humans.

Over the last few years, generative AI has grown faster than anyone expected. The release of ChatGPT in 2022 marked a turning point, quickly changing how people learn and work. Since then, generative AI has continued to evolve, with agentic AI quickly developing and driving new shifts. As new emerging technologies (like quantum computing) continue to expand and develop, they will continue to increase the power and scope of AI and its impact on society.

Iowa's AI standards are informed by the AI4K12 learning progressions, the AI learning priorities for all K-12 students and the AI literacy frameworks from both TeachAI and Digital Promise. These publications were heavily researched by experts from across the country and served as a foundation for our committee to create AI standards that meet the needs of Iowa students.

Since AI cannot exist without computer science, AI standards are a subset of the computer science standards. In addition to standards about how AI systems are created and function, there are broader digital literacy standards essential for living in a world where AI can create anything.

The K-12 AI standards are divided into five concept areas:

- Perception.
- Natural Interaction.
- Learning.
- Representation & Reasoning.
- Societal Impact.

Each of these areas contain smaller sub-concepts that, when combined, help students form a more complete understanding of the larger idea. In addition to these foundational areas, specialty standards support more advanced learning for students who are interested in going beyond the basics. Specialty standards help teachers plan more advanced AI courses to help students progress along AI career pathways.

Artificial Intelligence Concepts & Subconcepts

Perception (PC)

Perception is the process of extracting meaning from sensory signals. Similarly to how humans perceive the world around them through their senses, process that information and classify it to make decisions and react, AI systems perceive information through sensors, process it and classify it according to the existing data set to create a solution.

Sensing (SN)

In order to understand how AI and computing technologies sense data, students must first understand how humans and other living things perceive data. This begins at the early grades as students understand our senses and compare them to how computing technologies perceive information from the outside world. In the middle grades, students understand how information is combined and represented in the both human world and technologically. In high school students explore how computer sensors work and their limitations.

Processing (PR)

The standards in Processing are aimed at helping students understand how the information brought in from our sensors (whether technological or living) is turned into meaningful information. Students learn how visual, audio information is processed focusing on humans in the early grades to a deeper understanding of the process in algorithms and computing technologies in the upper grades.

Domain Knowledge (DK)
Domain Knowledge fills the gap between processing the data and finding patterns and making sense of meaning or context. In the early grades, this means understanding what a system must know to make sense of a question to classify images based on their content in the middle grades, and analyzing data sets at the high school level.

Natural Interaction (NI)

For AI systems to interact naturally with humans, they must be able to draw on human languages, recognize facial expressions and emotions, and understand cultural and social cues. First students must understand the nuances of human language and communication and then apply that understanding to computing systems, determining what the system would need to know to interact successfully and where there could be issues or difficulties for the computing system in interpreting human communication and needs. This reflects the need to ensure the computer understands humans rather than forcing humans to change behavior to work with the computer.

Natural Language (NL)
This section focuses on understanding language structures at the early grades with deepening understanding of ambiguity or challenges a computer could encounter interpreting human language and how to address that to decrease errors.

Commonsense Reasoning (CR)
This subconcept focuses on deepening the understanding of what a computing system would need to know to solve a problem. This includes everything from human behavior and language to the specific content knowledge that would be required.

Understanding Emotion (US)
Students develop an understanding of what is required for students to recognize human emotions in facial expressions and the tone of text and how they can modify their responses accordingly.

Philosophy of Mind (PM)
Students explore the difference between how AI and people understand things and what AI can and can not do. As they progress students explore the idea of consciousness and how that may or may not apply to AI.

Human-AI Interaction (HA)
Understanding how humans provide input and how AI systems respond helps students recognize the limitations of AI including errors, and lack of context so they can interpret outputs critically. Learning how to communicate clearly with AI systems, evaluate outputs and determine when human judgment is needed supports responsible and effective AI use.

Learning (LN)

The very early stages of artificial intelligence focused on teaching a computer like you would teach a small child. Though this was the start, it is important for students to differentiate between how humans learn and how machines learn. This understanding starts at the early grades and deepens as students progress through the standards building on the Representation and Reasoning standards. Part of understanding this process includes understanding data sets and how neural networks use data and pattern recognition to produce results.

Nature of Learning (NOL)
The nature of learning starts with understanding how humans and computers learn with the understanding becoming more nuanced as students progress. As this understanding deepens so does their ability to recognize patterns in data and how that data is used to train AI models.

Neural Networks (NN)
This subconcept area starts in upper elementary and addresses how neural networks are constructed and function. Moving from understanding simple networks to the training of a network.

Datasets (DS)
AI systems are built on data. As students move through these standards, they move from creating simple datasets to demonstrate sorting and classifying of objects to creating datasets for training decision trees at the middle school level to working with real world datasets in high school, increasing the size of datasets as they progress. As students work with datasets, they develop an understanding of flawed or biased data.

Modeling (MD)
Learning about modeling helps students understand how AI systems make decisions based on patterns in data rather than human reasoning. It is important for students to learn that models use rules or learned structures to classify information and make decisions. This understanding prepares students to interpret AI behavior, recognize limitations and evaluate how well models perform.

Representation & Reasoning (RR)

Representation and reasoning are essential for solving complex problems, whether by a human or AI. This concept area uses more specific skills like abstraction (filtering out unnecessary details), symbolic representations, and data structures to help students understand how humans and AI store information so it can be categorized and searched to make decisions and draw new conclusions. It is essential for students to understand that when AI makes decisions and draws conclusions, it does so solely based on its rules and data while humans also make decisions based on empathy, intuition and emotion.

Representation (RP)
In this subconcept, students learn about abstraction, symbolic representation, data structures and feature vectors (unique features of an object and how that is categorized), moving from an awareness level in the early grades to the ability to explain concept applications in the upper grades.

Search (SR)
Understanding how AI works means understanding how computing systems search for the next piece of information, whether it is in a search for a specific piece of information or in determining the next move in a game of tic-tac-toe. In the early grades students determine and illustrate all of the next possible moves in a game to develop the base understanding of the concept while in the upper grades students are illustrating breadth-first, depth-first and best-first searches and determining problems each is the best process for solving.

Reasoning (RS)
In both humans and AI, reasoning is the ability to use existing information/knowledge to solve a problem or create new information. The standards in this area are aimed at helping students understand this process by providing them with different levels of experience categorizing problems and determining the best course for solving them.

Societal Impact (SI)

Like all computing technologies, as AI transforms our society, it can provide great benefits but we must also be mindful of the negative impacts that can potentially occur. Students should learn to evaluate the creation and training process of AI systems as well as the data used in the system and how it was collected and organized.

Ethical AI (EA)
People design and control technology and are responsible for how it is used and the outcomes it produces. Ethical AI needs students who understand that AI systems rely on human data and decisions and are prepared to evaluate AI systems critically and use them responsibly.

Bias in AI (BA)
AI systems are not automatically neutral or objective. Their outputs depend on the information and assumptions of their builders and the data the systems are trained with. These standards help students with the skills they need to critically evaluate AI results, question potential unfairness and support the development and use of systems that are more accurate and transparent.

AI in Society (AS)

AI influences content, communication and access to information, changing how people communicate, learn, make decisions and create content. Understanding how AI systems impact our society helps students be better prepared to create and use AI systems in ways that benefit individuals, communities and society as a whole.

Kindergarten Standards

Perception

Standard Code	Iowa Academic Standard	Standard Clarification
EK-PC-DK-01 Domain Knowledge	Identify how humans use knowledge provided by people.	Students identify examples of things they know because another person taught or told them, such as a classroom rule, the name of an object, or how to complete a familiar task. They explain who shared that knowledge and how it helps them in everyday life. To show understanding, students should be able to connect a piece of knowledge to a person or source and describe how that shared information helps them make a decision, follow a routine, or understand the world around them.
EK-PC-PR-02 Processing	Identify how humans respond differently based on the information they receive.	Students look at familiar examples in which a person receives information such as hearing that it is raining, seeing a stop sign, or noticing that a line is long and describe what that person might do in response. They also compare how two people might respond differently to the same information and explain why that could happen. Evidence of understanding comes from their ability to connect the information received to a possible action and to recognize that different people may respond in different but reasonable ways.
EK-PC-SN-03 Sensing	Identify how humans use senses or tools to gather information.	Students identify examples of using their senses and simple tools to gather information. They explain what they noticed and how the sense or tool helped them learn something they might not have known otherwise. To show understanding, students should be able to describe not just what was used, but what information it helped them gather and why that information would have been harder to notice without that sense or tool.

Data Science Connection

EK-DR-ND-01 Identify that information can come from pictures, books, videos, sounds, and people.

Mathematics Connection

K.MD.A.1 Describe several measurable attributes (for example, length, width, weight) of objects by using words such as short, long, small, big, heavy, light.

Natural Interaction

Standard Code	Iowa Academic Standard	Standard Clarification
EK-NI-NL-04 Natural Language	Identify different ways that people can input information into computers.	Students identify examples of ways people give information to computers and describe when they might use different types of input such as voice, keyboard, touch, or pictures. They explain what kind of information each input gives the computer and why one form of input might work better than another in a particular situation. A strong response shows that students understand both that there are multiple ways to provide information and that each one serves a purpose in helping the computer respond.
EK-NI-CR-05 Commonsense Reasoning	Identify ways that people and computers are like and ways they are different.	Students discuss examples in which a computer might misunderstand a request, instruction, or situation and compare that to how a person would likely respond. They explain what a person knows or notices that the computer may not, such as background knowledge, common experiences, or clues from the situation. A strong response shows that students understand that computers do not automatically “know” what people mean just because the words or situation seem obvious to a person.

Learning

Standard Code	Iowa Academic Standard	Standard Clarification
EK-LN-MD-06 Modeling	Identify simple rules that can be used to group objects into classes based on their features.	Students sort a set of objects or pictures using a feature-based rule such as color, shape, or size. They explain the rule they used, describe why each item belongs in its group, and compare how the grouping would change if they used a different rule instead. A strong response shows that students understand the grouping is not random; it depends on a consistent feature and a rule that can be applied the same way across all items.



Computer Science Connection

EK-ALG-ML-02 Recognize attributes of objects to notice patterns and make decisions.



Data Science Connection

EK-AM-PR-07 Identify how two groups are alike or different after sorting and counting.



Mathematics Connection

K.MD.B.3 Classify objects into given categories; count the numbers of objects in each category and sort the categories by count.

Societal Impact

Standard Code	Iowa Academic Standard	Standard Clarification
EK-SI-EA-07 Ethical AI	Identify how people are responsible for how technology is used.	Students look at simple examples of people using technology in different ways and identify whether the use is helpful, harmful, or needs to be changed. They explain what the person did and why the person, not the tool, is responsible for the outcome. A strong response shows that students understand the same tool can be used in different ways and that people are responsible for those choices.
EK-SI-BA-08 Bias in AI	Identify how technology is created by humans.	Students identify familiar technologies and explain what each one helps people do. They describe why a person might have made that technology and what need it was designed to meet. A strong response shows that students understand technologies are created intentionally and reflect human decisions about purpose and use.
EK-SI-AS-09 AI in Society	Identify how people use AI tools in everyday life.	Students identify everyday tools that help people by answering, suggesting, or responding. They describe what the tool helps someone do and when a person might use it. A strong response shows that students are beginning to recognize that some digital tools are part of ordinary life and support everyday tasks.



Computer Science Connection

EK-SOC-HU-15 Explain that people design and develop computing technologies.



ELA Connection

W.K.2 Use a combination of drawing, dictating, and writing to compose informative/explanatory texts in which they name what they are writing about and supply some information about the topic.

First Grade Standards

Perception

Standard Code	Iowa Academic Standard	Standard Clarification
E1-PC-DK-01 Domain Knowledge	Describe how people give computers information to help them work.	Students describe examples of how people give computers information, such as typing, clicking, selecting, speaking, or entering data. They explain how that information helps the computer respond or complete a task. A strong response would show that students understand the computer is not acting on its own; it is using information or directions provided by people. Students may also compare different ways of giving information to a computer and describe how the computer's response depends on what it is given.

Natural Interaction

Standard Code	Iowa Academic Standard	Standard Clarification
E1-NI-NL-02 Natural Language	Describe ways people and computers share information with each other.	Students describe examples of how they give information to a computer and explain how the computer responds. They compare different ways of providing the same information, such as speaking versus typing, and discuss how the computer's response may change depending on how the information was given. A strong response shows that students understand that communication with a computer involves both the input and the response, and that the form of input can shape how the computer reacts.
E1-NI-HA-03 Human-AI Interaction	Identify tasks that computers can help people with.	Students identify a task they completed with computer help and describe what the computer contributed and what they contributed. They explain why both parts mattered to the task being completed successfully. A strong response shows that students understand the computer was helping with part of the work, while the person was still making choices, checking results, or deciding what to do.

Computer Science Connection

E1-SOC-HU-15 Differentiate between activities that humans do well and activities that computing technologies do well.

Learning

Standard Code	Iowa Academic Standard	Standard Clarification
E1-LN-NOL-04 Nature of Learning	Describe a specific difference between learning from personal experience and learning from a set of examples.	Students compare a familiar example of human learning, such as learning to tie shoes, recognize a friend, or remember a classroom routine, with a computer learning task such as sorting pictures or identifying examples. They explain one important difference between the two kinds of learning and use the example to support their explanation. A strong response shows that students understand the difference is not just what is learned, but how the learning happens.
E1-LN-MD-05 Modeling	Describe how a computer uses a rule to decide which class a new object belongs to.	Students are given a simple classification rule and a new example, then explain how the computer would decide where the example belongs. They identify which features matter, describe how the rule applies, and explain why the result makes sense. A strong response shows that students understand the decision comes from applying the rule to features, not from guessing or from memorizing one exact example.

Data Science Connection

E1-AM-MOD-10 Predict whether an object belongs in a group based on its characteristics and explain the reasoning.

Representation & Reasoning

Standard Code	Iowa Academic Standard	Standard Clarification
E1-RR-RP-06 Representation	Describe how certain information can change a decision.	Students describe how a decision would change if the available information changed, such as deciding what to wear, where to sit, or what to bring. They explain what the original information suggested, what changed, and why that new information led to a different choice. A strong response shows that students understand the decision is tied directly to the information available and that changing the information can change the outcome.
E1-RR-RN-07 Reasoning	Describe how to follow steps to reach a result.	Students describe the steps in a familiar task, such as washing hands, logging into a device, or making a snack, and explain why the order of those steps matters. They also describe what might happen if one step were skipped, repeated, or done out of order. A strong response shows that students understand a correct result depends on following the steps in a structured way.
E1-RR-SR-08 Search	Describe how different approaches can be used to reach a goal.	Students describe two different ways to solve the same problem or complete the same task and explain how the approaches are alike and different. They identify what each approach helps them do and which one may feel easier, faster, or clearer. A strong response shows that students understand there can be multiple valid paths to the same goal and that those paths can be compared.



Computer Science Connection

E1-ALG-PS-01 Decompose a problem or task into individual parts to develop an algorithm.



Data Science Connection

E1-IPR-MC-11 Compare a prediction to the results in order to explain how the new information changes the expected outcome.

Societal Impact

Standard Code	Iowa Academic Standard	Standard Clarification
E1-SI-EA-09 Ethical AI	Describe how people's choices influence how technology is used.	Students compare two situations where the same technology is used differently. They describe what choice each person made, how the results were different, and why the person's choice affected the outcome. A strong response shows that students understand technology use depends on human decisions rather than the tool deciding on its own.
E1-SI-EA-10 Ethical AI	Describe how people decide what technologies should do.	Students match familiar technologies to the problems they solve and explain what a person likely wanted the technology to do. They may also describe a simple tool they think would help solve a classroom or home problem. A strong response shows that students understand technology design begins with a human purpose or need.
E1-SI-EA-11 Ethical AI	Describe ways technologies can be used to help others.	Students identify examples of technology helping someone and explain what the technology made easier or possible. They describe who was helped and how the technology supported that person. A strong response shows that students understand technology can be used to benefit others, not just the person operating it.
E1-SI-BA-12 Bias in AI	Explain how the same technology can produce different results.	Students compare two examples in which the same technology produces different results. They explain what changed in the situation, what information may have been different, and how that influenced the result. A strong response shows that students understand the outcome depends not only on the tool, but also on the context and information involved.

Science Connection

K-2-ETS1-1 Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

Second Grade Standards

Perception

Standard Code	Iowa Academic Standard	Standard Clarification
E2-PC-SN-01 Sensing	Describe how devices use inputs to gather information.	Students identify different kinds of inputs on familiar devices and explain what information each one gathers. They describe how that input helps the device respond and what would change if that input were not available. To show understanding, students should be able to connect an input part such as a camera, microphone, touch screen, or motion sensor to the kind of information it collects and to the job that information helps the device do.

Natural Interaction

Standard Code	Iowa Academic Standard	Standard Clarification
E2-NI-NL-03 Natural Language	Explain how people and computers communicate using human language.	Students ask a computer the same question in more than one way and compare how the responses change. They explain what changed in their wording, what changed in the response, and why those differences might matter. A strong response shows that students understand that computers respond to the specific words they receive and that different phrasing can produce different outcomes even when the question seems similar to a person.
E2-NI-HA-04 Human-AI Interaction	Explain how people and AI systems work together to complete tasks.	Students describe ways people use a system to help complete work or solve problems. They identify what the person decided, what the system helped generate or organize, and why the person still needed to guide the process. A strong response shows that students understand the system is assisting with part of the work, but the person remains responsible for how the task is carried out and whether the result is useful.



Computer Science Connection

E2-SOC-HU-15 Investigate situations where humans have created computing technologies to solve problems.

Learning

Standard Code	Iowa Academic Standard	Standard Clarification
E2-LN-NOL-05 Nature of Learning	Explain how people and computers learn in different ways.	Students examine examples of learning situations and sort them into “how a person learns” and “how a computer learns.” They explain what clues helped them place each example and describe what the person or computer needed in order to learn. A strong response shows that students recognize people and computers both learn, but they depend on different kinds of input and experience in order to do so.
E2-LN-MD-06 Modeling	Predict the output of a simple reasoning model when given a new example that follows a known pattern.	Students are shown a simple rule or pattern and a new example that fits that pattern. They predict what output the model would give, explain which feature or part of the rule led to that result, and describe why the pattern still applies to the new case. A strong response shows that students understand the model is using a repeated rule or pattern, not making a one-time guess.
E2-LN-DS-07 Data Sets	Organize information into categories to show how data is structured for a computer.	Students organize information about objects, pictures, or examples into a simple chart with labeled categories. They explain why each category needs to be used the same way across all entries and what might go wrong if information is missing or inconsistent. A strong response shows that students understand data structure means not just sorting items, but organizing them in a consistent way that could be used again.

Computer Science Connection

E2-ALG-ML-02 Examine how data is used to train machine learning models.

Science Connection

2-PS1-1 Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.

Representation & Reasoning

Standard Code	Iowa Academic Standard	Standard Clarification
E2-RR-RP-08	Identify that devices use information to make choices.	Students identify examples of devices making choices based on information, such as a thermostat turning on heat when the temperature drops or a motion light turning on when it detects movement. They explain what information the device used, what choice it made, and why that choice followed from the information it received. A strong response shows that students understand the device's action is linked to the information available to it.
E2-RR-RN-09 Reasoning	Identify that devices follow rules to decide what to do.	Students examine familiar device behaviors, such as a stoplight changing, an automatic door opening, or a classroom device turning on, and explain what rule the device appears to be following. They describe what information triggers the rule and what action happens next. A strong response shows that students understand the device is behaving according to a rule, not making a free or personal choice.
E2-RR-SR-10 Search	Identify that devices can try different steps or paths to find a solution.	Students observe or simulate a simple navigation or maze-solving situation and explain how the device or system tried more than one path before finding a solution. They describe which path worked, which did not, and what this shows about how a device can search through options. A strong response shows that students understand search may involve trying several possibilities rather than immediately following one correct path.



Computer Science Connection

E2-ALG-ML-02 Examine how data is used to train machine learning models.

Societal Impact

Standard Code	Iowa Academic Standard	Standard Clarification
E2-SI-EA-11 Ethical AI	Explain why people should get credit for their ideas and creations.	Students examine examples of shared work, decide where credit should be given, and explain why it matters to name the creator. They may revise examples to show what proper acknowledgment would look like. A strong response shows that students understand credit is connected to fairness, honesty, and recognizing contribution.
E2-SI-AS-12 AI in Society	Explain how technology is part of culture and daily life.	Students compare how an everyday task happens with and without technology. They explain how technology changes the way the task is done and what difference that makes in daily life. A strong response shows that students recognize technology as part of ordinary routines, not just as something special or separate from everyday life.
E2-SI-AS-13 AI in Society	Explain how technology can be used to help people and communities.	Students identify a problem in their school or community and explain how technology could help address it. They describe who would benefit, how the technology would help, and why that use would matter beyond one individual person. A strong response shows that students understand technology can affect communities as well as individuals.

Computer Science Connection

E2-SOC-HI-14 Analyze the ways that people from different cultures, backgrounds, and time periods have designed computing technologies to help them solve problems and express themselves.

Third Grade Standards

Perception

Standard Code	Iowa Academic Standard	Standard Clarification
E3-PC-PR-01 Processing	Explain how changes in input information affect AI system outputs.	Students compare examples of the same system receiving different kinds of input and explain how those differences changed the result. They describe why clearer, more complete, or more relevant input may lead to a better output. A strong response would go beyond noticing that the answers changed and explain what feature of the input such as missing details, poor quality, or a mismatch with the task affected the system's result.



E3-ALG-ML-02 Investigate how machine learning models can change when new data is added to a training set.

Natural Interaction

Standard Code	Iowa Academic Standard	Standard Clarification
E3-NI-CR-02 Commonsense Reasoning	Explain why people and computers sometimes understand the same situation differently.	Students discuss examples where a computer misunderstands a situation and explain what contextual information a person would use to interpret it correctly. They should be able to describe what the computer was missing and why that missing understanding matters. A strong response shows that students recognize the role of background knowledge and common experience in human understanding.
E3-NI-UE-03 Understanding Emotion	Describe differences between human emotions and computer responses.	Students compare how a person might respond to an emotional situation with how a computer might respond. They describe what makes the person's response different, what the computer is likely responding to, and why the computer's reply may still sound helpful or caring. A strong response shows that students understand the difference between having feelings and producing a response that sounds emotional.

Learning

Standard Code	Iowa Academic Standard	Standard Clarification
E3-LN-NOL-04 Nature of Learning	Predict how a computer's learning might fail in an unfamiliar situation compared to a human's ability to adapt.	Students examine a scenario in which a computer has learned from a limited set of examples and is then shown something new that is related but not exactly the same. They predict how the computer might respond, compare that to how a person would likely respond, and explain why a person could adapt more easily. A strong response shows that students understand people can use broader experience or reasoning in unfamiliar situations, while computers depend more heavily on the examples they have already seen.
E3-LN-MD-05 Modeling	Explain the difference between the training phase and the application phase of a model.	Students create a simple visual or sequence showing the two stages of a model's work. They explain what happens while the model is learning, what happens when it is being used, and how the first stage prepares it for the second. A strong response shows that students understand the application phase depends on what happened during training rather than starting over each time.
E3-LN-DS-06 Data Sets	Identify instances where a computer's accuracy improved after receiving more examples.	Students observe a model before and after it is given more examples and compare how often it is correct in each situation. They explain what changed, why the additional examples helped, and how the system's performance improved. A strong response shows that students understand the computer improved because it had more examples from which to learn patterns, not because it changed by itself.
E3-LN-PM-07 Philosophy of Mind	Explain why people are responsible for decisions when using computers.	Students describe situations in which a computer provides information, suggestions, or help with a task and explain why the person using the computer is still responsible for the final decision. They should identify what the computer contributed and what the person still needed to decide. A strong response shows that students understand tools can help, but the human user still carries responsibility for the outcome.

Computer Science Connection

E3-ALG-ML-02 Investigate how machine learning models can change when new data is added to a training set.

Representation & Reasoning

Standard Code	Iowa Academic Standard	Standard Clarification
E3-RR-RP-08 Representation	Recognize that AI uses information to generate outputs.	Students identify examples of a system taking in information and producing an output. They describe what information went in, what came out, and how the output depended on the information that was provided. A strong response shows that students understand outputs are generated from information, not produced without a basis.
E3-RR-RS-09 Reasoning	Recognize that AI systems can follow steps to reach an output.	Students trace a simple step-by-step process used by a system and explain how that process led to the final output. They identify what information the system started with, what happened at each stage, and why the output followed from those steps. A strong response shows that students understand the result came from a sequence of operations, not from a random choice.
E3-RR-SR-10 Search	Recognize that AI systems can search through many possibilities to produce an output.	Students compare examples of a system trying one path versus trying several paths to solve a problem. They explain how searching through more possibilities can help a system find an answer and why a system may not always know the best option immediately. A strong response shows that students understand search involves exploring options before producing an output.



Computer Science Connection

E3-ALG-ML-02 Investigate how machine learning models can change when new data is added to a training set.

Societal Impact

Standard Code	Iowa Academic Standard	Standard Clarification
E3-SI-EA-11 Ethical AI	Identify situations where AI tools are used to create or generate content.	Students examine examples of content and identify whether a tool may have helped create it. They explain what clues suggest that a tool was involved and what role a person may still have played in making or shaping the final product. A strong response shows that students understand tools can contribute to creation without removing the person from the process entirely.
E3-SI-EA-12 Ethical AI	Identify that people make decisions about how AI systems behave.	Students identify examples of decisions people make about what an AI tool should do and how it should respond. They explain how those choices shape the tool's behavior and what that means for the outputs it produces. A strong response shows that students understand system behavior is connected to human decisions in design and use.
E3-SI-BA-13 Bias in AI	Identify that AI systems rely on information provided by people.	Students compare outputs from different prompts, examples, or kinds of information given to a system and explain how that information influenced the result. They describe how the output changed and what that suggests about the system's dependence on human-provided information. A strong response shows that students understand the system works from information people gave it rather than generating knowledge independently.



E3-SOC-HU-18 Examine why people design and build computing technologies.

Fourth Grade Standards

Perception

Standard Code	Iowa Academic Standard	Standard Clarification
E4-PC-SN-01 Sensing	Explain how sensors determine what information an AI system can use to identify or recognize things in the world.	Students examine examples of systems that rely on sensors and explain what information each sensor makes available. They describe how the output or decision would change if the sensor were missing, inaccurate, or limited in what it could detect. A full response should show that students understand the system's recognition ability depends on what information the sensors make available, not just on the system "being smart."
E4-PC-PR-02 Processing	Analyze how multiple inputs influence AI system processing and outputs.	Students examine a system that uses more than one input, describe what each input contributes, and explain how the combined information affects the output. They compare this to what the system could do if it relied on only one of those inputs. A strong response should show that students who understand multiple inputs can improve a result by adding useful context, but that each input still contributes something specific to the system's final decision.



E4-ALG-ML-02 Analyze relationships between the properties of training data and a machine learning model's output

Natural Interaction

Standard Code	Iowa Academic Standard	Standard Clarification
E4-PNUE-03 Understanding Emotion	Ask questions to determine the differences between human emotions and computers responses	Students analyze examples of how a computer might respond to emotional situations and compare those responses to how a person might respond. They explain what signals the computer may have used, what the computer may have misunderstood, and why the person's response includes something the computer does not have. A strong response shows that students understand the computer is interpreting cues, not actually feeling the emotion.
E4-PN-HA-04 Human-AI Interaction	Explain what people bring to a task that AI systems cannot	Students examine a task completed with system assistance, identify what the system contributed and what the person contributed, and explain why human judgment was still necessary. They should describe where the person had to interpret, decide, evaluate, or take responsibility in ways the system could not. A strong response shows that students understand the person's role is not just "checking," but bringing meaning, judgment, and context to the task.



E4-SOC-HU-18 Distinguish between human learning and machine learning processes.

Learning

Standard Code	Iowa Academic Standard	Standard Clarification
E4--LN-NOL-05 Nature of Learning	Explain the role of training data in helping an AI system "learn" a behavior without being explicitly programmed.	Students work through an example where a system learns from labeled examples instead of from step-by-step rules. They explain what the examples teach the system, how the examples help it notice a pattern, and why this is different from programming every case directly. A strong response shows that students understand the examples are shaping the behavior the system later shows.
E4--LN-DS-06 Data Sets	Predict the response of a computer based on patterns observed in previous examples.	Students examine an input-output table, identify the pattern across the examples, and predict how the computer would respond to a new case. They explain which earlier examples support their prediction and why the new example fits that same pattern. A strong response shows that students understand the prediction comes from repeated relationships in the examples rather than from guessing.
E4--LN-NN-07 Neural Networks	Identify digital devices that improve their performance using information from experience or examples.	Students identify devices that seem to improve or respond differently after repeated use and describe what kinds of information may have helped the device improve. They compare that change to how people improve with practice or experience. A strong response shows that students understand the device is changing based on information it has received rather than doing exactly the same thing every time.



Computer Science Connection

E4-ALG-ML-02 Analyze relationships between the properties of training data and a machine learning model's output.

Representation & Reasoning

Standard Code	Iowa Academic Standard	Standard Clarification
E4--RR-RN-08 Reasoning	Describe how certain information can change the output of an AI.	Students compare outputs from the same system when given different information. They explain what changed in the input, how the output changed, and why that difference matters for understanding how the system works. A strong response shows that students understand outputs are shaped by input information and that certain changes in information can produce meaningful changes in the result.
E4--RR-RN-09 Reasoning	Describe how AI follows steps to reach an output.	Students diagram or describe the step-by-step process a system uses to complete a task. They explain what happens at each stage, how the information changes as it moves through the process, and what might change if one step were altered, skipped, or removed. A strong response shows that students understand the final output depends on both the starting information and the sequence of operations used to work with it.
E4--RR-SR-10 Search	Describe how AI systems follow structured steps to provide multiple outputs.	Students describe how a system can use the same basic process with different inputs and explain why the outputs may still differ even though the steps stay the same. They compare several cases that follow the same process and explain how the input changes the result. A strong response shows that students understand consistency in process does not guarantee identical outputs when the information going in is different.



Computer Science Connection

E4-ALG-ML-02 Analyze relationships between the properties of training data and a machine learning model's output.

Societal Impact

Standard Code	Iowa Academic Standard	Standard Clarification
E4--SI-EA-11 Ethical AI	Explain why giving credit matters when creating or sharing work with AI.	Students examine examples of work created with tool support and decide when that support should be acknowledged. They explain how giving credit helps others understand how the work was made and what role the person still played in the final product. A strong response shows that students understand acknowledgment matters because it makes the creation process more honest and transparent.
E4--SI-EA-12 Ethical AI	Describe how rules or instructions influence how AI systems behave.	Students compare what happens when a system is given different instructions or follows different rules. They describe how those changes affect the result, what the system appears to be doing differently, and why the behavior changes when the rules change. A strong response shows that students understand rules and instructions shape system behavior in direct ways.
E4-SI-BA-13 Bias in AI	Describe how differences in information can influence AI system outputs.	Students compare examples where the information available to a system is different and describe how the result changes. They explain what kinds of information were missing, added, or uneven and why those differences mattered to the final output. A strong response shows that students understand outputs are shaped by the information a system has access to.



Computer Science Connection

E4-ALG-IM-03 Evaluate how different algorithms for solving the same problem produce outcomes that may benefit or disadvantage different groups of people.

Fifth Grade Standards

Perception

Standard Code	Iowa Academic Standard	Standard Clarification
E5-PC-SN-01 Sensing	Analyze how the limits of sensors affect AI system outcomes and reliability.	Students examine a case where a sensor misses or misreads information and analyze how that affects the system's output. They explain what information the system failed to detect, why that information mattered, and how the missing or weak signal made the result less reliable. A strong response should connect the system's outcome to a specific sensing limit rather than describing the failure only at the surface level.
E5-PC-PR-02 Processing	Explain how changes in input data affect how an AI system interprets information and constructs meaning from patterns.	Students compare how a system responds when the input data changes and explain how those changes affect what the system notices and what meaning it constructs from the patterns. They should identify what was different in the information provided, explain why that difference mattered, and describe how the system's interpretation changed as a result. A strong response should show that students understand interpretation depends on both the new input and what the system was prepared to recognize from earlier data.

Natural Interaction

Standard Code	Iowa Academic Standard	Standard Clarification
E5-NI-NL-03 Natural Language	Explain how AI systems process spoken or written language.	Students compare how a system responds to different words or phrases and explain how changes in wording affect the result. They should describe which features of the wording made the response more helpful, more specific, or less useful. A strong response shows that students understand the system is responding to patterns in language input and that changing the wording changes what the system is able to do.
E5-NI-HA-04 Human-AI Interaction	Analyze how people and AI systems share responsibility when completing tasks.	Students analyze a system-assisted task and identify where a person guided, checked, revised, or corrected the system's contribution. They explain why those moments of human involvement matter and what could go wrong if the person did not take an active role. A strong response shows that students understand the system may contribute part of the task, but responsibility for using the output wisely remains with the person.
E5-NI-PM-05 Philosophy of Mind	Explain why AI systems should support, not replace, human thinking.	Students describe situations where relying completely on a system could lead to problems and explain why human thinking is still necessary. They identify what the person must still do, such as interpreting, judging, questioning, or deciding, even when the system helps complete part of the task. A strong response shows that students understand support and replacement are not the same thing.

Learning

Standard Code	Iowa Academic Standard	Standard Clarification
E5-LN-NOL-06 Nature of Learning	Explain how an AI model learns to classify objects by identifying patterns in a provided labeled dataset.	Students work through a labeled dataset, identify the features that separate the categories, and explain how a system could use those repeated patterns to classify a new example. They should be able to describe both the pattern and how it supports a later decision. A strong response shows that students understand classification comes from patterns across examples, not from storing one answer at a time.
E5-LN-DS-07 Data Sets	Describe how AI systems use examples instead of explicit instructions to solve problems.	Students compare a system that follows step-by-step instructions with one that learns from examples. They explain how each one reaches a result, what each one depends on, and why one approach may work better than the other for certain kinds of problems. A strong response shows that students understand example-based learning is not the same as simply following prewritten instructions.
E5-LN-NN-08 Neural Networks	Describe a neural network as a series of connected parts that work together to make a decision.	Students use a diagram, analogy, or simple explanation to show how information moves through connected parts of a system and how those parts together contribute to the final result. They explain why changing one part of the system could change the outcome. A strong response shows that students understand the decision emerges from the connected system as a whole.

Representation & Reasoning

Standard Code	Iowa Academic Standard	Standard Clarification
E5-RR-RP-09 Representation	Compare how different representations affect AI system outputs.	Students compare the outputs of a system given the same underlying information in two different forms, such as categories, symbols, charts, or labels. They explain what the system may have noticed differently in each version and why the form of the information changed the result. A strong response shows that students understand representation affects what the system is able to use and therefore what output it produces.
E5-RR-RN-10 Reasoning	Compare how different reasoning strategies influence AI decisions.	Students compare two systems or methods that use different reasoning approaches for the same kind of task. They explain how each approach reaches a decision, identify what each one does well, and describe why one may be more effective in a particular situation. A strong response shows that students understand reasoning strategies are not all the same and that different strategies can lead to different strengths and weaknesses.
E5-RR-SR-11 Search	Compare different ways an AI system might search for a solution.	Students compare two different search approaches and explain how each one looks for a solution. They describe what each strategy gains and gives up, such as finding an answer quickly versus checking more possibilities before deciding. A strong response shows that students understand search involves tradeoffs and that different strategies may be better suited to different situations.

Societal Impact

Standard Code	Iowa Academic Standard	Standard Clarification
E5-SI-EA-12 Ethical AI	Explain how acknowledging the use of AI tools helps others understand how content was created.	Students examine examples of work made with different levels of tool support and explain what should be acknowledged. They describe how that acknowledgment helps others understand the final product, the process behind it, and the role the person still played. A strong response shows that students understand acknowledgment is about transparency, not simply adding a label.
E5-SI-EA-13 Ethical AI	Explain how human decisions influence whether AI systems are used responsibly.	Students analyze examples of AI use and explain what decisions made the use more or less responsible. They identify where people needed to guide, question, revise, or limit the system and explain why those choices mattered. A strong response shows that students understand responsible use depends on human judgment before, during, and after the tool is used.
E5-SI-BA-14 Bias in AI	Explain how biased or incomplete information can influence AI outputs.	Students compare outputs from examples with missing, uneven, or biased information and explain how those differences changed the result. They describe what kinds of information were not represented well and how that influenced the system's output. A strong response shows that students who understand biased or incomplete inputs can shape later outputs in predictable ways.



E5-SOC-HU-18 Evaluate when it is appropriate to use or not use computing technologies to solve a problem.

Sixth Grade Standards

Perception

Standard Code	Iowa Academic Standard	Standard Clarification
E6-PC-DK-01 Domain Knowledge	Evaluate how information shapes AI system behavior.	Students evaluate how the source, range, and quality of information influence a system's behavior in a real or simulated case. They explain how the information available to the system shaped the kinds of outputs it produced and analyze whether those information sources were appropriate for the setting in which the system was used. A strong response should connect the system's behavior to specific limits or patterns in the information it depended on.

Natural Interaction

Standard Code	Iowa Academic Standard	Standard Clarification
E6-NI-NL-02 Natural Language	Evaluate how the way a question is phrased shapes what an AI system can do with it, and revise prompts to improve results.	Students revise the same question or prompt several times, compare the responses, and explain how their wording changes improved the usefulness or accuracy of the result. They identify which changes mattered most and what that shows about how systems respond to language. A strong response shows that students are not only changing words, but also evaluating why those changes helped the system respond differently.
E6-NI-CR-03 Commonsense Reasoning	Analyze why an AI system's response to a familiar situation can sometimes be surprising or unexpected.	Students analyze examples of system responses that seem surprising, incomplete, or incorrect and explain what information the system may have been missing. They compare the system's response to what a person would likely infer and explain why the two differ. A strong response shows that students can connect a surprising output to the absence of context, background knowledge, or common assumptions.
E6-NI-UE-04 Understanding Emotion	Explain how computers respond to emotional cues without experiencing emotions.	Students compare how a person and a computer might respond to the same emotional situation and explain the differences. They identify what the system may be responding to, what it can detect, and what a person is able to understand or feel that the system cannot. A strong response shows that students understand emotional recognition and emotional experience are not the same thing.
E6-NI-PM-05 Philosophy of Mind	Justify why people must remain responsible when using AI systems.	Students compare completing a meaningful task independently, with system support, and by relying mostly on system output. They analyze how the quality of thinking and the final result changed across the three approaches and justify why people must remain responsible for the final decision. A strong response shows that students can explain not just that people stay responsible, but why relying too heavily on a system can weaken judgment, reduce thoughtful decision-making, or create problems in the final outcome.

Learning

Standard Code	Iowa Academic Standard	Standard Clarification
E6-LN-NL-06 Nature of Learning	Differentiate between supervised and unsupervised learning.	Students compare two learning situations—one with labels and one without—and explain what kind of learning each represents. They describe what the system is being asked to do in each case and why having labels changes what it can learn. A strong response shows that students understand the difference lies in the kind of guidance the system receives.
E6-LN-DS-07 Data Sets	Explain how a simple model is trained using labeled examples.	Students work through a simple training activity where a model is given labeled examples, makes a prediction, and receives feedback. They track how the model changes over several rounds and explain how the examples and feedback help it improve. A strong response shows that students understand the model improves through repeated cycles of prediction and correction.
E6-LN-NN-08 Neural Networks	Predict how a simple network might change its final answer if one connection is adjusted.	Students examine a simplified network and predict how adjusting one connection or value would change the final output. They explain how that change would affect the flow of information and why the overall result might shift. A strong response shows that students understand the final answer depends on how the connected parts interact, not just on the starting input.

Representation & Reasoning

Standard Code	Iowa Academic Standard	Standard Clarification
E6-RR-SR-09 Search	Analyze how search strategies that work in one context may be less effective in another.	Students compare the performance of the same search strategy in two different settings and explain why it works better in one than the other. They identify what changed about the problem, such as the number of possibilities, the structure of the search space, or the limits placed on the search, and describe how those changes affect the strategy's usefulness. A strong response shows that students understand search strategies need to be judged in relation to the context in which they are used.
E6-RR-RN-10 Reasoning	Analyze how inputs and programmed rules influence the outputs produced by AI systems.	Students examine a system's input and rules and explain how those two together led to a particular output. They then predict what might change if one input were changed or if one rule were adjusted. A strong response shows that students understand outputs depend on both the information given and the logic or structure used to process it.

Societal Impact

Standard Code	Iowa Academic Standard	Standard Clarification
E6-SI-EA-11 Ethical AI	Analyze how people's decisions about using AI tools influence outcomes.	Students examine examples of AI-assisted work and analyze how different user choices led to stronger or weaker outcomes. They explain what decisions made the difference, such as how the tool was prompted, whether the output was checked, or how much the person relied on it. A strong response shows that students understand outcomes are shaped as much by human use as by the tool itself.
E6-SI-EA-12 Ethical A	Explain why attribution and originality matter when using AI-generated content.	Students review examples of AI-assisted content, determine what needs acknowledgment, and explain how attribution helps clarify authorship and originality. They describe what contribution came from the tool, what came from the person, and why that difference should still matter. A strong response shows that students understand originality and attribution remain important even when a tool contributes to the work.
E6-SI-BA-13 Bias in AI	Analyze how bias can enter AI systems through data, rules, or design decisions.	Students analyze a simplified AI example and identify whether a problem came from the data, the rules, or the design of the system. They explain how that part of the system influenced the final outcome and why the bias appeared there. A strong response shows that students understand bias can enter a system at several stages rather than coming from one single source.
E6-SI-AS-14 AI in Society	Analyze how AI systems shape culture, media, and communication.	Students examine examples of AI-curated or AI-generated media and explain how those systems may influence what people notice, discuss, or believe. They describe what becomes more visible, what may be left out, and how that can shape communication or culture over time. A strong response shows that students understand these systems can influence attention and meaning, not just deliver content.

Middle School Standards

Perception

Standard Code	Iowa Academic Standard	Standard Clarification
MS-PC-DK-01 Domain Knowledge	Explain how an AI interprets and assigns meaning from sensory information.	Students explain how a system interprets sensory information based on what it has learned before. They describe how limited or narrow prior examples can affect the meaning the system assigns, and they connect the system's interpretation to the assumptions built into what it already knows. A strong response should make clear that systems do not simply "see" or "hear" meaning directly; they interpret information through learned patterns.
MS-PC-DK-02 Domain Knowledge	Evaluate how information and context influence AI system performance.	Students evaluate a case where a system is used in a context that differs from the one it was prepared for. They explain what information or assumptions fit the original setting, what changed in the new context, and how that mismatch affected performance. A strong response should show that students understand performance depends on both the information a system learned from and the context in which it is later used.
MS-PC-PR-03 Processing	Evaluate how processing choices and assumptions influence AI system outcomes.	Students analyze a system's design choices or assumptions and explain how those choices shape the result. They evaluate the consequences of those assumptions for different users or situations and describe how the system's outcomes might change if different processing choices had been made. A strong response should connect the outcome to a specific assumption rather than discussing the result in general terms.

Natural Interaction

Standard Code	Iowa Academic Standard	Standard Clarification
MS-NI-NL-05 Natural Language	Justify a position on the appropriate and inappropriate uses of AI language systems based on evidence of their strengths and limitations.	Students analyze examples of appropriate and inappropriate uses of generated language and explain what makes the use more or less appropriate. They support their conclusions with evidence about the system's strengths, limitations, and the demands of the task. A strong response should show that students are not just expressing a preference but are weighing task requirements, consequences, and the level of judgment the task requires.
MS-NI-CR-06 Commonsense Reasoning	Evaluate patterns in how AI systems and people interpret familiar situations differently.	Students compare several system responses to everyday situations and identify patterns in where the interpretations differ from human expectations. They explain what kinds of information, assumptions, or common experiences a person would bring to the same situation and why the system may not be using those same kinds of understanding. A strong response shows that students can move beyond isolated examples and recognize repeated kinds of differences between human and system interpretation.
MS-NI-CR-07 Commonsense Reasoning	Explain how an AI's response to an everyday scenario demonstrates the patterns and biases in the data it used to learn.	Students examine a system response to an everyday scenario, identify what patterns in the learning data might help explain that response, and explain why the output may make sense to the system even if it does not make sense to a person. They should identify what kinds of examples, assumptions, or imbalances in the system's prior data might have contributed to the result. A strong response shows that students can connect an output to the learning patterns behind it rather than treating the output as isolated or random.
MS-NI-UE-08 Understanding Emotion	Analyze how AI emotion recognition is used in the real world.	Students examine one or more real-world examples of emotion recognition and explain how the system is being used, what it is expected to detect, and how the result might influence decisions about people. They identify who might benefit, who might be affected, and what assumptions the system is making about how emotions should be recognized. A strong response should show that students understand emotion recognition is not just a technical tool, but something that shapes real decisions in real contexts.
MS-NI-PM-09 Philosophy of Mind	Evaluate the impacts of AI on human thinking.	Students evaluate examples of system use and explain how the tool may have supported, shaped, or weakened human thinking. They identify situations in which the system helped a person reason more carefully and situations in which it may have replaced parts of the person's thinking instead. A strong response should show that students understand the impact of a system is not only in the final product, but also in how it changes the process of thinking.
MS-NI-PM-10 Philosophy of Mind	Defend a position on whether AI systems can be said to understand, intend, or have beliefs.	Students construct a written or verbal argument about whether systems demonstrate understanding, intention, or belief. They support their claim with examples, explain what counts as evidence to them, and address at least one counterargument. A strong response should show that students are not only taking a position, but reasoning carefully about what terms like "understand," "intend," or "believe" mean when applied to systems.
MS-NI-HA-11 Human- AI Interactions	Design a human–AI collaboration protocol for a specific real-world application, specifying roles, checkpoints, and accountability.	Students analyze or design a workflow showing how a person and a system would work together on a task. They identify where human judgment is needed, where the output should be checked, and who remains responsible for the final decision. A strong response should show that students understand effective collaboration is not just about efficiency; it also depends on review, correction, and clear accountability.

Learning

Standard Code	Iowa Academic Standard	Standard Clarification
MS-LN-NL-12 Nature of Learning	Compare the effectiveness of human "trial and error" versus a computer's "thousands of trials" to solve a problem.	Students compare how a person and a computer might solve the same multi-step problem, such as choosing a route or testing many possibilities. They explain why the computer can test more options and describe what humans still contribute that repeated fast trials do not provide. A strong response shows that students understand the difference is not only speed, but also flexibility and judgment.
MS-LN-NL-13 Nature of Learning	Explain how a supervised learning algorithm creates a decision rule by adjusting its internal representations.	Students work through or simulate a supervised learning example where a model begins with a rough rule, receives feedback when wrong, and changes over time. They explain what was adjusted, why the adjustment mattered, and how repeated corrections improved the decision rule. A strong response shows that students understand the rule emerges through adjustment rather than being fixed from the beginning.
MS-LN-MD-14 Modeling	Explain how a decision tree represents the rules learned from a labeled dataset.	Students create or complete a decision tree from a labeled dataset, explain why each branching question helps separate categories, and test how the tree handles a new example. Their explanation should show that the tree represents the rule structure learned from the data. A strong response shows that students understand the decision tree makes the learned rule visible.
MS-LN-MD-15 Modeling	Analyze how changing parameters in a simple model affects its accuracy.	Students adjust one or more parameters in a simple model, compare how performance changes, and explain why the model became more or less accurate. They identify which setting worked best and support their conclusion with evidence from the results. A strong response shows that students understand model accuracy depends partly on choices inside the model, not only on the data.
MS-LN-MD-16 Modeling	Model how a supervised learning algorithm adjusts internal representations (like weights or nodes) to reduce errors.	Students analyze or simulate how a model changes after making an incorrect prediction. They explain what internal part changed, how that change affects future predictions, and why repeated adjustments improve the model over time. A strong response shows that students understand learning happens through internal changes that reduce future error.
MS-LN-DS-17 Data Sets	Compare the performance of an AI model when trained with small versus large datasets.	Students compare the results of the same model trained with smaller and larger datasets. They explain how performance changed, identify which kinds of errors improved or remained, and describe why the amount of data matters for learning patterns. A strong response shows that students understand dataset size changes what the model can learn, but that size alone does not explain everything.
MS-LN-DS-18 Data Sets	Model how a supervised learning algorithm identifies patterns in labeled data to create rules.	Students work through a labeled dataset, identify which features consistently align with each category, and explain how those patterns could be turned into a decision rule for a new example. A strong response shows that students understand the rule grows out of repeated patterns in labeled examples.
MS-LN-NN-19 Neural Networks	Describe the roles of the input layer, hidden layer, and output layer in a neural network.	Students label a neural network diagram and explain what role each part plays in moving from an input to an output. Their explanation should show how the layers connect, what each layer contributes, and why the final result depends on the interaction among all three. A strong response shows that students understand the different layers serve different functions within the network.

Standard Code	Iowa Academic Standard	Standard Clarification
MS-LN-NN-20 Neural Networks	Model the flow of information through a neural network by role-playing the function of different nodes.	Students use a diagram, role-play, or other representation to show how information moves through a neural network. They explain what each stage contributes and how changes in the middle of the system can affect the final output. A strong response shows that students understand the output is built through the flow and transformation of information across the network.
MS-LN-NN-21 Neural Networks	Explain how weights assigned to different features help a network recognize a complex object.	Students compare several features of an object, decide which ones should matter more for classification, and explain how changing those relative importance values would change the result. A strong response shows that students understand the network does not treat every feature equally and that weights shape which features have the most influence.



MS-ALG-ML-07 Investigate ways to improve the accuracy and fairness of a machine learning model and reduce bias by refining the quality of examples and nonexamples in the training data.

Representation & Reasoning

Standard Code	Iowa Academic Standard	Standard Clarification
MS-RR-RN-22 Representation	Analyze how different representations of the same information can lead to different outputs.	In grades 7–8, students compare outputs produced when the same information is represented in different formats and explain how those representation choices shaped the result. They identify what each representation makes easier or harder for the system to use and describe what that reveals about the importance of representation in system behavior. A strong response shows that students understand representation changes not just appearance, but also what the system is able to do with the information.
MS-RR-SR-23 Search	Analyze how search processes influence the speed and accuracy of AI system decisions.	In grades 7–8, students compare the results of two search processes and explain how each one affects both speed and accuracy. They describe which search was faster, which was more thorough, and what tradeoffs were involved in choosing one over the other. A strong response shows that students understand system decisions can be shaped by how the search is carried out, not just by the problem itself.
MS-RR-RN-24 Reasoning	Analyze how a reasoning strategy that works in one context may produce different outcomes in another.	In grades 7–8, students analyze a case in which a reasoning strategy worked well in one setting but poorly in another. They identify what changed about the context, explain which assumptions no longer held, and describe how that change influenced the final outcome. A strong response shows that students understand reasoning strategies can be highly dependent on the setting in which they are used.



Computer Science Connection

MS-ALG-PS-03 Verify the accuracy of an algorithm for given inputs.

MS-ALG-PS-04 Justify whether a problem is best solved using procedural instructions, rule-based logic, data-driven methods, or a combination of these approaches.

MS-ALG-ML-06 Hypothesize how a machine learning model generates classifications or predictions.

MS-ALG-ML-08 Evaluate the features and limitations of a machine learning model.

Societal Impact

Standard Code	Iowa Academic Standard	Standard Clarification
MS-SI-EA-25 Ethical AI	Analyze how different perspectives influence decisions about designing or using AI systems.	Students examine an AI-related case and compare how different people or groups might view the system. They explain what values or concerns shape each perspective and how those differing viewpoints could lead to different design or use decisions. A strong response shows that students understand technology decisions are shaped by competing priorities, not just by technical possibility.
MS-SI-EA-26 Ethical AI	Analyze how ethical decisions influence how AI systems affect people.	Students examine a case in which design or use decisions changed how people were affected by a system. They explain what ethical choice was made, who was helped or harmed, and how that decision shaped the result. A strong response shows that students understand ethical choices influence how technologies affect real people.
MS-SI-BA-27 Bias in AI	Identify that AI outcomes can affect users differently.	Students compare how different users are affected by the same system output and explain why the effects are not the same for everyone. They identify what makes the outcome more helpful for some people and more harmful or limiting for others. A strong response shows that students understand outcomes often produce uneven impacts rather than a single shared effect.
MS-SI-AS-28 AI in Society	Evaluate how AI systems shape culture and public understanding.	Students examine examples of AI-curated or AI-generated information and evaluate how those systems may shape what people notice, discuss, or come to believe. They identify what the system makes more visible, what may be reduced or excluded, and how that influences public understanding. A strong response shows that students understand AI systems help shape shared understanding, not just individual exposure to information.
MS-SI-AS-29 AI in Society	Evaluate how AI systems influence culture, media, and access to information.	Students analyze examples of systems that sort, recommend, rank, or filter content and evaluate how those systems shape access to information. They explain what becomes easier to find, what may become less visible, and how those patterns affect people's experience of media and culture. A strong response shows that students understand access is shaped by system design, not just by what information exists.

Computer Science Connection

MS-ALG-IM-09 Evaluate which human-centered design principles are present or missing in existing computing technologies.

MS-SOC-ET-41 Evaluate how design decisions in emerging technologies influence user experiences differently across different communities.

MS-SOC-ET-42 Debate ways an emerging technology impacts the social, cultural, and environmental issues in local communities.

MS-SOC-HU-43 Analyze how the decisions humans make when using computing technologies have ethical and social consequences.

Foundational High School Standards

Perception

Standard Code	Iowa Academic Standard	Standard Clarification
HS-PC-DK-01 Domain Knowledge	Analyze how domain knowledge embedded in AI systems influences relevance and performance.	Students analyze how domain-specific knowledge shapes a system's performance in a real or simulated example. They explain how the system becomes more useful, relevant, or accurate in one setting because of the knowledge built into it, and they also describe how that same specialization can become a limitation when the system is used in a different context. A strong response should show that students understand domain knowledge as both a strength and a boundary.
HS-PC-PR-02 Processing	Evaluate how processing assumptions and data handling choices influence AI system outcomes.	Students examine a system's design choices around filtering, organizing, or interpreting information and evaluate how those choices shape the outputs. They explain which kinds of patterns, perspectives, or results are strengthened or reduced by those choices and assess how those decisions influence the usefulness, fairness, or reliability of the system's outcomes. A strong response should connect specific data handling choices to concrete consequences in the final output.

Natural Interaction

Standard Code	Iowa Academic Standard	Standard Clarification
HS-NI-NL-03 Natural Language	Design a framework for evaluating how reliably and appropriately an AI system communicates in a specific real-world context, and apply it to produce evidence-based findings.	Students develop or apply a set of criteria to multiple system outputs in the same real-world context. They identify patterns of strength and weakness, explain what makes the communication more or less reliable or appropriate, and support their conclusions with evidence from the examples they reviewed. A strong response should show that students are evaluating outputs systematically rather than reacting to isolated strengths or errors.
HS-NI-NL-04 Natural Language	Evaluate a generative AI language system's outputs	Students analyze a collection of generated outputs, identify recurring strengths and weaknesses, and explain what those patterns suggest about the system's design, prompting, or limitations. They evaluate whether the outputs are appropriate for the intended use and support their conclusions with evidence from across the full set of examples. A strong response should show that students are looking for repeated patterns rather than judging the system from a single output.
HS-NI-CR-05 Commonsense Reasoning	Analyze how failures in AI systems create real-world risks in a specific domain.	Students analyze a documented or simulated system failure in a specific domain and construct an evidence-based explanation of why the failure had meaningful consequences. They identify what kind of misunderstanding, misinterpretation, or limitation was involved and explain how that failure created risk for people affected by the system's use. A strong response should show that students understand the connection between technical or communicative failure and real-world impact.

Standard Code	Iowa Academic Standard	Standard Clarification
HS-NI-UE-06 Understanding Emotion	Debate the appropriateness of AI emotion recognition in a specific context, addressing competing stakeholder perspectives.	Students analyze a specific use of emotion recognition, examine stakeholder perspectives, and justify a position using evidence about accuracy, consent, risk, potential benefit, and possible harm. They should show that their position takes into account both the purpose of the system and the people affected by it. A strong response should reveal that they understand appropriateness depends on more than whether the tool “works.”
HS-NI-HA-07 Human-AI Interaction	Design an AI interface that prioritizes transparency, explainability, and meaningful human oversight.	Students analyze or design an interface for a system and explain how its features support or fail to support transparency, explainability, and meaningful oversight. They identify what information a user would need in order to question, correct, or appropriately trust the system, and they justify their evaluation using specific interface features. A strong response should show that students understand oversight depends on what the interface makes visible and usable to the person interacting with it.
HS-NI-PM-08 Philosophy of Mind	Integrate perspectives from philosophy, computer science, and ethics to defend their own structured argument on whether or not AI can think, judge, understand, or create.	Students construct and defend an argument about whether systems can think, judge, understand, or create. They use examples, technical evidence, philosophical reasoning, and ethical considerations while also addressing counterarguments. A strong response should show that students are integrating multiple ways of thinking about the question rather than relying on a single definition or a single example.

Learning

Standard Code	Iowa Academic Standard	Standard Clarification
HS-LN-NOL-09 Nature of Learning	Analyze how the diversity and quantity of data in a training set directly impact the accuracy of a model.	Students compare model results from training sets that differ in size and diversity, analyze how those differences affect performance across multiple kinds of inputs, and explain why diversity of data can matter as much as or more than the total number of examples. A strong response shows that students understand both quantity and diversity shape what a model can learn.
HS-LN-NL-10 Nature of Learning	Critique an AI system's learning outcome by examining the bias, scale, and curation of its original training pipeline.	Students investigate a real or simulated system that produced a flawed, or limited outcome. They trace that outcome back to likely choices in the training process, explain how those choices shaped what the system learned, and critique which parts of the process most need improvement. A strong response shows that students can connect visible outcomes to earlier training decisions.
HS-LN-MD-11 Modeling	Differentiate between the structures of a decision tree (nodes/questions) and a neural network (layers/weights).	Students compare a decision tree and a neural network built for a similar task. They explain how each structure organizes decision-making, what kinds of information each handles well, and how the differences in structure affect the way each model reaches an output. A strong response shows that students understand model structure shapes both how the model works and how easy it is to understand.
HS-LN-MD-12 Modeling	Compare how different model architectures (e.g., Feed-forward vs. Convolutional) are suited for different tasks like text or images.	Students compare two or more model designs on different types of tasks and explain why one design is better suited to one kind of input than another. Their explanation should connect the structure of the model to the demands of the task. A strong response shows that students understand models are not interchangeable and that their design matters for the problems they can solve well.
HS-LN-MD-13 Modeling	Evaluate the mathematical fit of a model (such as a regression) using metrics like mean squared error or decision boundaries.	Students calculate, interpret, or compare evaluation measures for one or more models, explain what those measures reveal about performance on training and test data, and defend their conclusion about which model is the better fit. A strong response shows that students can use mathematical evidence to evaluate a model rather than relying on intuition alone.
HS-LN-DS-14 Data Sets	Detect potential sources of bias by examining the features and labels in a training set.	Students inspect a training set, identify features or labels that may contribute to flawed outcomes, and explain why those data choices matter. They describe how the problem might affect future predictions and propose ways the dataset could be improved. A strong response shows that students can connect possible bias in the data to later bias in model behavior.
HS-LN-DS-15 Data Sets	Analyze a learning curve to determine the point where more data no longer improves a model.	Students interpret a learning curve, identify where additional data produces little improvement, and explain what that suggests about the model's current limits. They then describe what a developer might investigate next, such as different features, another model, or changes to data quality. A strong response shows that students can use performance trends to reason about future model choices.

Standard Code	Iowa Academic Standard	Standard Clarification
HS-LN-DS-16 Data Sets	Evaluate the effectiveness of a machine learning pipeline based on data curation and test results.	Students review a full model-building process and evaluate how well it is likely to perform in its intended use. They identify strengths and weaknesses in how the data was prepared, how the model was tested, and how the results were interpreted. A strong response shows that students understand model performance depends on the full process, not just on the final output or score.
HS-LN-NN-17 Neural Networks	Model how a neural network uses feedback (backpropagation) to "fix" a mistake and improve its next guess.	Students analyze a simplified example of a network making an incorrect prediction, receiving feedback, and adjusting internal values. They explain how the correction changes later behavior and why repeated feedback helps the system improve over time. A strong response shows that students understand the network uses errors to change future performance.
HS-LN-NN-18 Neural Networks	Differentiate between the shallow layers (basic features like lines) and deep layers (complex features like faces) of a network.	Students examine examples showing what different layers in a network respond to and explain how simple features in early layers contribute to more complex representations in later layers. A strong response shows that students understand deeper layers build on earlier ones rather than repeating the same work.
HS-LN-NN-19 Neural Networks	Analyze how the number of hidden layers in a neural network affects its ability to solve complex problems.	Students compare networks with different numbers of hidden layers on the same task, analyze where added depth improves performance and where it creates problems, and explain why deeper is not always better. A strong response shows that students understand added complexity can create both advantages and costs.
HS-LN-NN-20 Neural Networks	Evaluate the performance of a deep learning model by analyzing its training loss and validation accuracy.	Students interpret training loss and validation accuracy graphs, identify important patterns in the curves, explain what those patterns suggest about the model's learning, and propose a reasonable next step such as changing the training time, revising the data, or adjusting the model. A strong response shows that students can use evidence from the graphs to reason about model performance over time.

Representation & Reasoning

Standard Code	Iowa Academic Standard	Standard Clarification
HS-RR-RN-21 Representation	Analyze how a representation that works in one context may fail in another due to differences in data or conditions.	Students analyze an example of a system failing when it is used in a different setting, with a different kind of data, or under changed conditions. They explain what assumption the original representation made, why that assumption no longer fits, and how that mismatch led to weaker results. A strong response shows that students understand representations that carry assumptions that can become limitations when the context changes.
HS-RR-RN-22 Representation	Evaluate how data representations influence AI system reliability, validity, and ethical implications.	Students analyze a system and identify a representation choice that affects what the system notices, emphasizes, or ignores. They evaluate how that choice influences the reliability of the results, the validity of the conclusions drawn, and the ethical risks that may follow from those outputs. A strong response shows that students understand representation choices can shape both technical performance and human impact.
HS-RR-SR-23 Search	Evaluate how heuristic search strategies guide AI systems toward solutions more efficiently	Students analyze a system using a heuristic search and explain how the heuristic guides the system toward a solution more quickly. They also examine a case in which that same heuristic could cause the system to miss a better answer and evaluate whether the efficiency gain is worth the possible cost. A strong response shows that students who understand heuristics improve speed by narrowing the search, but may do so at the expense of completeness or accuracy.
HS-RR-SR-24 Search	Analyze how constraints limit and guide the search process in AI systems.	Students analyze a problem with constraints and explain how those constraints affect the system's search process. They describe how adding, removing, or changing specific constraints changes the set of possible solutions and influences what the system is able to find efficiently. A strong response shows that students understand constraints are not only barriers; they also help guide the search toward solutions that fit the task.
HS-RR-SR-25 Search	Analyze how AI systems prioritize certain solution paths to improve search efficiency	Students analyze how a search system prioritizes some solution paths over others and explain what criteria or values are driving that priority. They evaluate how those priorities affect not only the speed of reaching a solution, but also what kinds of outcomes become more or less likely. A strong response shows that students understand prioritization changes both the efficiency of search and the nature of the result that is eventually found.
HS-RR-RN-26 Reasoning	Analyze situations where AI reasoning strategies may fail or produce unexpected results.	Students analyze a documented or simulated system failure and identify the reasoning strategy the system was using. They explain what condition caused the strategy to fail, why that condition mattered, and whether the failure could have been anticipated by looking more carefully at the system's assumptions. A strong response shows that students understand failures often reveal limits in the reasoning approach itself.
HS-RR-RN-27 Reasoning	Evaluate how AI reasoning processes manage uncertainty and influence decision reliability, validity, and ethical risk.	Students evaluate a system used in a high-stakes context and explain how the system manages and communicates uncertainty in its outputs. They assess whether the level of uncertainty is being handled appropriately for the decisions being made and consider how that affects reliability, validity, and ethical risk. A strong response shows that students understand uncertainty shapes both technical trustworthiness and human consequences.

Societal Impact

Standard Code	Iowa Academic Standard	Standard Clarification
HS-SI-EA-28 Ethical AI	Evaluate how different stakeholders may have different perspectives on AI decisions.	Students analyze an AI-related decision and compare how different stakeholders would likely view it. They explain what values, interests, or concerns shape each perspective and how those differences influence what should happen next. A strong response shows that students understand AI decisions cannot be evaluated fairly from only one viewpoint.
HS-SI-EA-29 Ethical AI	Evaluate how ethical principles influence decisions about how AI systems are designed and used.	Students examine an AI case and explain how different ethical principles would influence choices about design, deployment, or revision. They justify which principles should carry the most weight in that context and explain why. A strong response shows that students can apply ethical principles to actual system decisions rather than naming them in the abstract.
HS-SI-EA-31 Ethical AI	Evaluate responsibilities related to authorship, attribution, and originality when using AI	Students analyze examples of AI-assisted work and evaluate whether attribution is adequate. They explain what should count as original contribution, what should be acknowledged, and how responsibility should still be assigned when a tool contributes to the final product. A strong response shows that students understand attribution and originality remain meaningful even when systems are involved in creation.
HS-SI-BA-32 Bias in AI	Evaluate how bias emerges in AI systems and assess strategies used to identify or mitigate it.	Students examine a case where bias emerged in a system and explain how that bias developed. They assess one or more strategies that could be used to identify, reduce, or respond to the problem and explain the strengths and limits of those strategies. A strong response shows that students understand mitigation requires looking back through the design and development process, not just reacting to a visible output.
HS-SI-BA-33 Bias in AI	Analyze how biased AI outcomes can affect users differently.	Students analyze a documented or simulated case of biased AI output and explain how different users are affected. A strong response shows that students understand bias often produces unequal impacts rather than a single universal harm.
HS-SI-AS-34 AI in Society	Analyze how AI systems shape culture, power, and access to information	In high school, students analyze a real or simulated example of an AI system affecting media, information access, or influence. They explain how the system changes what becomes visible, trusted, or amplified and who is affected by those changes. A strong response shows that students understand AI can shape not just information flow, but also power and influence in society.
HS-SI-AS-35 AI in Society	Evaluate how AI can promote social good while introducing new risks.	Students evaluate an example of AI being used for social good and explain both the benefits it offers and the risks it introduces. They justify a position on whether the use is appropriate and describe what safeguards would be needed to reduce harm. A strong response shows that students can evaluate AI use in a balanced way rather than treating it as purely beneficial or purely harmful.

Artificial Intelligence Specialty Standards

Semester 1 Course

Design & Development

Standard Code	Iowa Academic Standard	Standard Clarification
S1-AIN-DD-01	Analyze AI systems to differentiate the types of problems they address.	Students should explore and compare different types of AI systems to understand how they work and what problems they solve. They should analyze generative AI (e.g., chatbots or image creators) and discriminative AI (e.g., image classifiers) to examine how each supports real-world applications (e.g., language translation, image recognition, sentiment analysis, recommendations, game playing). Students are not expected to evaluate the performance or quality of AI systems. Students are not expected to train, build, or modify AI models.
S1-AIN-DD-02	Modify AI system training data to improve fairness and accuracy in outputs.	Students should improve fairness and accuracy by modifying the data used to train an AI model. They should investigate changes in accuracy by modifying training data, making simple changes like improving data representation or balance, and keeping the changes that lead to better results. Students are not expected to understand the mathematical formulas behind fairness metrics or analyze why different fairness measures cannot be satisfied at the same time.
S1-AIN-DD-03	Create an application using pre-existing supervised learning models to make predictions or classifications.	Students should create a functional application (e.g., to classify, to predict) by selecting and integrating an appropriate, pre-existing supervised learning model. For example, students could use a pretrained image classification model (e.g., from a library) and integrate it into a simple web or mobile application that allows users to upload a photo and receive a prediction of the object in the image. Students are not expected to train models from scratch using raw data, develop production-ready applications, or work with advanced architectures requiring specialized hardware (e.g., large language models, deep convolutional networks with dozens of layers).
S1-AIN-DD-04	Compare data representations and how representation choice constrains applicable algorithms.	Students should analyze the trade-offs between different data representations (e.g., tabular vs. relational data, graph vs. network data, image vs. pixel data, text vs. sequence data) and articulate how the chosen representation dictates the suitable class of algorithms for analysis. Students are not expected to develop custom data representations, convert data into multiple representations, or mathematically prove why certain algorithms cannot work with specific data representations. Students are not required to work with specialized data formats beyond common types (e.g., tabular, graph, image, text).
S1-AIN-DD-05	Evaluate when AI versus non-AI computational solutions are appropriate for real-world problems.	Students should evaluate a real-world problem and systematically critique the trade-offs, feasibility, and appropriateness of AI-based solutions versus non-AI computational solutions. For example, students could evaluate whether to use a pre-trained image classification model (AI) to identify defective parts using assembly line photos or use a traditional image-processing algorithm that checks for specific pixel color ranges or geometric shapes (non-AI). Students should assess factors like data availability and interpretability, computational resources, and accuracy needed. Students are not expected to implement AI or non-AI solutions for real-world problems. Students are not expected to produce detailed cost estimates, but recognizing that cost is a factor in choosing between approaches is appropriate.

Data Science for AI

Standard Code	Iowa Academic Standard	Standard Clarification
S1-AIN-DS-06	Examine how data flows through a neural network structure.	Students should examine how input data moves through a neural network's layers, how weights and activation functions modify the data at each step, and how the final output is generated. They should conceptually trace how a numerical input value flows through a single neuron, is modified by the weight and bias, and is then transformed by the activation function before moving to the next layer. Students should explain this process clearly, using appropriate vocabulary and visual representations (e.g., diagrams, annotated examples). Students are not expected to implement neural networks from scratch, understand the mathematical formulas for backpropagation, or work with advanced architectures (recurrent neural networks, transformers, convolutional neural networks with many layers).
S1-AIN-DS-07	Apply data acquisition, cleaning, and transformation techniques to prepare data for AI analysis.	Students should perform hands-on application of data preparation steps, including acquiring data from sources (e.g., comma-separated values [CSV] files, public APIs, web scraping of small-scale data), identifying and handling missing values (imputation or removal), and performing basic transformations (normalization) necessary for training an AI model. For example, students could use a programming library to load a raw dataset, clean inconsistent entries, convert non-numeric features into a machine-readable format, and split the data into training and testing sets before model application. Students are not expected to work with datasets requiring distributed computing infrastructure or implement advanced data preprocessing algorithms from scratch.

Human Responsibility

Standard Code	Iowa Academic Standard	Standard Clarification
S1-AIN-HR-08	Plan safeguards for AI systems that protect human well-being and privacy while ensuring meaningful human involvement in decision-making.	Students should plan safeguards in AI systems focusing on practical measures to protect privacy, ensure human well-being, and maintain meaningful human involvement in critical decision-making processes. For example, students could analyze a scenario where an AI is used for medical diagnosis and formulate a human-in-the-loop workflow where the AI provides a recommendation, but a qualified human doctor is required to make the final, auditable diagnosis, thereby ensuring meaningful human involvement and protecting patient well-being. Students are not expected to develop formal methods for verifying AI safety.
S1-AIN-HR-09	Analyze the potential limitations of AI systems.	Students should employ both qualitative and quantitative methods to identify and analyze systemic issues in AI systems, investigating how l biases are encoded in the training data, model architecture, and application design. Students should analyze AI systems they created themselves as well as AI systems created by others.
S1-AIN-HR-10	Analyze the environmental impacts of widespread AI adoption.	Students should quantitatively and qualitatively analyze the environmental impacts of AI, specifically focusing on the energy consumption required for model training and inference and the resulting carbon footprint and electronic waste. Students should consider how these environmental impacts affect different communities, recognizing that the costs of AI infrastructure (e.g., data center energy use, water consumption, e-waste disposal) are often concentrated in specific regions and populations. For example, students could compare the estimated carbon dioxide emissions generated by training a large language model versus the energy used by a local, optimized model running on an edge device. Students are not expected to conduct complex, full life-cycle assessments for computing hardware.

Professional Practice

Standard Code	Iowa Academic Standard	Standard Clarification
S1-AIN-PP-11	Integrate a prebuilt AI agent into an application.	Students should integrate a prebuilt AI agent into a computational application to accomplish a specific task, given information on available AI agents or services. Such prebuilt AI agent templates may include web search, data analysis, creative writing, or customer support bots. Students are not expected to design or train their own agent.
S1-AIN-PP-12	Analyze how AI tools shape user experiences for people with different backgrounds and characteristics.	Students should analyze how AI tools produce different user experiences a). They should examine differences in outputs and interactions and explain how training data, system design, or deployment context contribute to those differences. Students are not expected to design user experience studies for AI tools or implement adaptive personalization systems.
S1-AIN-PP-13	Assess how unauthorized data collection has influenced the practice of training AI models.	Students should evaluate the tension between respecting creators' intellectual property rights and the practice of using copyrighted works to train AI models. They should also consider broader forms of unauthorized data collection, such as scraping personal images or collecting user behavior data without consent. Students could debate whether AI companies should obtain permission and provide compensation when training models on copyrighted works, considering arguments about fair use, the transformative nature of AI-generated outputs, and whether scraping publicly accessible content from the internet constitutes legitimate use or infringement. Students are not expected to cite specific legislation or case law.
S1-AIN-PP-14	Evaluate how ethical implications of AI have changed over time.	Students should conduct a critical evaluation of AI ethics, appraising how ethical considerations have changed over time. For example, students could assess the ethical concerns surrounding early conceptions of AI (Asimov's Three Laws of Robotics) and rule-based AI systems (concerns about programming errors and logic) and compare them with the ethical implications of contemporary AI systems that focus on fairness, and transparency. Students should also evaluate ethical challenges that may emerge as AI capabilities advance, drawing from futuristic depictions of AI in media or their own imaginations. Students should communicate their evaluation clearly, articulating how ethical concerns have shifted and presenting a reasoned perspective on emerging challenges. Students are not expected to conduct research on AI development trajectories or apply specific ethical frameworks. Students are not expected to rigorously define consciousness or sentience in discussions of future AI capabilities.

Semester 2 Course

Design & Development

Standard Code	Iowa Academic Standard	Standard Clarification
S2-AIN-DD-01	Analyze problems that can be addressed using unsupervised learning.	Students should analyze and categorize the types of real-world problems that can be effectively addressed using unsupervised learning approaches. They should categorize problem characteristics that make unsupervised learning appropriate (e.g., lack of labeled data, need to discover hidden patterns, exploratory data analysis) and provide examples of problem types (e.g., customer segmentation, anomaly detection, dimensionality reduction, pattern discovery in large datasets). Students are not expected to implement unsupervised learning algorithms or prove their mathematical convergence properties.
S2-AIN-DD-02	Optimize an AI algorithm's performance for a given problem.	Students should optimize the performance of a pre-existing AI algorithm or model for a given problem by modifying and tuning the parameters and structures of the algorithm or model. This involves actively altering the algorithm's control flow or hyperparameters, not simply using preset tools. For example, students might optimize an algorithm used in discriminative systems (e.g., by changing the depth of a decision tree used for an image classifier) or adjust the sampling parameters of a generative system. Students could work across different problem domains employing different optimization approaches, such as tuning weights for sentiment analysis, modifying neural network layers for image recognition, or adjusting model parameters for a recommendation system. Students are not expected to implement algorithms from scratch, work with production-scale systems, or optimize across all possible hyperparameters using advanced techniques (e.g., Bayesian optimization, neural architecture search).
S2-AIN-DD-03	Create an application using complex supervised learning models.	Students should design and develop an application that integrates complex supervised learning models to solve a real-world problem. Complex supervised learning models are defined as using more advanced model structures (e.g., random forests, neural networks), larger or richer feature sets, and multiple layers or decision paths. The design and development process includes selecting an appropriate model type (e.g., neural networks, ensemble methods, advanced regression and classification techniques), preparing and preprocessing labeled data, and training the model using suitable tools or libraries. Students should incorporate the trained model into an end-to-end application (e.g., a web app, mobile app, interactive tool) that accepts user input, performs inference, and returns predictions in a usable form. For example, students could create a home price prediction application, select relevant features from housing data (e.g., square footage, location, number of bedrooms), train a supervised learning model, and evaluate its performance by testing predictions against actual prices using appropriate metrics. Students are not expected to design or implement deep learning models.

Data Science for AI

Standard Code	Iowa Academic Standard	Standard Clarification
S2-AIN-DS-04	Evaluate metadata and data pipelines to support transparency in AI model selection and deployment.	Students should critically evaluate the entire data pipeline from acquisition through cleaning for potential sources of bias, inaccuracy, and lack of transparency. Students should use this appraisal to justify or critique the selection of a specific AI model and its deployment context. Students are not expected to design and implement algorithmic fairness metrics.
S2-AIN-DS-05	Transform data to meet the input requirements of AI algorithms.	Students should apply data transformation and restructuring techniques to prepare data for AI algorithms, including feature scaling, handling categorical data, aggregating data, and reshaping data. For example, students could take a raw dataset with mixed feature types and apply normalization to numerical columns and one-hot encoding to categorical columns to prepare the data for a specific algorithm (e.g., k-nearest neighbors classifier). Students are not expected to implement dimensionality reduction techniques.

Human Responsibility

Standard Code	Iowa Academic Standard	Standard Clarification
S2-AIN-HR-06	Develop policies that promote transparency in AI applications.	Students should develop a well-reasoned, actionable, and specific policy recommendation aimed at increasing transparency across the AI lifecycle, from raw data to deployed impact, and justify how that policy balances competing values like innovation and privacy. For example, students could draft a policy requiring that high-risk AI applications (e.g., in hiring, in criminal justice) publicly disclose the training data sources, the model type, and the results of a bias analysis before deployment. Students are not expected to cite existing state or federal statutes or implement the technical infrastructure (e.g., secure data vaults) required to make sensitive data accessible. Students are not expected to produce policy documents that meet professional or legal standards.
S2-AIN-HR-07	Analyze how model optimization choices impact a model's performance, interpretability, and fairness.	Students should analyze how different optimization choices (e.g., using gradient descent, adding regularization) and accuracy measures (e.g., F1-score, mean absolute error) affect how an AI model performs and how those choices can impact fairness and interpretability. Students are not expected to write code or calculate complex metrics.

Professional Practice

Standard Code	Iowa Academic Standard	Standard Clarification
S2-AIN-PP-08	Develop an AI agent to accomplish a defined task.	Students should design, develop, and optimize an AI agent by setting a clear goal, choosing the information it can use and defining simple steps for how it responds and takes actions. They should develop the agent using an accessible tool and optimize it by testing on a set of realistic prompts. Students are not expected to build custom AI models for their workflow.
S2-AIN-PP-09	Develop professional communications by interpreting technical AI results for all potential audiences.	Students should develop professional communications by translating model performance metrics (e.g., F1-score, precision, recall) and ethical risks into language that is relevant and actionable for specific nontechnical audiences. For example, students could create a presentation on an AI-driven school admissions model where the executive summary for the school board focuses on cost-savings and scalability, and the community group briefing focuses on fairness metrics and due process for appeals. Students are not expected to create publishable graphics or animated media or to participate in real-world communications campaigns.
S2-AIN-PP-10	Debate aspects of AI regulatory frameworks and legislation across countries.	Students should assess major AI regulatory frameworks from at least two regions of the world (e.g., the European Union's AI Act [EU AI Act] vs. a US state or federal approach). Students should critique the core philosophical approaches and practical impacts on key areas like data sovereignty and governance. For example, students could assess how the EU's focus on regulating "high-risk" AI systems differs from a less restrictive regulatory environment and debate the resulting impact on innovation speed versus human protections in areas like facial recognition. Students are not expected to read the text of legislation.

Data Science

Data science is an interdisciplinary field that combines scientific methods, algorithms, mathematics and statistics to extract and Data science is an interdisciplinary field that combines scientific methods, algorithms, mathematics and statistics to extract and communicate actionable insights and knowledge from structured and unstructured data. Data science focuses on collecting, organizing, analyzing, and interpreting data in order to discover patterns, generate insights, and support informed decision-making. It integrates methods from Statistics, Computer Science, and Mathematics to transform raw data into meaningful information.

In modern society, vast amounts of data are generated daily through digital technologies, scientific research, commerce, and public systems. Data science provides the tools and techniques necessary to process and analyze this information. Methods such as data collection, data cleaning, visualization, modeling, and interpretation allow individuals and organizations to understand complex systems and make evidence-based decisions.

The rapid expansion of data in nearly every sector has made data literacy and analytical thinking essential skills for students preparing for college, careers, and civic life. Learning these data science standards will help prepare students to ask meaningful questions, analyze information and draw evidence-based conclusions. Developing these skills will support success across academic disciplines and prepare students for a wide range of postsecondary pathways.

Data science is inherently interdisciplinary, providing meaningful connections across all content areas as it provides students with a more thorough understanding of human behavior, and societal and historical trends explored in those content areas through a systematic and comprehensive understanding of the related data allowing them to develop deep insights and understanding.

Though data science is used in every other content area, data science has a tighter connection to the math and science areas as it is heavily built upon the foundations learned in those content areas. Data science is built on the scientific principles of inquiry, evidence and systematic investigation while the foundations of mathematics provide the structure, precision and logic needed to collect, analyze and interpret data. Algebra and functions play a critical role in data science as they allow students to model relationships between variables, represent patterns symbolically and make predictions. Because of these foundational ties to math and science, these standards are meant to be used alongside the math and science standards. During the writing process, conscious decisions were made to not repeat standards necessary to data science that already existed in the math and science standards.

The K-12 Data Science Standards are divided into five concept areas, these include Dispositions & Responsibilities, Creation & Curation, Analysis & Modeling Techniques, Interpreting Problems & Results, and Visualization & Communication. Each of these concept areas contain smaller subconcepts that when combined help students form a more complete understanding of the larger concept. In addition to these foundational concept areas, there are specialty standards addressing more advanced learning for students who are interested in expanding their learning beyond foundational concepts. These specialty standards are designed to help teachers plan more advanced data science courses to help students progress along a data science career pathway.

Woven throughout the standards in these concept and subconcept areas are the Data Science Practices. The data science practices are methods and approaches that are essential to each concept area to ensure students fully comprehend the workings and impacts of data science and help them develop habits to better understand and utilize data.

Data Science Concepts & Subconcepts

Dispositions & Responsibilities (DR)

This concept is about knowing what data is, where it comes from and how people shape it. The nature of data is complex, dynamic, multifaceted and humanistic. Students learn to consider the form data can take, where it can come from and what it can and should be used for. Data can be powerful for supporting advancement and enacting change. Due to this, it is important to understand that all stages of the data process involve humans which can lead to concerns about ethics and responsibilities.

Nature of Data (ND)

Data comes in many forms (number, text, images, audio, etc.) and is complex, variable, often incomplete and heavily influenced by humans. Students start by identifying different types of data to ask and answer questions. Over time, they learn to distinguish categorical from numeric data, understand how multiple variables define a case, and analyze how data types influence interpretation. By high school, they explore qualitative vs. quantitative distinctions, discrete vs. continuous variables, and how multiple data types provide complementary insights. At all levels, students see data as a tool for investigation, reasoning, and evidence-based decision-making.

Data Ethics & Responsibilities (ER)

This subconcept focuses on the impact of humans on data and of data on humans focusing on the power and pitfalls of data that can stem from the choices in data collection, analysis and display.

Investigative Dispositions (ID)

Working with data is an iterative cycle in which questions, analysis and interpretation evolve continuously. Students learn that making sense of data requires combining skills from across strands—such as designing questions, analyzing results, and applying context—and that conclusions may change as new data or insights emerge. They also develop an awareness that the context of an investigation shapes interpretation and that cultivating curiosity and agency with data helps them engage with data in all areas of life, understand its impacts, and adapt their thinking as they explore real-world questions.

Creation & Curation (CC)

This concept focuses on how data originates and how it is gathered, organized and prepared for analysis. They learn to create data collection plans, make decisions about measurement and clean and transform data in ways that support meaningful analysis developing skills for handling increasingly complex datasets.

Organization & Processing (OP)

Students learn to organize raw data into structured formats, clean errors and quality issues, and transform or manipulate data through actions like sorting, grouping, and filtering, learning the steps necessary to making data reliable and ready for deeper investigation.

Designing Data for Collection (DC)

Students learn to plan thoughtful, purposeful data investigations that start with identifying a meaningful problem or question and then choosing appropriate methods to gather data that can help answer it, including understanding different techniques for creating data, developing systematic plans for what and how to collect data, exploring, locating, evaluating and retrieving datasets collected by others, ensuring data collection supports reliable and insightful analysis.

Measurement & Datafication (MD)

Students learn how data is collected and how the choices made during collection affect the quality and usefulness of the data. They will collect, measure and document their own data using appropriate tools and methods and evaluate data collected by others. Students will also practice using data responsibility, considering privacy, fairness and potential impacts of collecting and using the data.

Complexity of Data (CD)
Students develop skills to work with increasingly complex data sets. As students progress through the standards, they develop experience recognizing and cleaning increasingly complex datasets with different types of variables for different analytical purposes. They also learn to organize and restructure data in more sophisticated ways, combining and transforming to uncover patterns and insights.

Analysis & Modeling Techniques (AM)

Analysis and Modeling Techniques helps students make sense of data by developing skills in summarizing data, examining distributions, comparing variables and recognizing how missing data, variability can influence results. As students progress they use visualizations, statistical methods and digital tools to analyze data, build and refine models and make predictions.

Summarizing Data (SD)
Summarizing data provides students with the learning they need to move data from raw information to more meaningful and interpretable forms of data so it can be used to answer questions, make claims or tell a story.

Identifying Patterns & Relationships in Data (PR)
Identifying patterns and relationships in data helps learning make sense of how variables interact and what those interactions reveal about the world. This work focuses on numerical, and non-traditional data forms including text, sound, or sensor data as students learn to compare variables, develop an understanding of distributions and organize data to identify trends, relationships and correlations.

Variability in Data (VD)
Variability in data reflects how data points differ from one another and from summary measures. Students explore how variability can come from natural differences, measurement errors, bias or missing values and how these sources influence the interpretation of data.

Digital Tools of Data Analysis (DT)
As datasets grow in size and complexity, it becomes increasingly necessary to use digital tools to explore and analyze data. Students learn to select and apply the appropriate tools to summarize data, create visualizations, identify patterns, clean and prepare data and perform deeper analysis or simulations that reveal trends and relationships. There is also a focus in this strand about the broader ethical considerations of using digital tools.

Models of Data (MOD)
Students learn to deepen their understanding of data and the underlying context by increasing their understanding of using and creating data models. Models use summary measures, visualizations or mathematical functions to highlight essential structure and reveal trends. When creating models, students make and evaluate assumptions, consider sources of variability and uncertainty and refine models to improve accuracy and usefulness.

Interpreting Problems & Results (IPR)

Students learn to use data thoughtfully to formulate strong questions and make evidence-based claims through clearly defining problems that can be answered with data, understanding the limitations of datasets and explaining reasoning within the context of how data was collected and analyzed.

Making and Justifying Claims (MC)
Because all data contains variability, claims should be grounded in careful thinking rather than simple observation, paying attention to patterns within and across variables and things such as expected and prior values, sample sizes and significance.

Problem Identification & Question Formulation (PI)
Clearly defined problems and questions create more purposeful, efficient, valid and actionable insights. Students develop the skills to do this by identifying questions that can be answered by data, practice identifying alternative explanations for a result, explaining the limitations of a conclusion and ensuring the method of analysis does not distract from the problem.

Generalization & Application (GA)

Students practice identifying when generalization issues arise, understanding how sample size and potential biases affect what can be inferred and recognizing that filtering data into subsets can sometimes change conclusions. Students also learn how to strengthen claims and reflect on how multiple trials or broader evidence related to a generalization.

Visualization & Communication (VC)

Effective communication of data insights is essential. Students learn to communicate insights with purpose-driven visualizations and narratives tailored to specific audiences through creating and interpreting graphical representations connected to compelling stories about data to support real-world action and societal benefit.

Representations & Dynamic Visualizations (RV)

Students learn to create clear and accurate visual summaries including charts and graphs to convey insights effectively, incorporating graphical literacy.

Data Storytelling (DS)

Students learn how to combine accurate visualizations with narrative elements to guide interpretation, emphasize key findings and connect results back to real-world context or decisions. The goal of data storytelling is not just to present data but to help others understand why the information matters and what conclusions or actions are supported by the evidence.

Acting on Data to Benefit Society (BS)

One of the goals of working with data is applying interpretations and conclusions to real-world problems to enact positive change on the world. Students learn how to question the perspective behind the analysis and be transparent about one’s own viewpoint.

Kindergarten Standards

Dispositions & Responsibilities

Standard Code	Iowa Academic Standard	Standard Clarification
EK-DR-ND-01 Nature of Data	Identify that information can come from pictures, books, videos, sounds, and people.	Students should be able to recognize that they can find out facts and learn new things from many different sources in the world around them. This involves understanding that information doesn't just come from numbers on a page, but from things they see, hear, and talk about every day. For example, a student might look at a picture of a rainy day to know it is wet outside or listen to a recording of a bird to learn what its song sounds like. The focus is on helping children see that pictures, books, videos, sounds, and people are all different ways to get information. Students are not required to write down a list of where they found their facts, use a computer to search for data, or explain why one source might be better than another.
EK-DR-ER-02 Data Ethics & Responsibilities	Explain how counting or collecting information can help make decisions.	Students should be able to see how counting or gathering simple information can help them make better choices for their group or classroom. This involves connecting a choice they need to make to the act of checking what everyone wants or what is available. For example, if a class is trying to decide which game to play at recess, a student could count how many children want to play tag versus how many want to play hide-and-seek to pick the most popular choice. The focus is on showing that looking at data is a helpful way to plan ahead and be fair to everyone. Students are not required to create formal ways to gather data or look at the long-term impact of their decisions.
EK-DR-ER-03 Data Ethics & Responsibilities	Explain how the way we collect or count things can change our results.	Students should be able to understand that the way they choose to count or look at things can change the answer they get. This involves realizing that different methods of gathering information might lead to different stories about what is happening in the classroom. For example, if a student counts how many friends like apples by only asking the people sitting at their own table, they might get a different result than if they asked everyone in the whole class. The focus is on seeing that how we collect information matters and can change what we think is true. Students are not required to understand sampling bias or write down how they collected data.

AI Connection

EK-PC-DK-01 Identify how humans use knowledge provided by people.

Computer Science Connection

EK-DAT-DC-08 Use collected data to help answer questions.

EK-DAT-DI-09 Investigate a question that can be answered by collecting data in students' everyday environments.

EK-DAT-IM-10 Investigate how data can help a person make informed decisions in everyday life.

Creation & Curation

Standard Code	Iowa Academic Standard	Standard Clarification
EK-CC-DC-04 Designing for Data Collection	Ask a simple question that can be answered by counting or sorting.	Students should be able to think of a simple question that can be answered by looking at or grouping the things around them. This involves turning a curiosity about their classroom or friends into a goal that can be solved by counting. For example, if a student wonders which color of block is the most popular, they could ask, "How many red blocks and how many blue blocks are in the bin?" The focus is on learning how to ask a question that has a clear, countable answer rather than a question that is just a guess. Students are not required to collect data.
EK-CC-DC-05 Designing for Data Collection	Identify various places information can be found to answer a question.	Students should be able to recognize that when they have a question, they can look in different places around the room to find the answer. This involves realizing that different tools, like a colorful picture book, a specific classroom bin, or a website, hold the facts they are looking for. For example, if a student wants to know what a butterfly eats, they could look for a book with pictures of insects or find a poster on the classroom wall about nature. The focus is on knowing that they don't have to guess because information is tucked away in many familiar places they can access themselves. Students are not required to use search engines to find specific websites.
EK-CC-MD-06 Measurement & Datafication	Explain why using the same unit each time is important.	Students should be able to understand that using the same tool or object every time they measure something helps them get a fair and correct answer. This involves realizing that if the "unit" changes size, the count will not make sense to anyone else. For example, if a student measures the length of a rug using their own footsteps and then a friend measures it using their footsteps, they might get different numbers because their feet are different sizes. The focus is on learning that for a measurement to be helpful and true, the "ruler" or object used must stay the same size every time. Students are not required to use standard tools like rulers with inches or centimeters.



Computer Science Connection

EK-DAT-DC-08 Use collected data to help answer questions.

EK-DAT-IM-10 Investigate how data can help a person make informed decisions in everyday life.

Analysis & Modeling Techniques

Standard Code	Iowa Academic Standard	Standard Clarification
EK-AM-PR-07 Identifying Patterns & Relationships in Data	Identify how two groups are alike or different after sorting and counting.	Students should be able to look at two groups of items they have sorted and describe how they are the same or different based on their counts. This involves moving beyond just naming the groups to comparing the numbers or sizes between them. For example, after sorting a bag of blocks into a red pile and a blue pile, a student might notice that the red pile is much taller, meaning there are more red blocks than blue ones. The focus is on using the results of sorting to make simple comparisons like "more," "less," "the same," or "bigger." Students are not required to calculate the exact numerical difference using subtraction, or use greater-than or less-than symbols.
EK-AM-MOD-08 Models of Data	Recognize that having a rule for sorting objects helps organize them and see patterns.	Students should be able to understand that using a specific rule to group objects makes it much easier to see what is happening with their data. This involves realizing that without a rule, a pile of items is just a mess, but with a rule, patterns like "most" and "least" appear. For example, if a student decides the rule is "sort by shape," they can put all the circles in one spot and all the squares in another to quickly see that the circle pile is much bigger. The focus is on recognizing that a consistent rule is the key to turning a jumble of things into organized information that tells a story. Students are not required to follow multiple rules at once (like color and shape combined).



AI Connection

EK-LN-MD-06 Identify simple rules that can be used to group objects into classes based on their features.



Mathematics Connection

K.MD.B.3 Classify objects into given categories; count the numbers of objects in each category and sort the categories by count.

Interpreting Problems & Results

Standard Code	Iowa Academic Standard	Standard Clarification
EK-IPR-MC-09 Making and Justifying Claims	Predict an outcome before collecting data.	Students should be able to make a smart guess about what might happen before they actually start counting or looking at information. This involves using what they already know about their world to imagine what the results might look like. For example, students might guess which flavor of ice cream will be the class favorite before asking their friends, or predicting that it will be sunny tomorrow because they saw no clouds in the sky today. The focus is on practicing the habit of thinking ahead and forming a "guess" that they can later check against the real facts. Students are not required to use the word "hypothesis."

Visualization & Communication

Standard Code	Iowa Academic Standard	Standard Clarification
EK-VC-RV-10 Representations & Dynamic Visualizations	Sort information in different ways, like a bar graph for numbers or a picture graph for categories.	Students should be able to see that the same information can be organized in different ways depending on what they want to show. This involves moving their items or pictures into different shapes to answer different questions, such as "how many" versus "what kind." For example, if a student has a collection of toy animals, they could arrange them into a tall tower (a bar graph) to show which group is the highest, or place them next to pictures of a forest and a farm (a picture graph) to show where they live. The focus is on realizing that changing the way data is arranged can help others understand the information more clearly. Students are not required to label axes with specific mathematical terms, or ensure that every picture in a graph is exactly the same size.
EK-VC-DS-11 Data Storytelling	Describe what a collection of objects shows.	Students should be able to look at a group of items they have organized and tell a simple story about what the information is saying. This involves moving beyond just naming the items to explaining what the whole collection means as a group. For example, if a student has sorted a pile of shoes by those with laces and those with Velcro, they could describe the collection by saying, "Most kids in our class wear Velcro shoes because they are faster to put on." The focus is on helping children use their own words to share the "big idea" behind the data they have gathered. Students are not required to write using formal data terminology, or present to tell their story.

First Grade Standards

Dispositions & Responsibilities

Standard Code	Iowa Academic Standard	Standard Clarification
E1-DR-ND-01 Nature of Data	Explain the importance of knowing where data was collected before using it to answer a question.	Students should be able to check where a piece of information came from to decide if it is the "right" data to help them solve a specific problem. This involves moving beyond just reading numbers to thinking about whether the source actually matches the group or place they are studying. For example, if students are trying to decide which snack to serve at their own class party, they should recognize that a survey of the 5th graders down the hall might give them the "wrong" answer because older kids often have different tastes. The focus is on helping children realize that the origin of data dictates its usefulness, and using the wrong source can lead to an incorrect conclusion. Students are not yet required to evaluate the credibility of professional news organizations, identify "misinformation," or understand the technical ways data is stored.
E1-DR-ER-02 Data Ethics & Responsibility	Describe how choices in how data is collected or recorded can change the results or how we understand them.	Students should be able to see that the way we choose to ask a question or record an answer can completely change the "story" the data tells. This involves recognizing that different methods of gathering information—like a "Yes/No" vote versus a list of several choices—might lead to different understandings of what the class actually wants. For example, a classroom could first vote for a snack using broad categories like "Crunchy or Salty," but then re-vote using specific names like "Pretzels or Popcorn" to see how the winning choice might shift once more detail is added. The focus is on helping 1st graders explain why one way of collecting data might be more helpful or accurate than another for reaching a specific goal. Students are not yet required to understand complex survey design, identify use digital data collection tools.

Creation & Curation

Standard Code	Iowa Academic Standard	Standard Clarification
E1-CC-OP-03 Organization & Processing	Record each person's answer to make sure everyone is included.	Students should be able to use simple tracking tools to ensure that for data to be fair and accurate, every classmate's voice is captured and accounted for. This involves moving beyond just gathering a few answers to verifying that the total number of responses matches the number of students present in the room. For example, during a "Question of the Day" activity, students might use name magnets or a sign-in chart to see at a glance who has already shared their answer and who is still missing. The focus is on helping 1st graders understand that an accurate conclusion requires including everyone's input. Students are not yet required to explain the specific reasons why someone might be missing or use digital spreadsheets to manage their lists.
E1-CC-DC-04 Designing for Data Collection	Identify what information is needed and where it might be found to answer simple questions.	Students should be able to hear a simple question and figure out exactly what kind of information they need and the best place to find it. This involves moving from a general curiosity to a specific plan for gathering facts, such as deciding whether they need to look at something happening right now or ask their friends for their opinions. For example, if students want to know if it is windy enough to fly kites, they might decide to look out the window at the trees rather than asking a person. The focus is on helping 1st graders distinguish between questions that need an observation (looking) versus those that need a survey (asking). Students are not yet required to use search engines, conduct complex experiments, or evaluate the reliability of multiple different digital sources.
E1-CC-MD-05 Measurement & Datafication	Explain why measurements can be different each time and that results might change.	Students should be able to see that measuring the same thing can lead to different numbers and explain why that happens in simple ways. This involves moving beyond the idea that there is only one "perfect" number to recognizing that things like where you start measuring or the size of the tool you use can change the result. For example, a classroom routine could involve several students measuring the length of the same rug using their own footsteps; they would then discuss why the "count" was different for someone with big shoes versus someone with small shoes. The focus is on helping 1st graders use plain language to describe why two measurements might not match exactly, such as "we didn't start at the very edge" or "my feet are smaller." Students are not yet required to use standard rulers with precision or determine which specific measurement is the most "accurate" one.
E1-CC-MD-06 Measurement & Datafication	Use clean datasets that have no missing or incorrect information to answer questions.	Students should be able to look at a simple collection of information and spot "gaps" or obvious mistakes before they try to use it. This involves moving beyond just looking at the numbers to making sure every category is tidy and every person is counted correctly. For example, a classroom routine could include a "Data Clean-up" where students look at a survey chart and notice that a few names have no tally marks next to them; they would then explain that they can't pick a "class favorite" yet because some information is missing. The focus is on helping 1st graders develop the habit of checking for completeness—like using a "Partner Check" to verify tally marks—so their answers are based on the best possible information. Students are not yet required to explain why data might be missing or handle "outliers" that look very different from the rest of the group.

Standard Code	Iowa Academic Standard	Standard Clarification
E1-CC-CD-07 Complexity of Data	Use a prepared chart or table to answer questions about data.	Students should be able to look at a picture graph or a simple table and find specific numbers or compare groups to answer questions. This involves moving beyond just looking at the pictures to using helpful tricks, such as sliding a finger across a row or using a ruler to see how tall a bar is on a graph. For example, a classroom routine could include using a "Weather of the Month" chart to count exactly how many days were sunny versus how many were rainy. The focus is on helping 1st graders use these tools to pull out facts and make simple comparisons. Students are not yet required to create their own graphs from scratch or use complex digital data tools.



Mathematics Connection

1.MD.C.4 Organize, represent, and interpret data with up to three categories; ask and answer questions about the total number of data points, how many in each category, and how many more or less are in one category than in another.

Analysis & Modeling Techniques

Standard Code	Iowa Academic Standard	Standard Clarification
E1-AM-SD-08 Summarizing Data	Explain where, when, and how the data was collected.	Students should be able to look at a collection of information and tell the story of where it came from, when it was gathered, and how it was recorded. This involves using simple identification methods, such as pointing to a title on a chart or explaining to the class that they gathered their data by asking friends on the playground during recess. For example, a classroom routine could include looking at a "Favorite Book" tally and deciding if data from last year still tells the truth about what the class likes today. The focus is on helping 1st graders name the person, place, or time the data came from to make sure it actually matches their current goal. Students are not yet required to explain if a source is "reliable," identify if a survey was "fair" or "unfair," or use the data to make predictions about the future.
E1-AM-PR-09 Identifying Patterns & Relationships in Data	Use charts, graphs, or hands-on materials to sort and organize objects by characteristics like color or shape.	Students should be able to take a messy collection of items or information and group them logically using tools like sorting bins, pocket charts, or simple T-charts. This involves moving beyond just looking at a pile to creating a clear system where everything has a place based on how it looks or what it does. For example, a classroom routine could include sorting a "lost and found" bin by item type—putting all the hats in one pile and all the mittens in another—or using colored blocks to represent and organize the results of a class vote on favorite fruits. " The focus is on helping 1st graders see how organizing items makes it easier to understand a whole collection. Students are not yet required to sort by two things at once (like color and shape together) or create their own complex Venn diagrams.
E1-AM-MOD-10 Models of Data	Predict whether an object belongs in a group based on its characteristics and explain the reasoning.	Students should be able to look at a new object or piece of information, identify a specific characteristic like color or texture, and decide which group it belongs in before they actually place it there. This involves moving beyond random sorting to using "if-then" reasoning to explain their choice. For example, a classroom routine could include looking at a new button and saying, "This button is blue, so it belongs in the blue jar with the others." The focus is on helping 1st graders see data as information they create themselves through careful observation and logical thinking. Students are only required to sort by a single characteristic at a time and are not yet expected to sort by multiple traits, such as grouping objects by both color and shape simultaneously.



AI Connection

E1-LN-MD-05 Describe how a computer uses a rule to decide which class a new object belongs to.

E1-RR-RP-06 Describe how certain information can change a decision.



Mathematics Connection

1.MD.C.4 Organize, represent, and interpret data with up to three categories; ask and answer questions about the total number of data points, how many in each category, and how many more or less are in one category than in another.

Interpreting Problems & Results

Standard Code	Iowa Academic Standard	Standard Clarification
E1-IPR-MC-11 Making and Justifying Claims	Compare a prediction to the results in order to explain how the new information changes the expected outcome.	Students should be able to make a "best guess" about what might happen and then look at the actual results to see how their thinking has changed. This involves moving from just guessing to using real information to adjust what they expect to happen next. For example, if students initially predicted that "Tag" would be the favorite playground game, they would compare that guess to a finished tally chart; if the chart shows "Slides" won, they could explain that they now expect more kids to be at the slide tomorrow. The focus is on helping 1st graders use "new information" to update their ideas rather than just being right or wrong. Students are not yet required to use probability terms like "certain" or "impossible," or perform complex data analysis.



AI Connection

E1-RR-RP-06 Describe how certain information can change a decision.

Visualization & Communication

Standard Code	Iowa Academic Standard	Standard Clarification
E1-VC-RV-12 Representations & Dynamic Visualizations	Compare two or more ways of showing the same data and explain how they are different.	Students should be able to explore how the same set of information can look different when it is moved into different formats. This involves moving beyond just looking at one chart to comparing two different versions, such as a physical tower of snap-cubes and a hand-drawn picture graph that both show the same classroom snack preferences. For example, a classroom routine could include "translating" data by having students first build a concrete graph with actual objects, like shoes or blocks, and then drawing those same results onto a paper grid. Students should be able to describe simple physical differences, such as noting that a tally chart uses quick marks for counting while a picture graph uses drawings to show exactly what was collected. The focus is on helping 1st graders identify visual changes in height, color, or the symbols used to represent their information. Students are not yet required to determine which graph is "best" for a specific purpose or evaluate the readability of the display.
E1-VC-DS-13 Data Storytelling	Describe what a graph, chart, and collection of objects shows.	Students should be able to look at a group of items or a display and tell a simple story about what the information is saying. This involves moving beyond just naming the items to explaining the "big idea" or the main topic being represented, such as stating that a tally chart shows the class's favorite colors or a pile of buttons represents all the different shapes found in the math bin. For example, a classroom routine could include a "Gallery Walk" where students visit different data stations and verbally describe what each category is measuring and what the individual marks or pictures stand for. The focus is on helping children use their own words to identify the purpose of a display and what it is trying to teach the viewer. Students are not yet required to create their own formal labels or write titles for the data displays.
E1-VC-BS-14 Acting on Data to Benefit Society	Identify how data represents real-world situations and helps answer everyday questions.	Students should be able to see that data is not just numbers on a page, but a tool made from the world around them to help solve problems or make real-life decisions. This involves moving beyond simply counting items to understanding that those counts represent real things—like using a "Lost Tooth" tally to see how many friends have a gap in their smile or tracking fruit choices to make sure there is enough for everyone at a party. For example, a classroom routine could include checking a daily weather graph to decide if the class needs to wear coats for recess or sorting a bin of recycled materials to see which item the class uses the most. The focus is on helping 1st graders bridge the gap between a physical count and a specific action, showing them that data helps us know what to do next. Students are not yet required to use data to solve complex mathematical word problems or analyze global trends.



Computer Science Connection

E1-DAT-IM-10 Examine a variety of data questions that address the needs of a person or community.



Mathematics Connection

1.MD.C.4 Organize, represent, and interpret data with up to three categories; ask and answer questions about the total number of data points, how many in each category, and how many more or less are in one category than in another.

Second Grade Standards

Dispositions & Responsibilities

Standard Code	Iowa Academic Standard	Standard Clarification
E2-DR-NS-01 Nature of Data	Describe two or more different conclusions that can be drawn from the same dataset.	Students should be able to identify that a single data display can provide multiple pieces of information. This involves looking at one collection of data, such as a picture graph of favorite class pets, and generating different observations. For example, a student might conclude that dogs are the most popular while also concluding that more students chose fish and birds combined than chose cats. The focus is on using math language like most, least, and total to verbalize these different findings. Students are not required to use multiplication to compare groups or analyze datasets where the total sum exceeds 20.
E2-DR-ER-02 Data Ethics & Responsibilities	Explain that some information about people should not be collected or shared with technology.	Students should be able to identify that certain personal details are private and should not be shared or collected through digital tools. This involves discussing what makes information sensitive, such as a home address, phone number, or passwords. For example, students could look at a list of information and sort items into categories of what is safe to share with a website and what should remain private. The focus is on recognizing that technology can store information forever and that protecting privacy is a way to stay safe online. Students are not required to understand the technical details of data encryption or the legal complexities of privacy laws.
E2-DR-ID-03 Investigative Dispositions	Recognize that there is a step-by-step process for exploring questions about the world using data.	Students should be able to identify that answering questions about their environment follows a specific, logical sequence of actions. This involves following a structured path, such as the data investigation cycle, which begins with asking a question and ends with sharing what was learned. For example, students could practice this routine by first asking which snack the class prefers, then collecting tally marks, and finally looking at the results to answer their original question. The focus is on recognizing that data investigation is an intentional process rather than a random collection of facts. Students are not required to define formal statistical terms or conduct independent research projects without teacher guidance.

Creation & Curation

Standard Code	Iowa Academic Standard	Standard Clarification
E2-CC-OP-04 Organization & Processing	Identify the categories used to describe an object or event.	Students should be able to recognize that objects or events can be sorted and described using specific characteristics. This involves looking at a group of items and determining the labels, such as color, size, shape, or type, that define each piece of information. For example, students could look at a collection of buttons and identify that they are grouped by the number of holes or by their material. The focus is on understanding that data is organized into buckets based on shared attributes so that it can be easily understood. Students are not required to sort items into more than two categories at the same time or use computer spreadsheets to organize their lists.
E2-CC-DC-05 Designing for Data Collection	Explain that a variable measures the same characteristic across different individuals or objects.	Students should be able to understand that a variable is a specific feature that is tracked the same way for every person or item in a group. This involves recognizing that while the answer might change from person to person, the question being asked stays the same, such as asking every student in class to name their favorite color. For example, in a weather log, the variable is sky condition, and students record whether it is sunny, cloudy, or rainy for every single day. The focus is on seeing that data collection is consistent because it looks at the same trait across the whole group. Students are not required to use the formal term variable in their explanations or create data tables with more than two different variables.
E2-CC-MD-06 Measurement & Datafication	Identify that simulations, models, or digital representations can provide information to study.	Students should be able to recognize that digital tools and pretend versions of real-life situations can be used to gather facts and learn new things. This involves looking at a data source that is not a physical object, such as a computer program that shows how a plant grows over time or a digital map that tracks bird migrations. For example, students could use a classroom weather simulation to see what happens to a virtual garden when they increase the amount of digital rain. The focus is on understanding that we can use technology to create and study information that might be hard to see or measure in person. Students are not required to build their own digital models or understand the computer code used to create a simulation.
E2-CC-MD-07 Measurement & Datafication	Use datasets that include 1–2 variables and 10–30 observations.	Students should be able to work with small collections of information to find patterns and answer questions. This involves looking at datasets, such as a class survey about favorite fruit or a chart tracking the daily weather for one month. For example, students could look at a list of 20 students and their choice of lunch to see which meal was picked the most. The focus is on handling a manageable amount of data points so that students can practice counting and comparing without becoming overwhelmed by a large number of entries. Students are not required to analyze datasets with more than two variables or manage collections of data that exceed 30 individual observations.
E2-CC-CD-08 Complexity of Data	Create a chart or table with data to help answer questions about data.	Students should be able to organize raw information into a clear visual format to find answers to specific questions. This involves taking a messy list of observations and putting them into a structured display, such as a tally chart, a picture graph, or a simple table. For example, after asking classmates about their favorite recess activity, a student would record the results in a table to easily see which activity is the most popular. The focus is on using the table or chart as a tool to make data easier to read and interpret than a random list. Students are not required to create scales where one picture represents more than one object or use digital software to generate their charts.



Mathematics Connection

2.MD.D.10 Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple problems: put-together, take-apart, and compare, using information presented in a bar graph.

Analysis & Modeling Techniques

Standard Code	Iowa Academic Standard	Standard Clarification
E2-AM-SD-09 Summarizing Data	Describe how data is grouped or spread out.	Students should be able to look at a data display and use their own words to explain where the information clusters or how it is distributed. This involves identifying patterns in a graph, such as noting that the data is all together in one tall column to show a clear favorite. For example, a student looking at a line plot of shoe sizes might observe that the marks are spread out across many different numbers rather than being in one spot. The focus is on moving beyond just naming the most or least and starting to describe the overall shape of the information using descriptive language. Students are not required to find the exact middle number in a list of data or subtract the smallest number from the largest number to find the difference.
E2-AM-PR-10 Identifying Patterns & Relationships in Data	Collect, graph, and analyze simple data.	Students should be able to complete the full cycle of working with information to answer a question. This involves gathering their own facts, such as by asking classmates about their favorite season, and then turning those counts into a visual display like a tally chart or a bar graph. For example, a student might collect data on the types of shoes being worn in the classroom and then use that information to build a picture graph. The focus is on the connection between the real-world objects and the pictures or bars that represent them. Students are not required to use scales where one symbol represents more than one item or use digital tools to create their graphs.
E2-AM-MOD-11 Models of Data	Predict whether a new object belongs to a group based on defined characteristics and justify the prediction.	Students should be able to use the shared traits of a group to guess where a new item fits. This involves looking at the rules that define a category, such as all objects must be red and round, to decide if a new object belongs there. For example, if a student has a group of woodland animals like deer and squirrels, they might predict that a fox belongs in that group because it also lives in the woods. The focus is on providing a reason for the choice by pointing back to the specific features that the group members have in common. Students are not required to sort objects based on more than two characteristics at a time.



AI Connection

E2-LN-MD-06 Predict the output of a simple reasoning model when given a new example that follows a known pattern.



Mathematics Connection

2.MD.A.1 Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes.

2.MD.D.10 Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories.

Interpreting Problems & Results

Standard Code	Iowa Academic Standard	Standard Clarification
E2-IPR-MC-12 Making and Justifying Claims	Describe events as likely or unlikely based on given information	Students should be able to look at what they know about a situation and decide if something is probably going to happen or probably not going to happen. This involves using evidence from a dataset or a physical set of objects to use words like likely or unlikely when talking about chance. Such as looking at a jar containing eight red blocks and two blue blocks to explain why picking a red block is likely. The focus is on using the more or less relationship in a dataset to justify a claim about a future outcome rather than just guessing. Students are not required to use fractions to describe probability or compare the likelihood of more than two different outcomes at once.
E2-IPR-GA-13 Generalization & Application	Determine whether a pattern found in one situation applies to another and explain the decision.	Students should be able to identify a pattern in one set of information and decide if that same rule works for a different group. This involves comparing two different situations to see if they follow the same logic, such as noticing that a pattern of one red block and two blue blocks in a classroom is the same as one apple and two oranges in a kitchen. Such as looking at a graph of favorite snacks in Class A and comparing it to a graph of Class B to see if the most popular choice is the same for both groups. The focus is on using observation to justify why a rule is or is not a good fit for a new situation. Students are not required to explain patterns using multiplication or identify growing patterns that change by a different amount each time.

Visualization & Communication

Standard Code	Iowa Academic Standard	Standard Clarification
E2-VC-RV-14 Representations & Dynamic Visualization	Identify and describe the titles, labels, legends, and colors in bar graphs and picture graphs and explain what each part shows.	Students should be able to look at a data display and name its specific parts while explaining how each part helps a reader understand the information. This involves pointing to the title to explain the main topic and looking at the labels to describe what each category or group represents. Such as looking at a picture graph of garden flowers and identifying that the legend shows one flower icon equals one real plant. The focus is on recognizing that these text and visual features are clues that translate a picture into a meaningful story about the data. Students are not required to interpret graphs with a scale where one symbol represents more than one object or create their own legends for complex maps.
E2-VC-DS-15 Data Storytelling	Compare what two different graphs, charts, or collections show.	Students should be able to look at two different displays of information side by side to explain how they are the same or how they are different. This involves comparing two graphs that might show the same topic in different ways, such as seeing how a tally chart and a bar graph both show that most students chose apples as their favorite snack. Such as looking at a picture graph of sunny days in May compared to a picture graph of sunny days in December to describe which month had more sun. The focus is on using the visual shape of the data to make a simple comparison between two sets of information. Students are not required to combine data from two different graphs to find a new total or use graphs where one picture represents two or more objects.
E2-VC-BS-16 Acting on Data to Benefit Society	Identify how data can be used to make simple decisions at school or home.	Students should be able to recognize that the information we collect can help us make choices that improve our daily lives or our community. This involves looking at simple data displays to solve a problem, such as checking a tally chart of favorite snacks to decide which healthy food to buy for a class party. Such as looking at a graph showing which playground equipment is used the most to help a teacher decide where the class should play for recess. The focus is on connecting the numbers or pictures in a chart to a real action that makes a situation better or easier for others. Students are not required to analyze complex budgets or use data to solve problems that involve large groups beyond their own school or family.

Third Grade Standards

Dispositions & Responsibilities

Standard Code	Iowa Academic Standard	Standard Clarification
E3-DR-ND-01 Nature of Data	Identify the differences between categorical and numerical data.	Students should be able to distinguish between two fundamental types of data: categorical and numerical. Categorical data are descriptive labels or groups that cannot be meaningfully counted or measured (e.g., types of pets), while numerical data are quantities represented by numbers that can be measured or counted (e.g., number of pets). Students should be able to correctly classify a given set of data variables into these two groups based on how the data is collected and what it represents. This foundational skill ensures students understand the basic properties of data before moving on to visualization or analysis.
E3-DR-ER-02 Data Ethics & Responsibility	Explain how collecting certain types of data can create risks and describe ways to protect privacy.	Students should be able to identify that some data variables are more sensitive than others and understand that collecting and sharing sensitive information can create potential risks, such as identity theft, unauthorized tracking, or unwanted targeting. Students should be able to articulate simple methods for safeguarding this information, emphasizing the foundational concepts of privacy, consent, and respectful data handling. This standard ensures students develop an ethical disposition toward data as they move into collection and analysis practices.
E3-DR-ER-03 Data Ethics & Responsibility	Evaluate the strength of arguments that include data compared to those that do not.	Students should be able to recognize and explain that arguments supported by specific, relevant data (evidence) are stronger and more reliable than arguments based purely on opinion or anecdotal claims. Students should focus on whether the data presented actually relates to the claim and whether the data is clearly shown. This standard introduces the essential concept of data-grounded reasoning and persuasive communication.
E3-DR-ID-04 Investigative Dispositions	Plan and carry out a simple investigation that includes collecting, organizing, and visually representing data to answer a question.	Students should be able to execute the foundational steps of the data science lifecycle for a simple, single-variable question. This includes determining an appropriate method for collecting data, physically gathering the information, arranging the raw data into a structured format, and using a visual representation to effectively communicate the answer to the initial question. This standard focuses on developing procedural fluency in basic data inquiry.

Creation & Curation

Standard Code	Iowa Academic Standard	Standard Clarification
E3-CC-OP-05 Organization & Processing	Examine a dataset to identify missing information.	Students should be able to identify gaps or blank entries within a simple dataset, recognizing that data is often incomplete due to collection issues or human error. Furthermore, students should be able to articulate the necessity of complete data for drawing accurate conclusions. This standard focuses on developing data cleaning skills at a foundational level, ensuring students can spot when data is absent and requires further investigation or collection. (e.g. Present students with a simple, incomplete class roster or survey results table (e.g., Name, Favorite Color, Height, Number of Pets) where some cells are left intentionally blank. Ask students to circle or highlight all the missing data points and explain what information they are missing.
E3-CC-DC-06 Designing for Data Collection	Design an investigation that includes collecting and analyzing more than one variable.	Students should be able to plan a simple inquiry that systematically collects two different data variables and then analyze those variables together to look for basic patterns or connections. This moves beyond single-variable counting to foundational bivariate thinking, where students seek to answer questions like, "Does one variable change when another one changes?" This requires students to design collection instruments that keep the two variables linked during collection and organization.
E3-CC-DC-07 Designing for Data Collection	Find and use simple datasets to answer specific questions.	Students should be able to locate a pre-existing, small-scale dataset relevant to a specific question and then extract the necessary information from that set to formulate an answer. This standard focuses on developing the ability to source appropriate data—specifically those labeled as "educational resources or child-friendly repositories"—and read simple tables, charts, or lists to gain information, shifting the focus from collecting data to consuming it ethically and effectively.
E3-CC-MD-08 Measurement & Datafication	Identify reasonable values for variables and recognize values that may be incorrect or unusual.	Students should be able to apply real-world context and knowledge to assess whether a reported numerical value is plausible or represents a likely error (an outlier). This involves determining a reasonable range for a variable (e.g., human height) and then scanning a dataset to flag any values that fall outside that expected range. This standard ensures students develop critical thinking about data quality and learn to identify potential errors before analysis.
E3-CC-MD-09 Measurement & Datafication	Explain why personal data must be handled respectfully and recognize that misuse has occurred in the past.	Students should be able to articulate that personal data, such as a name, address, or preferences, belongs to the individual and requires respectful handling to maintain trust and prevent harm. Respectful handling involves using the data only for the purpose it was collected and with explicit permission.
E3-CC-CD-10 Complexity of Data	Select the criteria necessary to answer a specific question.	Students should be able to identify and select the specific pieces of information (data variables or criteria) that are directly needed to answer a given question, ignoring extraneous or irrelevant details. Students are not required to evaluate the criteria's reliability or the technical difficulty of obtaining the data; the focus is purely on relevance.

Computer Science Connection

E3-DAT-DC-09 Evaluate numeric and non-numeric data for accuracy and completeness.

Analysis & Modeling Techniques

Standard Code	Iowa Academic Standard	Standard Clarification
E3-AM-SD11 Summarizing Data	Explain how metadata like date, time, location, or type help describe a dataset.	Students should be able to identify metadata as "data about data" and explain its importance in understanding the context and reliability of a dataset. They should recognize that metadata variables (such as when the data was collected [date/time], where it was collected [location], or what format it is in [type]) are essential for judging the relevance of the dataset. Students are not required to use advanced tools for metadata inspection or processing.
E3-AM-PR-12 Identifying Patterns & Relationships in Data	Examine two variables and describe whether there appears to be a relationship between them.	Students should be able to articulate this relationship using simple language, such as stating that the variables "increase together," "go opposite ways," or show "no connection." This standard focuses on developing visual pattern recognition skills within bivariate data. Students are not required to determine causation, calculate statistical measures of correlation (like the correlation coefficient), or analyze complex non-linear relationships; the focus is on foundational visual pattern recognition.
E3-AM-DT-13 Digital Tools & Data Analysis	Summarize data that is represented in a digital tool.	Students should be able to read and interpret data representations generated by digital tools (such as charts, tables, or graphs in a spreadsheet application) and use that information to create a brief, accurate textual summary. The summary should focus only on the descriptive facts visible in the digital representation.
E3-AM-MOD-14 Models of Data	Recognize that patterns and relationships in data provide different types of information.	Students should be able to look at a dataset or a data model (like a bar graph or a scatter plot) and recognize that different types of patterns yield different types of information. The focus is on differentiating the insights provided by basic visual patterns. Students are not required to analyze complex statistical models of data (such as decision trees or cluster analysis).

Interpreting Problems & Results

Standard Code	Iowa Academic Standard	Standard Clarification
E3-IPR-MC-15 Making & Justifying Claims	Explain how unusual a result is compared to what is expected in a given situation.	Students should describe the difference between the observed data point and the general cluster of expected data, fostering critical assessment of data validity and context. Students are not required to use statistical software or tools for modeling the expected distribution of results.
E3-IPR-PI-16 Problem Identification	Provide reasons and evidence to support or challenge conclusions drawn from data.	This standard emphasizes the logical connection between evidence and claims, a fundamental skill in data literacy. Students use sentence frames like "I support this conclusion because the data shows...", or comparing the data to the claim using a "Claim vs. Evidence" chart. Students are not required to prove causation, assess the statistical validity or bias of the data, or use advanced tools for analysis.
E3-IPR-GA-17 Generalization & Application	Explain why patterns or results from one dataset may not apply to other situations.	Students should be able to recognize that the patterns and conclusions derived from a specific dataset are often limited to the context in which that data was collected (e.g., location, time, or population size). Students are not required to calculate statistical measurements of variability (like margin of error) or understand formal sampling methods; the focus is on the foundational concept of data context and its limits.

Visualization & Communication

Standard Code	Iowa Academic Standard	Standard Clarification
E3-VC-RV-18 Representations & Dynamic Visualizations	Construct data visualizations, such as bar graphs or pictographs, to summarize categorical data.	Students should be able to translate raw, counted categorical data (e.g., tally marks or frequency counts of favorite colors) into a simple, accurate visual representation. Students are not required to construct complex chart types, such as pie charts, histograms, or advanced multi-variable plots (e.g., stacked bar charts or scatter plots).
E3-VC-DS-19 Data Story Telling	Include sufficient background information and explanation when presenting data.	Students should be able to recognize that raw data or visualizations are meaningless without context. Students are not required to provide detailed, technical explanations of data processing steps.
E3-VC-BS-20 Acting on Data Benefiting Society	Ask questions about where the data came from and discuss how it was collected	Students should be able to discuss simple differences between collection methods (e.g., observing versus surveying) and how those differences might influence the resulting data. Students are not required to perform complex web searches or use external verification tools to assess the professional credibility.

Fourth Grade Standards

Dispositions & Responsibilities

Standard Code	Iowa Academic Standard	Standard Clarification
E4-DR-ND-01 Nature of Data	Differentiate between categorical and numerical data and clearly define the characteristics and appropriate uses of each type.	Students should demonstrate the ability to distinguish between categorical data (information grouped by traits or names) and numerical data (information represented by measurable quantities). Teachers can support this by having students classify datasets based on their characteristics, such as identifying "favorite ice cream flavors" as categorical and "the height of bean plants in centimeters" as numerical. Instructional routines should focus on how these data types determine the representation used, such as using a bar graph to compare categories versus using a line plot to show the distribution of measurements. Students are not required to differentiate between discrete and continuous numerical data or use complex statistical terminology like "nominal" and "ordinal" scales.
E4-DR-ND-02 Nature of Data	Ask and evaluate questions about how data was collected, measured, or selected.	Students should be able to look at a dataset and pose specific questions about the people, tools, and methods used to gather the information. Teachers can facilitate this by presenting "mystery data" and asking students to investigate its history, such as questioning if a count of "favorite books" was collected by looking at library checkout records or by just asking a few students in the hallway. Instructional routines should focus on identifying whether the data selection was representative and if the measurement tools were used correctly, such as asking if a temperature chart is reliable if the thermometer was kept in the sun for one reading and in the shade for another. Students are not required to provide written critiques of data or use mathematical formulas to prove things like a sample size being too small.
E4-DR-ER-03 Data Ethics & Responsibility	Analyze how datasets can benefit society while identifying potential risks to individuals.	Students should understand that while data helps communities solve problems, it must be handled carefully to protect people’s private information. Teachers can facilitate this by exploring real-world scenarios where data is used for the "greater good," such as looking at how city traffic data helps engineers decide where to build safer crosswalks or how school lunch tallies ensure every student gets a meal. Instructional routines should balance these benefits with discussions on privacy, such as asking students if a list of "favorite toys" should include everyone's full names and home addresses or if the data can still be useful without identifying specific individuals. Students are not required to analyze complex legal privacy laws or understand the technical architecture of data encryption and cybersecurity systems.
E4-DR-ER-04 Data Ethics & Responsibility	Examine how the way data is collected, represented, or used can influence decisions and conclusions.	Students should understand that the way data is selected, collected, and represented can reflect a particular purpose or perspective. Teachers can support this understanding by comparing different collection goals, such as when a coach collects data only from students who want to play soccer to form a team, versus when a survey about the best school lunch only includes students who bring their own meals from home. Instructional routines should emphasize how these choices affect the resulting dataset and can lead to different decisions and conclusions, such as a school club being formed based on information that does not represent the entire class. Students are not required to define different types of sampling or explain unconscious influences in a social or psychological context.

Standard Code	Iowa Academic Standard	Standard Clarification
E4-DR-ID-05 Investigative Dispositions	Recognize that data may be interpreted differently depending on social or cultural perspectives.	Students should understand that a single set of data can lead to different conclusions based on a person's background, experiences, or community values. Teachers can facilitate this by presenting a dataset and asking students to explain it from different points of view, such as looking at a chart of "popular playground games" and discussing why a student who loves sports might see it as a list of fun activities, while a student who prefers quiet reading might see it as a list of noisy distractions. Instructional routines should focus on how perspective changes the "story" the data tells, such as analyzing a map of a neighborhood to see how a delivery driver might focus on the roads while a child might focus on the parks and ice cream shops. Students are not required to analyze global cultural conflicts or explain sociological perspectives of different countries.



AI Connection

E4-LN-NOL-05 Explain the role of training data in helping an AI system "learn" a behavior without being explicitly programmed.

Creation & Curation

Standard Code	Iowa Academic Standard	Standard Clarification
E4-CC-OP-06 Organization & Processing	Examine datasets to identify missing and unreasonable values or recording errors and suggest reasonable additional values when appropriate.	Students should be able to look at a collection of information and spot "mistakes" that don't fit the pattern, such as empty boxes, numbers that are impossible, or simple typos. Teachers can support this by providing "messy" data for students to clean, such as looking at a list of student ages where one person is listed as "100" years old or a temperature log where a Tuesday reading is left blank. Instructional routines should focus on using logic to fix these errors, such as suggesting that the "100" was likely a "10" or using the temperatures from Monday and Wednesday to estimate a reasonable number for the missing Tuesday entry. Students are not required to calculate the mean to fill in gaps or use mathematical rules to define "outliers" beyond what can be identified through common sense and basic pattern recognition.
E4-CC-DC-07 Designing for Data Collection	Design investigations that collect numerical data over time to analyze change.	Students should be able to plan a simple experiment or observation that records numbers regularly to see how something grows or moves. Teachers can support this by setting up a recording schedule for a class project, such as measuring the height of a bean plant every Friday for a month or tracking the temperature outside at the same time every day for a week. Instructional routines should focus on consistency in measurement, such as using the same ruler or thermometer each time to ensure the "change" being analyzed is accurate and not just a mistake in how the data was gathered. Students are not required to use decimals beyond tenths, calculate the "rate of change" using division, or set up controlled experiments with multiple changing variables.
E4-CC-DC-08 Designing for Data Collection	Explain the tools and procedures that can be used to measure a specific quantity.	Students should be able to select the correct instrument and describe the step-by-step process needed to find the size, weight, or amount of an object. Teachers can support this by providing various objects and a "toolkit" of measuring devices, such as choosing a stopwatch to measure how long it takes to run a race or using a graduated cylinder to find the volume of water in a cup. Instructional routines should emphasize precision and the "rules" of the tool, such as reminding students to start measuring at the "0" mark on a ruler rather than the very edge of the wood or ensuring a scale is balanced before adding an object. Students are not required to convert measurements between metric and customary systems or use specialized scientific tools like digital calipers or triple-beam balances.
E4-CC-MD-09 Measurement & Datafication	Work with datasets that include missing or incomplete data and apply basic cleaning strategies.	Students should be able to identify "holes" in a dataset and use simple logic to make the information usable. Teachers can support this by providing a small dataset with missing pieces, such as a class attendance chart where one day is blank or a survey of "favorite snacks" where some students forgot to write their answer. Instructional routines should focus on basic cleaning strategies, such as deciding whether to leave a blank space out of the total count or asking the person for their missing information to complete the record. Students are not required to use "placeholder" values like zeros or nulls in a database, nor are they expected to use the average of a group to mathematically estimate what a missing number should be.

Standard Code	Iowa Academic Standard	Standard Clarification
E4-CC-MD-10 Measurement & Datafication	Convert data between formats, such as tally marks, numerical counts, tables, or simple graphs.	Students should be able to take information from one visual style and translate it into another without changing the original meaning of the data. Teachers can support this by providing a "starter" format and having students rewrite it, such as taking a list of tally marks from a classroom vote and turning them into a numerical table or a simple bar graph. Instructional routines should focus on the accuracy of the transfer, such as double-checking that the number of "votes" on the bar graph matches the number of tallies on the original scratch paper. Students are not required to create circle graphs (pie charts) that involve calculating percentages or convert data into multi-line graphs.
E4-CC-CD-11 Complexity of Data	Select and use only the criteria necessary to answer a specific question.	Students should be able to look at a large amount of information and pick out only the specific facts that help them solve a problem. Teachers can support this by providing a "crowded" dataset and a specific goal, such as giving students a spreadsheet of school bus routes that includes bus numbers, driver names, and departure times, then asking them to find only the departure times for their specific bus. Instructional routines should focus on filtering out "distractors," such as circling the relevant data points on a chart while ignoring columns of information that don't help answer the current question. Students are not required to use digital database filters or answer questions that involve multiple related tables.

Analysis & Modeling Techniques

Standard Code	Iowa Academic Standard	Standard Clarification
E4-AM-SD-12 Summarizing Data	Interpret the range of a numerical dataset.	Students should be able to identify the difference between the highest and lowest values in a dataset to describe the "spread" of the information. Teachers can support this by providing datasets with clear boundaries, such as looking at the heights of sunflower plants and identifying that the tallest is 60 inches and the shortest is 40 inches, meaning the data spans a 20-inch range. Instructional routines should focus on what the range tells us about the group, such as noticing that a small range means the data is very similar (consistent), while a large range means the data is more varied. Students are not required to use the word "distribution" or use subtraction to find the range of datasets involving large numbers or complex fractions.
E4-AM-VD-13 Variability of Data	Describe simple measurement errors and how they can affect results.	Students should understand that even with the best tools, measurements are rarely "perfect" and that small mistakes can change what the data tells us. Teachers can support this by having students measure the same object multiple times, such as having three different students measure the length of a desk and noticing if their answers are slightly different. Instructional routines should focus on identifying common causes for these differences, such as holding a ruler at a slight angle, starting at the "1" instead of the "0," or misreading a scale because they were looking at it from the side. Students are not required to use the words like "uncertainty" or speculate the percentage of error for a measurement.
E4-AM-MOD-14 Models of Data	Identify information from patterns and relationships in the dataset.	Students should be able to look at a group of data points and spot "rules" or trends, such as things increasing, decreasing, or repeating. Teachers can support this by presenting data that follows a clear path, such as looking at a weather chart and noticing that temperatures consistently rise from 8:00 AM to 2:00 PM or a plant growth log where the leaves double in number every week. Instructional routines should focus on making predictions based on these patterns, such as asking students to guess what the next number in a sequence might be or identifying a relationship, like "the more it rains, the fewer students play outside at recess." Students are not required to write mathematical equations to describe the relationship or identify complex patterns.

Interpreting Problems & Results

Standard Code	Iowa Academic Standard	Standard Clarification
E4-IPR-MC-15 Making and Justifying Claims	Explain that a sample may or may not represent the entire population.	Students should understand that a small group (a sample) used for a study might not accurately reflect the feelings or traits of the whole group (the population). Teachers can support this by testing "fair" versus "unfair" samples, such as asking only the students on the basketball team what the best after-school activity is, and then discussing if their answer represents the entire school's opinion. Instructional routines should focus on the idea of variety, such as explaining that to know the school's favorite movie, you need to ask students from every grade level, not just your own friends. Students are not required to determine the specific sample size needed for "statistical significance" or use random number generators to pick participants.
E4-IPR-MC-16 Making and Justifying Claims	Explain how random selection promotes fairness and identify risks of biased selection methods.	Students should understand that picking names or items "out of a hat" gives everyone an equal chance and prevents a specific group from being left out. Teachers can support this by demonstrating different ways to choose helpers or winners, such as comparing the "fairness" of picking only students in the front row versus using a spinner or drawing popsicle sticks with everyone’s name on them. Instructional routines should highlight the risks of biased picking, such as discussing how choosing only "people who are wearing red" might accidentally exclude a student who doesn't own a red shirt. Students are not required to use software to generate "random numbers" themselves or explain the mathematical probability (like 1 out of 25) of being selected.
E4-IPR-PI-17 Problem Identification & Question Formation	Determine which types of real-world questions can be answered using measurable data.	Students should be able to distinguish between questions that are based on personal opinions and those that can be answered by counting, weighing, or measuring. Teachers can support this by sorting everyday questions into categories, such as comparing "Is the playground fun?" (an opinion) to "How many students can fit on the swing set at one time?" (measurable data). Instructional routines should focus on whether a question leads to a specific number, such as asking if "Which lunch is the tastiest?" can be measured, or if we should instead ask "How many students chose tacos today?" Students are not required to turn "opinion" questions into surveys or use data to answer broad social questions that require expert knowledge beyond their own classroom or school.
E4-IPR-GA-18 Generalization & Application	Explain how too few trials in a random process can lead to misleading conclusions.	Students should understand that doing something only a few times might give a "lucky" or "unlucky" result that doesn't show what usually happens. Teachers can support this by having students flip a coin or roll a die, such as flipping a coin twice and getting "heads" both times. Instructional routines should focus on how that small result can be misleading, such as discussing whether it’s true that a coin always lands on heads, or if we need to flip it 20 more times to see the real 50/50 pattern. Students are not required to perform full computer simulations or use complex probability formulas to prove how many trials are needed for a "perfect" result.

Visualization & Communication

Standard Code	Iowa Academic Standard	Standard Clarification
E4-VC-RAV-19 Representations & Dynamic Visualization	Identify outliers in a dataset and suggest possible explanations for their presence.	Students should be able to spot a piece of information that looks "way off" compared to the rest of the group and think about why that might have happened. Teachers can support this by providing a simple list of numbers, such as looking at the number of books students read in a month: five students read between 2 and 4 books, but one student read 25. Instructional routines should focus on brainstorming reasons for the odd result, such as wondering if the student read very short comic books, if someone typed an extra "0" by mistake, or if that student is simply a very fast reader. Students are not required to do "extra math" to prove a number is an outlier or decide if they should delete the "weird" number from their final chart.
E4-VC-DS-20 Data Storytelling	Identify the purpose of a data-driven story and how it addresses a specific audience's needs.	Students should be able to explain why a set of information is being shared and who is supposed to learn something from it. Teachers can support this by showing data in different contexts, such as looking at a chart of the most popular playground games. Instructional routines should focus on how the "story" changes depending on who is looking at it: a student might use the story to find friends to play with, while the principal might use the same story to decide which sports equipment to buy more of. Students are not required to create multi-page presentations or explain how data can be used to "persuade" people to change their minds about complex or controversial topics.
E4-VC-BS-21 Acting on Data to Benefit Society	Ask questions about where the data came from and how it was collected to determine the validity of the data.	Students should understand that data isn't "magic," instead it comes from somewhere, and the way it was gathered matters. Teachers can support this by encouraging students to be "data detectives," such as looking at a claim that "90% of people love broccoli" and asking, "Wait, did you only ask people at a salad bar?" Instructional routines should focus on the source and the method, such as asking if a survey about the best school lunch was done by talking to every student or just the ones having pizza for lunch. Students are not required to do "background checks" on sources or prove that a data collector is a "liar." The goal is just to check if the method used to get the numbers was fair.



Computer Science Connection

E4-DAT-IM-11 Investigate how data collected about people may affect individuals and groups.

Fifth Grade Standards

Dispositions & Responsibilities

Standard Code	Iowa Academic Standard	Standard Clarification
E5-DR-ND-01 Nature of Data	Define a case as a single data point that includes multiple variables, and identify the variables and values associated with each case in a dataset.	Students should be able to recognize that a single case represents one individual unit, such as one student or one object, which holds multiple pieces of information known as variables. This involves identifying that in a data table, a horizontal row contains all the information for one case, while the columns show the specific values for each trait. Such as looking at a table of Olympic athletes where one case is a single runner, and the variables are their home country, race time, and age. The focus is on understanding how different data points are connected to describe the same individual unit. Students are not required to classify variables as numerical or categorical or use software to link multiple tables together.
E5-DR-ND-02 Nature of Data	Explain how people make decisions about what to measure and how to measure it.	Students should be able to explain that data does not just exist but is created by people making specific choices about what is important to track. This involves thinking about a goal and choosing a unit or method that best captures that information fairly. Such as deciding whether to measure a school garden's success by the height of the plants in inches or by the total weight of the vegetables harvested. The focus is on recognizing that the way we define and collect data affects the final results and the decisions we make from them. Students are not required to calculate measurement error or evaluate the validity of the data that was measured or how it was measured.
E5-DR-ER-03 Data Ethics & Responsibilities	Analyze the context, scope, and purpose of a dataset to identify and reduce potential bias.	Students should be able to look at how data was collected to see if it treats everyone fairly or if it is missing important information. This involves asking who was included in a survey and why the data was gathered to check for a one-sided view. Such as noticing that a survey about favorite recess games should include students from all grade levels rather than just one class to get a more accurate picture of what the whole school wants. The focus is on finding ways to make data more balanced by including different groups of people or different types of situations. Students are not required to calculate statistical significance or identify complex sampling methods.
E5-DR-ID-04 Investigative Dispositions	Explain how conclusions or inferences change as new data becomes available during an investigation.	Students should be able to understand that conclusions are not final and must be updated when new information is discovered. This involves being willing to change an original idea if new data contradicts it or provides a more complete picture. Such as starting an investigation thinking that most students walk to school, but changing that conclusion after surveying the bus riders who arrive at a different entrance. The focus is on the flexibility of the scientific and data process where more data leads to a more accurate and reliable explanation. Students are not required to conduct formal hypothesis testing.

Creation & Curation

Standard Code	Iowa Academic Standard	Standard Clarification
E5-CC-OP-05 Organization & Processing	Examine datasets for missing and unreasonable values or recording errors and correct them when accurate information is available.	Students should be able to review a dataset to find mistakes that do not make sense or pieces of information that are clearly missing. This involves scanning a list for outliers or typos, such as a student's height being listed as 10 feet or a temperature for a summer day being listed as 20 degrees below zero. Such as looking at a table of jump rope counts and finding a blank cell where a classmate forgot to write their score. The focus is on ensuring data is clean and reliable before using it to tell a story or make a decision. Students are not required to use math formulas to find outliers.
E5-CC-DC-06 Designing for Data Collection	Develop a plan that specifies what data will be collected, which tools will be used, and what sources will be accessed.	Students should be able to write out a step-by-step guide for gathering information before they begin their investigation. This involves identifying the exact items they need to count or measure, choosing the right instrument for the job, and deciding where the information will come from. Such as planning to measure the growth of classroom bean plants by using a centimeter ruler to check height every Friday morning. The focus is on being organized and intentional so that the data collected actually answers the question being asked. Students are not required to write formal research proposals or choose between different digital tools for scientific precision.
E5-CC-DC-07 Designing for Data Collection	Determine whether a dataset is appropriate for answering a specific question based on topic, timeframe, and location.	Students should be able to evaluate if a collection of information actually fits the problem they are trying to solve. This involves checking if the data covers the right subject, was gathered at the right time, and comes from the right place. Such as realizing that a list of temperatures from 1950 cannot be used to describe today's weather, or that a survey about favorite sports in Australia might not represent what students in their own town like to play. The focus is on being a critical thinker about where data comes from before using it. Students are not required to analyze the specific methodology of how the data was gathered or use filters in digital databases to narrow down search results.
E5-CC-MD-08 Measurement & Datafication	Identify measurable characteristics and collect both categorical and numerical data during an investigation.	Students should be able to look at an object or event and decide which parts can be turned into data, making sure to collect both types of information: categories (words) and measurements (numbers). This involves observing a subject and recording "what kind" it is alongside "how much" or "how many." Such as investigating a collection of rocks by recording their color and texture as categorical data, while recording their weight in grams and width in centimeters as numerical data. The focus is on recognizing that a complete investigation uses different types of information to provide a full picture. Students are not required to convert units between different measurement systems or use scales that involve fractions beyond halves or fourths.
E5-CC-CD-10 Complexity of Data	Analyze the criteria necessary to answer a specific question.	Students should be able to identify exactly what information is needed to answer a question before they begin looking at or collecting data. This involves breaking down a big question into smaller, specific requirements like the time period, the people or objects involved, and the type of units required. Such as realizing that to answer "Which school lunch is the healthiest?", they first need to define the criteria for "healthy," such as low sugar, high protein, or the inclusion of a vegetable. The focus is on planning the "must-haves" for a dataset so the final answer is accurate and relevant. Students are not required to weigh the importance of different criteria using mathematical percentages or use models to map out every possible variable.

Analysis & Modeling Techniques

Standard Code	Iowa Academic Standard	Standard Clarification
E5-AM-SD-11 Summarizing Data	Summarize categorical and numerical datasets.	Students should be able to provide a clear, condensed overview of what a collection of data shows by using words for categories and single numbers for measurements. This involves looking at a large amount of information and picking out the most important "big picture" details. Such as summarizing a categorical survey of favorite ice cream flavors by stating which flavor was chosen most often (the mode) and which was chosen least. Other tasks include summarizing a numerical dataset, like the number of books read by classmates, by identifying the highest and lowest values (the range) and the value that falls right in the middle (the median). The focus is on taking a messy list of information and turning it into a few simple facts that describe the whole group. Students are not required to calculate the mean (average) by adding and dividing.
E5-AM-PR-12 Identifying Patterns & Relationships in Data	Use distributions to compare similarities and differences between two groups.	Students should be able to look at how data is spread out (the distribution) for two different groups to see how they are alike or different. This involves looking at the "shape" of the data on a graph, like where the numbers cluster together and where the gaps are, rather than just looking at individual points. For example, by comparing a dot plot of heights for the 5th-grade basketball team to a dot plot for the 5th-grade drama club, students might notice that the basketball team's data is distributed further to the right (taller) while the drama club's data is more spread out. The focus is on using the overall visual spread to describe how two groups behave differently. Students are not required to use formal terms like "skewness" or "bimodal" or use complex calculations to prove the groups are different.
E5-AM-PR-13 Identifying Patterns & Relationships in Data	Use survey data to construct and interpret a basic model.	Students should be able to take information gathered from a survey and organize it into a simple visual tool that helps explain a situation or predict an outcome. This involves turning "if/then" thinking into a logical map, like a decision tree, to show how one choice leads to the next. For example, students could use survey data about what classmates want to do at a party (Inside or Outside? Games or Movies?) to build a tree that helps a teacher decide which activity to plan based on the weather. The focus is on using data to build a simple "rule-based" model that others can follow to reach a conclusion. Students are not required to use complex coding languages or create models that involve multiple layers of mathematical probability.
E5-AM-VD-14 Variability of Data	Determine whether a data point is reasonable based on dataset characteristics and context.	Students should be able to look at a single piece of information and decide if it makes sense within the "story" the rest of the data is telling. This involves using common sense and the patterns found in the other numbers to spot something that looks like an impossible or highly unlikely error. For example, if a dataset shows the number of minutes students spend brushing their teeth, a data point of 120 minutes would be considered unreasonable because it doesn't fit the context of a daily routine. The focus is on being a "data detective" who uses the typical range of the group to flag outliers that don't belong. Students are not required to use the vocabulary “outliers” or prove a point is an anomaly.
E5-AM-MOD-15 Models of Data	Describe how relationships between variables help explain real-world phenomena.	Students should be able to explain how two different pieces of information might change together and what that tells us about how the world works. This involves looking for a "link" between variables. If one goes up, does the other go up, too? For example, students might notice a relationship between outside temperature and ice cream sales; as the weather gets hotter, more people buy ice cream. O The focus is on using data to explain "why" things happen in everyday life by connecting two related facts. Students are not required to calculate a correlation between variables or determine if one variable definitely causes the other using complex scientific investigation.



AI Connection

E5-RR-RP-09 Compare how different representations affect AI system outputs.



Computer Science Connection

E5-DAT-DI-10 Analyze a dataset to identify the nature and possible sources of variability in the data.

Interpreting Problems & Results

Standard Code	Iowa Academic Standard	Standard Clarification
E5-IPR-MC-16 Making and Justifying Claims	Explain how repeated samples improve estimates of a larger population.	Students should be able to understand that taking several different samples from a group gives a much better guess about the whole group than just taking one sample. This involves seeing that if you only ask five people their favorite color, you might get a lucky or unusual result, but if you repeat that survey with five different people several times, the combined results start to look more like the actual truth for the entire school. For example, if you want to know the most common pet in your city, taking one survey on a single street might only show dogs, but repeating the survey on ten different streets will give a more accurate estimate. The focus is on the idea that more data points from different small groups lead to a more reliable "big picture" answer. Students are not required to calculate the margin of error or prove statistical probability.
E5-IPR-MC-17 Making and Justifying Claims	Identify and describe trends or relationships in two-variable datasets using different visuals.	Students should be able to look at two different pieces of information on a graph and describe how they move together. This involves looking at visuals like scatter plots or line graphs to see if the dots or lines generally go up, go down, or stay the same. For example, a student might look at a graph showing a person's age on one side and their height on the other and describe the trend that as age increases, height typically increases too. The focus is on using the visual shape of the data to tell a simple story about how two things are related. Students are not required to draw a line of best fit or create models for the datasets.
E5-IPR-PI-18 Problem Identification & Question Formation	Identify data or comparisons that are not relevant to answering a given investigation question.	Students should be able to look at a list of information and pick out the parts that do not help answer their specific question. This involves focusing on the goal of the investigation and ignoring "distractor" data that might be interesting but is not actually related to the topic. For example, if a student is investigating which brand of battery lasts the longest in a flashlight, knowing the color of the flashlight or the price of the batteries is not relevant to how long they actually power the light. The focus is on being precise and keeping the data collection strictly tied to the problem being solved. Students are not required to collect the data but should be able to look at given data and make these identifications.
E5-IPR-GA-19 Generalization & Application	Identify possible human or technological sources of error in data collection and analysis	Students should be able to brainstorm what might have gone wrong if their data looks a little strange or doesn't seem right. This involves thinking about how a person might make a mistake, like misreading a ruler or accidentally skipping a name on a list, as well as how a tool might fail, like a digital scale with a low battery or a stopwatch that was started too late. For example, if three students measure the same desk and get three different answers, they can identify that human error in where they placed the ruler is a likely cause. The focus is on realizing that data isn't always perfect and being able to explain why. Students are not required to calculate an error percentage.



Computer Science Connection

E5-DAT-DI-10 Analyze a dataset to identify the nature and possible sources of variability in the data.

Visualization & Communication

Standard Code	Iowa Academic Standard	Standard Clarification
E5-VC-RV-20 Representations & Dynamic Visualizations	Compare multiple visualizations of the same dataset and explain how design changes affect interpretation.	Students should be able to look at two different types of graphs made from the exact same information and describe how each one changes the way we see the data. This involves noticing that a bar graph might make it easy to compare exact amounts between groups, while a pie chart makes it easier to see how each part fits into the whole. For example, if a class tracks how they spend their 24-hour day, a line graph might show the ups and downs of activity levels, while a picture graph might just highlight the most popular activity. Other tasks might include explaining how changing the colors, the labels, or the scale on a side axis can make a difference look much bigger or smaller than it really is. The focus is on understanding that the way you present data can change the story people take away from it. Students are not required to create 3D visualizations or use graphic design software to manipulate data perspectives.
E5-VC-DS-21 Data Storytelling	Adjust explanations and data storytelling to meet the needs and understanding of different audiences.	Students should be able to take the same set of data and change how they explain it depending on who they are talking to. This involves choosing the right words and the right level of detail so that the message makes sense to the specific group listening. For example, if a student is sharing data about a school recycling project, they might use simple pictures and exciting stories for a kindergarten class, but use specific numbers and charts when talking to the school principal. The focus is on being flexible and making sure the audience can actually use the information being shared. Students are not required to give formal public speeches or use strategies to influence people.
E5-VC-BS-22 Acting on Data to Benefit Society	Identify situations where data can be used to make informed decisions to solve a community problem.	Students should be able to recognize specific moments where gathering and looking at information can help fix a problem in their neighborhood or school. This involves connecting real-life challenges to the types of data that could provide a solution. For example, if students notice that a specific street corner is dangerous for bikers, they could identify that counting how many cars speed past or how many bikes use that path would help the city decide to add a bike lane. The focus is on seeing data as a tool for helpful action rather than just a school assignment. Students are not required to create presentations to share with anyone in the community.

Sixth Grade Standards

Dispositions & Responsibilities

Standard Code	Iowa Academic Standard	Standard Clarification
E6-DR-ND-01 Nature of Data	Make sense of the variability of data through an iterative process of refinement by questioning.	Students should recognize that data is not "one and done" and requires asking better questions to find the real story. This involves identifying unexpected data points or clusters and adjusting an investigation to see if those patterns stay the same or change. For example, a student might use a tally chart to track how many people like pizza, but after noticing some people only like specific toppings, they refine their question to ask about "pepperoni vs. cheese" to get a clearer picture of the class's tastes. The focus is on the cycle of questioning to understand variability. Students are not required to calculate formal measures of spread like standard deviation or use software to perform automated data cleaning.
E6-DR-ER-02 Data Ethics & Responsibility	Describe how social groups can be inadequately represented by existing data and data schemes.	Students should be able to identify how the way we set up surveys or categories can accidentally leave people out or group them unfairly. This involves looking for "missing" choices or narrow labels that prevent a dataset from telling an accurate story about everyone. For example, a student might analyze a graph about "student athletes" and realize it excludes students who participate in community sports outside of school. The focus is on recognizing bias in how data is structured. Students are not required to calculate mathematical weighting to fix sample bias or conduct a formal sociological study.
E6-DR-ID-03 Investigative Dispositions	Analyze and interpret data to draw evidence-based conclusions about real-world problems.	Students should be able to look at information from several different sources to build a logical argument that solves a problem. This involves using the data as specific proof for a claim rather than relying on personal opinion or guesses. For example, a student might look at a map of local parks and a list of where most kids live to argue that a new playground should be built on the north side of town because the data shows there is currently no equipment there. The focus is on using data as evidence. Students are not required to use advanced statistical modeling software or perform multi-variable regression analysis.

Computer Science Connection

MS-DAT-DC-21 Evaluate how different levels of precision and granularity in data collection affect accuracy, storage, and analysis.

Mathematics Connection

6.SP.A.1 Recognize a statistical question as one that anticipates variability in the data related to the question and accounts for it in the answers.

6.SP.A.2 Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall shape.

6.SP.B.4 Display numerical data in plots on a number line, including dot plots, histograms, and box plots.

6.SP.B.5 Summarize numerical data sets in relation to their context.

Creation & Curation

Standard Code	Iowa Academic Standard	Standard Clarification
E6-CC-OP-04 Organization & Processing	Group categorical variables or bin numerical variables to reorganize and analyze data.	Students should be able to organize raw data into categories or ranges to identify patterns. This involves grouping categorical items into sets or "binning" numerical data into equal intervals to make the information easier to see. For example, a student might take a list of student ages in months and group them into bins like 120–125 months and 126–130 months to create a histogram. The focus is on understanding that the way data is organized can clarify the story the data tells. Students are not required to perform data transformation techniques like logarithmic scaling or use multi-level hierarchical clustering.
E6-CC-DC-05 Designing for Data Collection	Design data collection plans that include data types needed, collection methods, sample sizes, and timing considerations for investigations.	Students should outline the methods and participants of an investigation before data is gathered to ensure the collection tool aligns with the research question. This involves creating a plan that specifies variables, such as categorical labels or numerical measurements, and selecting collection methods like digital forms, tallies, or logs. For example, a student investigating school spirit might use a digital survey to reach 50 students across all grade levels on a Tuesday morning to get a balanced view. A component of this planning involves anticipating sources of bias, such as a sample size that is too small or timing that excludes participants, and adjusting the strategy for a representative outcome. Students are not required to perform power analyses to determine sample size or design longitudinal studies.
E6-CC-MD-06 Measurement & Datafication	Distinguish between categorical and numerical data and select the appropriate type for specific measurements.	Students should recognize that the nature of a question dictates the type of data collected and how it is analyzed. This involves identifying whether a measurement yields categorical data, which represents qualities or labels, or numerical data, which represents quantities that can be measured or counted. For example, a student should identify that asking classmates for a favorite sport results in categorical data, while measuring the distance of a long jump results in numerical data. In practice, students should select the data type for an investigation to ensure the analysis is meaningful, such as choosing to collect the number of minutes spent on homework rather than asking if the homework was "short" or "long." The focus is on the choice between categories and numbers. Students are not required to classify data into scales like ratio or interval, nor are they required to use data transformation techniques.
E6-CC-CD-07 Complexity of Data	Work with datasets that have multiple variables that can suggest or answer different questions.	Students should explore datasets where more than one characteristic is tracked, allowing them to pivot between different questions using the same source. This involves identifying the variables within a dataset and determining which combinations can answer specific inquiries. For example, a student looking at a school census dataset could choose to compare "hours of sleep" against "extracurricular participation" to answer one question, or pivot to comparing "grade level" against "favorite subject" to answer another. By navigating these multivariate sets, students learn to distinguish between relevant and irrelevant information based on their goal, often using digital tools to filter or sort data, such as using spreadsheet headers to isolate columns for analysis. The focus is on the flexibility to see multiple investigative paths within one collection of data. Students are not required to perform multivariate regressions or analyze how three or more variables interact simultaneously.

Mathematics Connection

6.SP.A.2 Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall shape.

6.SP.A.3 Recognize that a measure of center for a numerical data set summarizes all of its values with a single number, while a measure of variation describes how its values vary with a single number.

6.SP.B.4 Display numerical data in plots on a number line, including dot plots, histograms, and box plots.

6.SP.B.5 Summarize numerical data sets in relation to their context.

Analysis & Modeling Techniques

Standard Code	Iowa Academic Standard	Standard Clarification
E6-AM-SD-08 Summarizing Data	Compare measures of center to determine which is most appropriate to the context.	Students should evaluate how the distribution of a dataset influences whether the mean or median provides a more accurate representation of the center. This involves calculating both measures and determining which one better describes a typical value based on the presence of outliers or skewness. For example, a student might choose the median to represent typical household income when a few extreme values would pull the mean uncharacteristically high. Instruction should focus on using visual models, such as dot plots or box plots, to identify data symmetry before selecting a measure. The focus is on the conceptual and computational comparison of mean and median within real-world scenarios. Students are not required to work with weighted averages or the mathematical properties of normal distributions.
E6-AM-PR-09 Identifying Patterns & Relationships in Data	Use simple diagrams to make important decisions for everyday choices.	Students should use visual logic models to map out options and evaluate potential outcomes for relatable, everyday dilemmas. This involves constructing and interpreting categorical flowcharts or organizational visuals to reach a logical conclusion rather than relying on gut feelings. For example, a student might use a decision tree to prioritize after-school activities based on available time and personal interest. The focus is on illustrating how specific conditions dictate a logical result. Students are not required to use complex probability trees with numerical weights or create automated decision-making algorithms.
E6-AM-VD-10 Variability of Data	Identify and/or calculate the center, spread, and shape of a distribution.	Students should see a dataset as a whole entity rather than a collection of isolated points. This involves identifying the center (mean or median), describing the spread (Interquartile Range or Mean Absolute Deviation), and characterizing the overall shape of the data. For example, a student might use dot plots or histograms to determine if a distribution is symmetrical, skewed, or contains gaps. Another task could involve using a box plot to visually represent a five-number summary and identify potential outliers. The focus is on providing a formal descriptive summary of a single variable to tell the data's story. Students are not required to calculate standard deviation or variance, nor are they expected to use the normal distribution curve to find probabilities.
E6-AM-MOD-11 Models of Data	Explain how visualizations or representations account for variation.	Students should explain how different graph types highlight the spread or diversity within a dataset. This involves articulating why certain representations are chosen to show individual data points versus grouped summaries, such as using a dot plot to show every unique response or a box plot to emphasize the range and concentration of the middle 50% of data. For example, a student might analyze a dot plot of jump-rope scores to identify gaps and clusters that show where most students performed, or use the "whiskers" on a box plot to explain the full extent of the variation. The focus is on describing how a visualization makes variation visible to help understand data consistency. Students are not required to calculate standard deviation or variance, as the mastery at this level is focused on the qualitative explanation of variation in standard plots.

Mathematics Connection

6.SP.A.2 Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall shape.

6.SP.A.3 Recognize that a measure of center for a numerical data set summarizes all of its values with a single number, while a measure of variation describes how its values vary with a single number.

6.SP.B.5 Summarize numerical data sets in relation to their context.

Interpreting Problems & Results

Standard Code	Iowa Academic Standard	Standard Clarification
E6-IPR-MC-12 Making and Justifying Claims	Identify the sources of potential bias in a sample or population.	Students should evaluate how the method of selecting a group can lead to results that do not accurately represent the whole population. This involves scrutinizing a data source to determine if certain individuals were excluded or if the environment influenced the responses. For example, a student might identify that a survey about favorite music conducted only at a classical concert would be biased toward a specific genre. The focus is on the qualitative identification of skewed sampling methods to ensure the data is fair. Students are not required to calculate the mathematical quantification of bias.
E6-IPR-MC-13 Making and Justifying Claims	Describe how bias may impact the results of an investigation.	Students should connect flawed data collection methods to the "story" the data tells. This involves explaining how specific biases, such as leading questions, can skew averages and create misleading conclusions. For example, a student might evaluate an investigation's findings by explaining how a survey about school start times would yield different results if only teachers were asked versus only students. By using "What If" analysis, students can predict how results would change if a survey were conducted at a different time or location. The focus is on the conceptual understanding of how bias weakens a claim. Students are not required to use mathematical formulas to calculate bias or perform complex probability simulations.
E6-IPR-PI-14 Problem Identification & Question Formation	Refine an investigative question to ensure it is purposeful based on how the method of analysis relates directly to the problem.	Students should evaluate a draft question and adjust its wording to ensure it is specific and measurable, leading to a clear analytical path. This involves identifying a specific population and variable to ensure the research is focused. For example, a student might refine the broad question "Do people like lunch?" into "What percentage of sixth graders prefer pizza over tacos?" to allow for a direct categorical analysis. This practice ensures that the chosen method—whether calculating a mean or creating a frequency table—is a purposeful response to the problem rather than an arbitrary calculation. The focus is on the logical alignment between a simple research question and its corresponding data type. Students are not required to develop multi-year research proposals or use complex academic research terminology.
E6-IPR-GA-15 Generalization & Application	Identify factors that limit how well data from one situation applies to other contexts.	Students should recognize that data findings are often specific to the conditions under which they were collected and cannot always be generalized to different groups or settings. This involves identifying "contextual mismatches" by evaluating factors like geography, age, and timing to determine if a dataset is truly relevant to a new situation. For example, a student might explain why data about favorite winter sports collected in Alaska would not apply to students living in Florida because the climates are too different. Similarly, they might identify that a survey of 5th graders' favorite playground equipment may not be useful for planning a park for high schoolers. The focus is on the qualitative identification of environmental and demographic limits. Students are not required to calculate margin of error or perform formal statistical comparisons between different contexts.



Mathematics Connection

6.SP.A.1 Recognize a statistical question as one that anticipates variability in the data related to the question and accounts for it in the answers.

6.SP.B.5 Summarize numerical data sets in relation to their context.

Visualization & Communication

Standard Code	Iowa Academic Standard	Standard Clarification
E6-VC-RV-16 Representation & Dynamic Visualization	Create fully labeled visualizations that include titles, units of measurement, and data sources.	Students should produce charts that stand alone as clear communication tools. This involves transforming raw data into a polished visual by applying descriptive titles, labeling axes with specific units of measurement, and citing the origin of the data to establish credibility. For example, a student might use a spreadsheet to generate a bar graph and then add a footer that identifies the "Data Source: School Cafeteria 2024 Survey." This practice ensures all components are legible and accurate so that an outside viewer can understand the data without further explanation. The focus is on the structural completeness of static graphs. Students are not required to use advanced data storytelling software or create interactive dashboards and multi-layered infographics.
E6-VC-DS-17 Data Storytelling	Evaluate whether visualizations and accompanying text are consistent with one another.	Students should act as "data detectives" who verify that a chart's visual message matches its written claims. This involves cross-checking specific values, trends, and proportions shown in a graph against summary statements or headlines to ensure there are no contradictions or exaggerations. For example, a student might verify if a "majority" mentioned in a report actually corresponds to more than 50% of the data shown in a related pie chart. The focus is on the literal alignment of data points and text to ensure information is communicated honestly. Students are not expected to identify complex logical fallacies in persuasive data storytelling.
E6-VC-BS-18 Acting on Data to Benefit Society	Describe situations where data can be used to make informed decisions to solve a community problem.	Students should recognize the bridge between local challenges and the evidence needed to address them. This involves identifying community issues and proposing how data could be collected and analyzed to drive a solution. For example, a student might propose using a school-wide survey to determine which library resources are most needed or analyzing city park usage logs to advocate for better lighting in specific areas. This practice connects abstract data to real-world advocacy, helping students see data as a tool for civic engagement and problem-solving. The focus is on the conceptual identification of data-driven opportunities. Students are not required to perform complex statistical modeling or execute the final solution.



Mathematics Connection

6.SP.A.1 Recognize a statistical question as one that anticipates variability in the data related to the question and accounts for it in the answers.

6.SP.A.2 Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall shape.

6.SP.B.4 Display numerical data in plots on a number line, including dot plots, histograms, and box plots.

6.SP.B.5 Summarize numerical data sets in relation to their context.

Middle School Standards (7-8)

Dispositions & Responsibilities

Standard Code	Iowa Academic Standard	Standard Clarification
MS-DR-ND-01 Nature of Data	Explain how data provides only partial information about the object or phenomenon being studied, including the limitations of the available data.	Students should analyze a data set, collection method, or visualization to articulate what information is available and, crucially, what information is missing, or restricted by measurement choices, thereby impacting the overall conclusions. This involves recognizing that data is a "snapshot" rather than the whole picture. For example, a student might look at a leaderboard for a video game that only ranks "total points" and point out that it doesn't show "hours played," which is essential for understanding who is actually the most skilled player versus who just spends the most time online.
MS-DR-ER-02 Data Ethics & Responsibility	Analyze how missing perspectives in datasets can affect conclusions and outcomes	Students should recognize that datasets, even when collected ethically, may not fully represent all groups or perspectives, which can lead to incomplete conclusions and unintended outcomes. For example, a student might analyze a “Most Popular Music” chart and explain how the results may not represent their peers if the data comes only from a paid streaming service that many students cannot access. Another task could involve critiquing a survey about "the best time for after-school tutoring" that was only handed out to students who take the bus, noting how this excludes athletes or students who walk home and may have different needs. The focus is on explaining how restricted data leads to a restricted—and often unfair—understanding of a community. Students are not yet required to perform complex statistical weighting or use advanced demographic modeling.
S-DR-ID-03 Investigative Dispositions	Modify conclusions when new data becomes available and support revised claims with evidence.	Students should integrate additional data—whether it strengthens, weakens, or contradicts their original findings—to logically modify their initial conclusions and support the revised claim using a comprehensive set of evidence. This practice treats conclusions as flexible rather than final, emphasizing the importance of intellectual honesty when new information arrives. For example, a student might initially conclude that a new video game is "the most popular in school" based on a survey of their own friend group, but then revise that claim after seeing school-wide library data showing that a different game's strategy guides are checked out ten times more often. The focus is on the process of evolving a claim based on the totality of the evidence. Students are not yet required to perform formal Bayesian updating or complex statistical significance testing.

Computer Science Connection

MS-DAT-IM-29 Analyze how decisions made at different stages of working with data can lead to biased data, misleading conclusions, and compromised AI models.

Mathematics Connection

7.SP.A.1 Describe how statistics can be used to gain information about a population by examining a sample of the population, recognizing that generalizations about a population from a sample are valid only if the sample is representative of that population.

7.SP.A.2 Use data from a random sample to draw inferences about a population with an unknown characteristic of interest.

Creation & Curation

Standard Code	Iowa Academic Standard	Standard Clarification
MS-CC-OP-04 Organization & Processing	Interpret documentation to understand dataset context and limitations.	Students should analyze accompanying documentation, such as metadata, data dictionaries, or data safety disclosures, to identify the data source, the date and method of collection, the definition of key variables, and any limitations noted by the creator. This involves moving beyond the raw numbers to understand the "rules" of the data. For example, a student might review the "About this Data" section of a fitness tracking app to see if a "step" is counted by arm movement or GPS location, which changes how they interpret their daily activity.
MS-CC-DC-05 Designing for Data Collection	Develop questions that explore relationships between variables and evaluate how data collection methods influence evidence quality.	Students should formulate questions that explore correlations or potential causality between measurable variables, moving from simple descriptions to investigating how one thing might affect another. For example, a student might ask, "Is there a relationship between the time of day a student takes a test and their performance?" This involves not only asking the question but also evaluating how the "how" of data collection changes the answer. A student might recognize that if they only collect data on Tuesdays, their evidence quality is lower than if they collected it across the whole week.
MS-CC-MD-06 Measurement & Datafication	Consider when and where data were collected and its precision to understand its limitations.	Students should examine a data set to determine the exact time frame and location of collection, as well as the precision of the measuring instrument, and use this information to articulate the limitations on how the data can be interpreted or applied to different situations. This involves recognizing that data is often "stuck" in its own context. For example, a student might analyze a dataset of "average outdoor noise levels" and point out that if the data was collected only at midnight, it cannot be used to describe the noise level during a busy school day. The focus is on understanding that the "where," "when," and "how exactly" of data collection sets the boundaries for the conclusions we can draw. Students are not yet required to calculate significant figures or perform complex error analysis.
MS-CC-CD-07 Complexity of Data	Identify patterns within a data set.	Students should use various techniques to visualize and process data to find and describe different types of patterns, such as trends, anomalies, cycles, and correlations. This involves looking beyond individual data points to see the "shape" of the information. For example, a student might look at a graph of cafeteria pizza sales and identify a cycle (sales peak every Friday), a trend (overall sales are increasing each month), or an anomaly (one Tuesday had zero sales because of a field trip).



Computer Science Connection

MS-DAT-DC-21 Evaluate how different levels of precision and granularity in data collection affect accuracy, storage, and analysis.

Mathematics Connection

7.SP.A.1 Describe how statistics can be used to gain information about a population by examining a sample of the population, recognizing that generalizations about a population from a sample are valid only if the sample is representative of that population.

7.SP.A.2 Use data from a random sample to draw inferences about a population with an unknown characteristic of interest.

8.SP.A.1 Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities.

Analysis & Modeling Techniques

Standard Code	Iowa Academic Standard	Standard Clarification
MS-AM-SD-08 Summarizing Data	Identify measures of center that describe the typical value in a dataset.	The purpose of this standard is to ensure students can calculate and interpret the three most common measures of central tendency—mean, median, and mode—to describe what a typical value is within a given set of data. For example, students could investigate a dataset of standardized test scores to describe the typical value. Students are not expected to create, curate, or download the dataset, conduct a statistical analysis, or model the data.
MS-AM-PR-09 Identifying Patterns & Relationships in Data	Utilize graphs (e.g., bar graphs, line graphs) to describe patterns and identify trends, similarities, and differences within data.	The purpose of this standard is to ensure students can translate raw data into visual representations to facilitate the discovery and clear communication of insights. Students should analyze appropriate graphs, such as bar graphs for comparing categories or line graphs for showing change over time, to clearly articulate patterns, describe how variables relate (trends), highlight similarities and differences among data groups, and use the visual evidence to support their observations. For example, students could investigate a graph illustrating the size and assessed value of homes in a geographic region. Students are not expected to model the data.
MS-AM-VD-10 Variability of Data	Explain the center, spread and shape of a distribution.	Students should first identify the center (the typical value, using mean or median), then quantify the spread (the variability or range of the data), and finally describe the shape (how the data is clustered or skewed) using visual tools like histograms or box plots. For example, students could consider the MSRP of different models of a specific automobile manufacturer to consider the average price of a new car and compare the number of models that are below average and above average. Students are not expected to calculate descriptive statistics such as standard deviation, or identify a potential underlying distribution.
MS-AM-MOD-11 Models of Data	Analyze patterns of increasing, decreasing, or no relationship between variables in graphical representations.	Students should analyze scatter plots or line graphs to determine if the plotted points show a clear increasing relationship (as one variable increases, the other generally increases), a decreasing relationship (as one variable increases, the other generally decreases), or no discernible relationship (the points appear randomly scattered). For example, students might consider the relationship between heights and grade levels or how much students like vegetables and grade level. Students are not expected to quantitatively measure the strength of relationship or correlation coefficient.



Mathematics Connection

7.SP.B.4 Use measures of center (for example, mode, median, mean) and measures of variability (for example, range, interquartile range, mean absolute deviation) for numerical data from random samples to draw informal comparative inferences about two populations.

8.SP.A.1 Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities.

8.SP.A.2 For scatter plots that suggest a linear association, informally fit a straight line, and informally assess the model fit by judging the closeness of the data points to the line.

Interpreting Problems & Results

Standard Code	Iowa Academic Standard	Standard Clarification
MS-IPR-MC-12 Making and Justifying Claims	Generate an original statement that answers the original investigation question in a direct way and provides relevant statistical data to support one's statistical conclusion.	Students should formulate a succinct, declarative claim that answers the original question, and support this claim by integrating relevant statistical evidence (such as measures of center, counts, or rates) derived from the data analysis, effectively linking their findings back to the initial problem. Example: Identifying the relationship between sample size and the accuracy of your claim.
MS-IPR-PI-13 Problem Identification & Question Formation	Analyze a conclusion to determine its limitations.	Students should assess their data to determine which parts of their original question can be answered and identify which areas still require further investigation. This involves recognizing that a single conclusion rarely tells the whole story and identifying potential "blind spots". For example, a student who concludes that "8th graders prefer pizza for lunch" based on a survey might realize a limitation: the survey was only taken on a Friday, so they still need to investigate if preferences change on "Taco Tuesday." Students are not yet required to use formal bias-correction formulas or complex sensitivity analysis. To help students with this standard, ask them: "What is one question your data CAN'T answer yet?" or "Who did we accidentally leave out when we collected this information?"
MS-IPR-PI-14 Problem Identification & Question Formation	Identify where the method of analysis may have distracted from or obscured the original problem.	Students should analyze whether their choice of analysis method—such as a specific chart type or a complex calculation—helped or hindered the answer to the original question. This involves recognizing when a method overcomplicates a simple problem or accidentally hides the most important information. For example, a student might realize that using a "3D exploding pie chart" to show favorite school subjects actually made it harder to compare the sizes of the slices than a simple bar graph would have. The focus is on choosing the most direct and honest way to represent data. Students are not yet required to perform advanced data auditing or critique professional-grade statistical modeling.
MS-IPR-GA-15 Generalization & Application	Identify how a sample may be systematically skewed due to collection methods, data availability, survey design, or other factors, as demonstrated in a direct data collection activity.	Students should identify how the "how, when, and who" of data collection can lead to a systematically skewed sample—one that consistently misrepresents the truth in a specific direction. This involves recognizing that errors aren't always random; often, the way a survey is designed or where it is shared guarantees a biased result. For example, a student might conduct an activity where they "survey" the school's favorite sport but only ask students entering the gym, identifying how this method skewed the results toward indoor sports like basketball or volleyball. The focus is on spotting the structural flaws that make data unrepresentative. Students are not yet required to calculate sampling error or use formal stratification formulas.



AI Connection

MS-RR-RN-24 Analyze how a reasoning strategy that works in one context may produce different outcomes in another.

Mathematics Connection

7.SP.A.1 Describe how statistics can be used to gain information about a population by examining a sample of the population, recognizing that generalizations about a population from a sample are valid only if the sample is representative of that population.

7.SP.A.2 Use data from a random sample to draw inferences about a population with an unknown characteristic of interest.

7.SP.B.4 Use measures of center (for example, mode, median, mean) and measures of variability (for example, range, interquartile range, mean absolute deviation) for numerical data from random samples to draw informal comparative inferences about two populations.

8.SP.A.1 Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities.

8.SP.A.2 For scatter plots that suggest a linear association, informally fit a straight line, and informally assess the model fit by judging the closeness of the data points to the line.

8.SP.A.3 Use the equation of a linear model to solve problems in the context of bivariate measurement data, interpreting the slope and intercept.

8.SP.A.4 Construct and interpret a two-way table summarizing data on two categorical variables collected from the same subjects.

Visualization & Communication

Standard Code	Iowa Academic Standard	Standard Clarification
MS-VC--RV-17 Representations & Dynamic Visualization	Evaluate the success data representations based on key visual elements and what they mean.	Students should analyze how data is presented to determine if it clearly communicates its message or if it is misleading. This involves checking for essential components like clear titles, labeled axes, units of measure (e.g., "degrees Celsius" vs. "degrees Fahrenheit"), and a cited data source. For example, a student might review a chart from a popular news site about "social media usage" and evaluate if the choice of a bubble map actually makes it harder to compare the data than a standard bar graph would. The focus is on being a critical consumer of media who can articulate whether a visualization is helpful and honest or confusing and poorly designed. Students are not yet required to create complex interactive dashboards or use professional graphic design software.
MS-VC-RV-18 Representations & Dynamic Visualization	Identify potential errors in data through the use of visualizations of common data distributions.	Students should generate simple visualizations of single-variable distributions, such as histograms, box plots, or frequency charts, to visually inspect the data's shape and distribution for values that are logically inconsistent or statistically anomalous. For example, students might create a visualization of student heights where the dataset contains values reported in different units. Students are not expected to create a dataset with errors or display mastery of common distributions.
MS-VC-DS-19 Data Storytelling	Explain what the data reveals and whether it supports or contradicts any claims initially made.	Students should examine the key results (e.g., summary statistics, patterns, correlations) derived from their analysis and generate a clear, narrative explanation of what those results communicate about the studied phenomenon, specifically stating whether the evidence found validates or refutes the claims that were made before the investigation began. For example, students might hypothesize the most common color for automobiles, then use a dataset of automobile sales to evaluate the hypothesis. Students are not expected to conduct advanced analyses or modeling of the data.
MS-VC-DS-20 Data Storytelling	Create explanations of data visualizations to tell their story.	Students should create a data visualization (e.g., a bar chart, line graph, or scatter plot) and synthesize its key elements—such as labels, trends, comparisons, and outliers—into a compelling, simple story that accurately reflects the data and addresses the original question. For example, students could create a histogram or pie chart showing menu preferences and drawing conclusions. Students are not expected to conduct advanced analyses or create sophisticated visualizations.
MS-VC-BS-21 Acting on Data to Benefit Society	Evaluate the effectiveness of a data story in addressing an audience's needs and propose how the data could be used to solve a community problem.	Students should critically assess a completed data story (including its visualizations and narrative) based on its success in clearly communicating to a specific audience. For example, students might evaluate an infographic about local recycling habits to decide if it would persuade community members or review a data-based presentation on school lunch choices and suggesting how it could guide menu changes. Students are not expected to create the data story or conduct original community research.



Computer Science Connection

MS-DAT-DI-26 Create data visualizations to show how different design choices can impact the interpretation of the same data.



Mathematics Connection

7.SP.A.2 Use data from a random sample to draw inferences about a population with an unknown characteristic of interest.

8.SP.A.1 Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities.

8.SP.A.4 Construct and interpret a two-way table summarizing data on two categorical variables collected from the same subjects.

Foundational High School Standards

Dispositions & Responsibilities

Standard Code	Iowa Academic Standard	Standard Clarification
HS-DR-ND-01 Nature of Data	Explain qualitative and quantitative data relationship to categorical and numerical data.	Students should be able to tell the difference between data that describes things and data that measures things. Students should understand that qualitative data uses words or labels (categorical), while quantitative data uses numbers you can count or measure (numerical). They should practice sorting information in real-world situations, such as deciding if a "Jersey Number" is a label for a player or a number used for math. To keep the lesson focused, students should only learn the basic link between the type of data and how it is used. Students are not expected to use advanced math formulas or professional coding software at this introductory level.
HS-DR-ND-02 Nature of Data	Describe how data-based decisions are updated when new evidence or societal needs emerge.	Students should understand that conclusions made from data are not permanent and must change when new information or different community needs appear. Students should be able to explain that as we collect more evidence or as the world around us changes, the "best" decision might also change to stay fair and accurate. They should practice looking at how rules or plans are updated over time, such as explaining why a city might change a bus route after seeing new traffic data or hearing from people who moved into a new neighborhood.
HS-DR-ND-03 Nature of Data	Evaluate why data models require updates to maintain accuracy and relevance over time.	Students should understand that data models are built on information collected at a specific point in time and can become outdated, inaccurate, or misleading as the world changes around them. Students should be able to identify and explain specific reasons a model may need updating, such as shifts in population demographics, new laws or policies, or major events that were not present in the original data. Students should express their evaluations using evidence-based reasoning, such as "This model may no longer be accurate because the data was collected before...." Students are not expected to retrain a model, write code, or apply statistical methods such as cross-validation or error analysis.
HS-DR-ND-04 Nature of Data	Explain models using independent variables (inputs), dependent variables (outputs), and predictors or weights.	Students should be able to explain how a data model works by identifying what information goes into it (inputs), what the model is trying to predict or produce (output), and which inputs carry more or less influence on the result (predictors or weights) — such as explaining how a music recommendation model uses listening history, genre, and time of day as inputs to produce a suggested playlist, with listening history weighted most heavily. Students are not expected to calculate weights mathematically, interpret regression coefficients, or build or code any model.
HS-DR-ER-05 Data Ethics & Responsibility	Analyze how data-driven decisions can reinforce existing patterns or conditions that result in unequal outcomes.	Students should understand that data is not always "neutral" and can reflect or even grow existing unfairness in society. Students should be able to explain that if the information used to train a system or make a decision is missing certain groups of people or contains historical prejudices, the results will continue to treat people unfairly.

Standard Code	Iowa Academic Standard	Standard Clarification
HS-DR-ER-06 Data Ethics & Responsibility	Evaluate the benefits and risks of interpreting data in specific contexts.	Students should be able to explain that using data can help people make better choices, but it also comes with dangers that need to be managed. Students should understand that while data can improve things like medical treatments or personal safety, it can also lead to a loss of privacy if handled incorrectly. They should practice weighing the "good" against the "bad" in different scenarios, such as comparing how a fitness app helps you stay healthy versus the risk of the company sharing your location data with others.
HS-DR-ER-07 Data Ethics & Responsibility	Explain how incomplete or unbalanced data can make valid conclusions more difficult to recognize.	Students should be able to explain that when a dataset is tilted toward one point of view the conclusions we draw might seem correct but are actually wrong or incomplete. They should practice spotting how this can lead to mistakes, such as realizing that a survey about "the best school lunch" is incomplete if only the students who go home for lunch are allowed to vote.
HS-DR-ER-08 Data Ethics & Responsibility	Analyze how data can drive innovation and inform community-level decision-making.	Students should understand that data can be used to invent new solutions and help local leaders make better choices for everyone. Students should be able to explain how looking at patterns in information allows communities to see what is working and what needs to change to make life better or more efficient. They should practice identifying how data leads to progress, such as explaining how a city uses "bike-share" data to decide where to build new, safer bike lanes.
HS-DR-ER-09 Data Ethics & Responsibility	Design investigations addressing social, educational, business, medical, or governmental issues.	Students should be able to plan a research project to answer questions about their community, school, or health while being honest about what their data can and cannot prove. Students should understand that every investigation has limits and that their own choices—like who they ask or what questions they use—can accidentally create bias. They should practice building a research plan, such as designing a way to find out if a local park needs more trash cans by counting litter and interviewing people who visit at different times of the day.
HS-DR-ID-10 Investigative Dispositions	Apply iterative methods to strengthen data interpretations and generate new questions.	Students should understand that looking at data once is often not enough to get the whole story. Students should be able to use a "repeat and refine" process where they look at their results, improve their explanation, and then come up with new questions to dig deeper. They should practice this cycle of improvement, such as looking at a chart of school library checkouts, realizing they need to know which grades are visiting the most, and then creating a new plan to collect that specific information.
HS-DR-ID-11 Investigative Dispositions	Compare findings using a variety of investigative approaches.	Students should understand that there is more than one way to study a problem and that different methods can lead to different or better conclusions. Students should be able to look at results from various sources—like a survey, an experiment, or looking at old records—and explain why they might show different things. They should practice comparing information, such as looking at how a "tasting test" and a "sales report" both explain which school snack is the most popular.

Creation & Curation

Standard Code	Iowa Academic Standard	Standard Clarification
HS-CC-OP-12 Organization & Processing	Identify relevant data subsets based on context and problem requirements.	Students should be able to examine a larger dataset and intentionally select only the records, categories, or variables that are relevant to the question they are trying to answer. Students should understand that effective analysis depends on narrowing the data to what is useful for the task, rather than trying to use every available piece of information. They should practice filtering, sorting, or isolating data based on a clear purpose so that the resulting subset is better suited for analysis and decision-making. Students are not expected to clean highly complex datasets, write advanced database queries, or manage large-scale professional data systems.
HS-CC-OP-13 Organization & Processing	Compute group-level summary measures, for comparative analysis.	Students should be able to take a large set of data and calculate simple "summary numbers"—like the average (mean) or the middle value (median)—for different groups. Students should understand that these numbers allow them to compare two or more groups side-by-side to see how they are different or similar. They should practice finding these measures, such as calculating the average height of the 9th-grade class versus the 10th-grade class to see which group is taller overall.
HS-CC-DC-14 Designing for Data Collection	Identify comparison or association questions appropriate for addressing data-driven problems.	Students should be able to look at a problem and decide if they need to compare groups or find a connection between two different things. Students should understand that a "comparison" question asks how groups are different (like Boys vs. Girls), while an "association" question asks if two variables change together (like Study Time and Test Scores). They should practice picking the right kind of question for a task, such as deciding whether to ask "Do athletes sleep more than non-athletes?" (comparison) or "Does the amount of sleep you get affect your grades?" (association).
HS-CC-DC-15 Designing for Data Collection	Locate datasets from scientific, civic, or government sources using search tools and filters.	Students should be able to use internet search engines and specific data portals to find information from reliable sources like the government or scientific groups. Students should understand how to use filters—such as date, file type, or region—to narrow down their results and find the exact data they need for a project. They should practice navigating these tools, such as using the filters on Data.gov to find only "CSV" files about "Air Quality" in their specific state.
HS-CC-DC-16 Designing for Data Collection	Assess datasets for quality, sample size, and collection methods to determine suitability for investigation.	Students should be able to look at a dataset and decide if it is good enough to use for their specific project. Students should understand that they need to check if the data is clean (quality), if there is enough of it to be helpful (sample size), and if the way it was gathered was fair and organized (collection methods). They should practice judging the value of information, such as looking at a survey about "favorite movies" and realizing it isn't suitable if only three people answered or if the questions were confusing.
HS-CC-MD-17 Measurement & Datafication	Interpret metadata and data dictionaries to understand dataset context and content.	Students should be able to use "data about data" to understand what a dataset is really showing and where it came from. Students should understand that a data dictionary acts like a translation guide that defines what every column header and code means so they don’t have to guess. They should practice using these guides to get the full context of a project, such as looking at a data dictionary to realize that a column labeled "Status" uses "1" for "Active" and "0" for "Inactive."

Standard Code	Iowa Academic Standard	Standard Clarification
HS-CC-CD-18 Complexity of Data	Identify the difference between true zero values and blank cells.	Students should be able to distinguish between data values that are recorded as zero and data entries that are blank or missing, and explain how each affects data interpretation and analysis. Students should recognize that a true zero represents a measured value of none or no amount, while a blank cell indicates that data were not collected, not recorded, or are unavailable, and they should account for this distinction when summarizing or visualizing data. Students are not expected to apply data-cleaning techniques, write conditional formulas, or use statistical software to impute missing values at this grade level.
HS-CC-DT-19 Data Transformation & Preprocessing	Clean datasets to address missing values, errors, and anomalies before analysis.	Students should understand that real-world data is often "messy" and must be fixed before it can be used to reach accurate conclusions. Students should be able to identify common issues like missing information, obvious typos (errors), or numbers that don't make sense (anomalies) and decide how to handle them. They should practice cleaning techniques, such as deciding whether to delete a row with a missing age or replace it with an average, and fixing a weight entry that was accidentally typed as "5000 lbs." instead of "50 lbs."
HS-CC-DT-20 Data Transformation & Preprocessing	Create an ordinal scale of measurement.	Students should be able to define categories that can be logically ordered based on a clear criterion and explaining what the order represents. Students should determine an appropriate ranking, ensure that the order is meaningful and consistent, and apply the scale to classify data or responses, such as in a Likert scale. Students are not expected to calculate numerical differences between ranks or treat ordinal data as if it were interval or ratio data at this grade level.

Analysis & Modeling Techniques

Standard Code	Iowa Academic Standard	Standard Clarification
HS-AM-SD-21 Summarizing Data	Select appropriate methods to summarize data.	Students should examine the purpose, type, and structure of a dataset, choose a reasonable method for summarizing it, and use that method to communicate the most important information clearly. Such as deciding whether a table, graph, or numerical summary best fits the data, comparing two possible summary approaches before choosing one, or revising a summary when it does not effectively highlight the key pattern or takeaway. Teachers should plan for students to engage in routines where they organize data, justify their choices, and explain how the selected summary supports understanding for a particular question or audience. Students are not expected to choose among advanced statistical techniques or defend their choices using formal statistical theory.
S-AM-SD-22 Summarizing Data	Explain how data are distributed across ranges, including skewness and asymmetry.	Students should examine how values are spread across intervals, describe noticeable patterns in shape, and use those observations to support interpretation or comparison. Such as sorting data into ranges before discussing where values are concentrated, using a graph to describe whether one side of a distribution extends farther than the other, or comparing two displays to explain which dataset appears more balanced or uneven. Teachers should plan for students to engage in routines where they describe distribution shapes in words, connect what they see to the question being studied, and use evidence from the display to support their thinking. Students are not expected to calculate advanced measures of distribution shape or provide formal statistical proofs about skewness or asymmetry.
HS-AM-IP-23 Identifying Patterns & Relationships in Data	Interpret variability in distributions using numerical methods.	Students should calculate and interpret measures of variability to describe how spread out a dataset is, with emphasis on using interquartile range to describe the spread of the middle half of the data and standard deviation to describe how far values typically vary from the mean. Students should organize data, determine quartiles, compute interquartile range, calculate standard deviation, and explain what each measure reveals about consistency, clustering, or spread within a distribution - such as comparing two class quiz score sets to determine which is more consistent, analyzing rainfall data to describe variation across months, or examining reaction-time data to decide whether values are tightly grouped or widely dispersed. Teachers should plan for students to connect numerical measures to the shape and context of the distribution and to use these measures to support comparisons between datasets. Students are not expected to derive formulas, justify procedures mathematically, or use advanced inferential statistics beyond grade-level interpretation of variability.
HS-AM-PR-24 Identifying Patterns & Relationships in Data	Detect correlations, trends, or clustering patterns.	Students should detect correlations, trends, and clustering patterns in data and use those patterns to describe relationships, changes over time, or natural groupings within a dataset. Students should identify whether variables appear related, recognize upward or downward trends, notice when data points form groups, and explain what those patterns suggest within the context of the discipline being studied. Such as examining the relationship between study time and quiz scores, identifying trends in population growth across years, or noticing clusters in consumer survey responses or environmental measurements. Teachers should plan for students to interpret these patterns as evidence for explanation and decision-making rather than simply spotting them visually. Students are not expected to prove causation, apply advanced statistical tests, or use machine learning techniques to identify complex patterns.

Standard Code	Iowa Academic Standard	Standard Clarification
HS-AM-VD-25 Variability of Data	Differentiate between a variety of visualizations to appropriately display data.	Students should differentiate among common data displays and summary measures and select an appropriate way to represent data based on the type of information being communicated. Students should identify when a line graph is useful for showing change over time, when a curve or distribution shape helps show patterns in how values are spread, and when a summary measure helps communicate a key feature of the data, such as center or spread. Such as choosing a line graph to show attendance across months, using a curve or histogram shape to describe score distributions, or using the mean, median, or range to summarize a dataset for comparison. Teachers should plan for students to explain why one display or summary is more appropriate than another based on the purpose, audience, and structure of the data. Students are not expected to master advanced graphing conventions, create highly technical statistical displays, or justify choices using formal statistical theory.
HS-AM-MOD-26 Models of Data	Construct linear models, test predictions, and refine models using technology.	Students should follow an iterative modeling process in which they use digital tools to build a representation, check how well it works, and revise it based on evidence. Such as entering data into a spreadsheet and reviewing the output, comparing a projected result to additional information, or adjusting inputs or assumptions after noticing that the result is not useful for the question being studied. Teachers should plan for students to see modeling as a cycle of drafting, checking, revising, and explaining rather than as a one-time answer. Students are not expected to evaluate models using advanced statistical diagnostics or independently manage complex modeling tools.
HS-AM-MOD-27 Models of Data	Use technology to create, test, and improve predictive models.	Students should engage in an inquiry cycle in which they use technology to generate outputs, check those outputs against evidence, and improve their approach over time. Such as running multiple trials in a digital tool, comparing projected outcomes to newly collected information, or revising an approach after identifying an input or assumption that weakened the result.

Interpreting Problems & Results

Standard Code	Iowa Academic Standard	Standard Clarification
HS-IPR-MC-28 Making and Justifying Claims	Analyze how confirmation and availability biases affect interpretation of data.	Students should understand that our brains often take "shortcuts" that can lead to wrong conclusions when looking at data. Students should be able to explain that confirmation bias happens when we only pay attention to data that agrees with what we already believe, while availability bias happens when we give too much importance to information that is easy to remember or recently happened. They should practice spotting these mental traps, such as noticing if they are ignoring a high-quality report because it disagrees with their favorite sports team's stats.
HS-IPR-MC-29 Making and Justifying Claims	Explain how randomization can affect representation of data and influence the reliability of conclusions.	Students should understand that randomization is like "shuffling a deck of cards" to make sure every person or item has an equal chance of being picked. Students should be able to explain that choosing participants by chance helps prevent researchers from accidentally picking only people who agree with them or who share the same traits. They should practice identifying how this makes data more trustworthy, such as explaining why picking names out of a hat for a survey is fairer than only asking the first five people who walk into a room.
HS-IPR-PI-30 Problem Identification & Question Formation	Identify additional questions to explore based associations between variables in a dataset.	Students should be able to look at a connection between two things in a dataset and think of new, deeper questions to ask. Students should understand that finding an association—like seeing that "higher temperatures" match with "more water used"—is just the beginning, and they should use that information to wonder why or how that connection happens. They should practice generating follow-up questions, such as seeing a link between "breakfast" and "test scores" and then asking, "Does it matter what kind of food students ate?"
HS-IPR-PI-31 Problem Identification & Question Formation	Log questions during data analysis and identify additional factors to clarify associations.	Students should keep a running list of questions that come up while they are looking at data to help them understand the "why" behind a pattern. Students should be able to identify other factors—outside of the data they already have—that might be influencing a connection between two things. They should practice documenting their curiosity, such as noting that "ice cream sales" and "sunburns" both go up at the same time and asking if "outdoor temperature" is the hidden factor causing both.
HS-IPR-GA-32 Generalization & Application	Document data analysis steps in user-friendly formats for collaboration.	Students should be able to record the steps they took to organize and study their data so that someone else can understand and repeat their work. Students should understand that clear documentation prevents confusion and allows a team to work together effectively without having to guess how a conclusion was reached. They should practice presenting their "data trail" in simple, organized ways, such as creating a bulleted list of the filters they used or writing a short "How-To" guide for their teammates.
HS-IPR-GA-33 Generalization & Application	Recognize that findings may change when data is filtered into categories and/or groups.	Students should understand that the "big picture" story of a dataset can change completely when you zoom in on specific groups or categories. Students should be able to explain that a conclusion that seems true for everyone might not be true for a smaller sub-group, a phenomenon sometimes known as Simpson's Paradox. They should practice analyzing these shifts, such as noticing that while overall school grades are going up, they might actually be going down for one specific grade level.

Visualization & Communication

Standard Code	Iowa Academic Standard	Standard Clarification
HS-VC-RV-34 Representations & Dynamic Visualizations	Properly cite data sources near visualizations to ensure transparency and credibility.	Students should understand that every chart or graph needs to show exactly where its information came from. Students should be able to place a clear citation—such as a website link, the name of an organization, or a specific report title—directly next to or underneath their visualization. They should practice this habit to ensure their work is transparent (so others can check the facts) and credible (so people know the information is from a trustworthy source).
HS-VC-RV-35 Representations & Dynamic Visualizations	Use complementary or contrasting visual elements to represent dichotomous ideas in visualizations.	Students should be able to use opposites in design—like contrasting colors, shapes, or positions—to show clear differences between two competing ideas (dichotomous ideas). Students should understand that when data has two distinct sides (such as "Success vs. Failure" or "Urban vs. Rural"), the visual elements should make that split obvious at a glance. They should practice using these elements effectively, such as using a "diverging color scale" where one side is dark blue and the other is dark orange to show the contrast between "Agree" and "Disagree."
HS-VC-RV-36 Representations & Dynamic Visualizations	Create visualizations with accessibility in mind.	Students should understand that not everyone sees colors the same way and that design choices can make data easier or harder to read. Students should be able to apply principles of contrast (the difference in brightness between objects) and color selection to ensure their visualizations are accessible to people with color vision deficiencies (color blindness) or low vision. They should practice making accessible design choices, such as using a high-contrast palette (like black text on a white background) or using both color and patterns to distinguish between bars in a graph.
HS-VC-RV-37 Representations & Dynamic Visualizations	Extract key insights, trends, and patterns from a variety of data visualizations.	Students should be able to "read" a chart, map, or graph to figure out the story the data is telling. Students should understand that a visualization is more than just a picture; it is a tool used to spot trends (how things change over time), patterns (things that repeat), and insights (surprising or important facts). They should practice looking beyond the individual numbers to describe the overall message, such as looking at a line graph of global temperatures and identifying that while there are small ups and downs, the long-term trend is moving upward.
HS-VC-DS-38 Data Storytelling	Identify an audience and tailor data stories to communicate effectively.	Students should understand that the way you present data depends entirely on who is looking at it. Students should be able to adjust the complexity, tone, and format of their data story to make sure it is easy for their specific audience to understand and use. They should practice tailoring their communication, such as explaining the same set of "recycling stats" differently when talking to a group of 1st graders (using simple pictures) versus the school board (using detailed charts and costs).
HS-VC-DS-39 Data Storytelling	Explain implications and actionable takeaways from data for real-world use.	Students should be able to look at the results of their data analysis and answer the question, "So what?" Students should understand that data is most powerful when it leads to a specific change or decision in the real world. They should practice moving from "what the data says" to "what we should do," such as seeing that most student injuries happen on the blacktop and recommending that the school move certain sports to the grass field.

Standard Code	Iowa Academic Standard	Standard Clarification
HS-VC-BS-40 Acting on Data to Benefit Society	Analyze consequences of decisions made based on unreliable data.	Students should understand that when the data used to make a decision is wrong, messy, or incomplete, the results can be unfair or even dangerous. Students should be able to explain that "bad data in" leads to "bad decisions out," and identify who might be hurt or what resources might be wasted because of those errors. They should practice tracing the impact of mistakes, such as explaining how a city might build a new park in the wrong neighborhood because their survey only counted people with expensive smartphones.
HS-VC-BS-41 Acting on Data to Benefit Society	Evaluate impactful data stories and their societal implications.	Students should be able to analyze how data is used to tell a story and how that story affects the world around them. Students should understand that a "data story" isn't just numbers; it is a narrative designed to change how people think or act, and it can have both positive and negative effects on society. They should practice evaluating these impacts, such as looking at a famous data visualization about climate change and discussing how it led to new laws or changed how people use energy.

Data Science Specialty Standards

Semester 1 Course

Dispositions & Responsibilities

Standard Code	Iowa Academic Standard	Standard Clarification
S1-DSS-DR-ND-01 Nature of Data	Explain how flawed training data affects Machine Learning predictors, weights, and resulting outputs.	Students should understand that Machine Learning models are "mirrors" of the data they are given. Students should be able to explain that if training data contains human prejudices or unfair gaps, the model will bake those flaws into its mathematical weights (the importance it gives to certain features). This results in predictors that are systematically skewed, leading to outputs that unfairly favor or disadvantage specific groups, even if the developer didn't intend for that to happen.
S1-DSS-DR-ND-02 Nature of Data	Construct a basic predictive algorithm using weighted inputs to explain how training adjusts parameters.	Students should be able to build or trace a simple mathematical "decision machine" where different pieces of information (inputs) are given different levels of importance (weights). Students should understand that "training" a model is the process of adjusting these weights based on whether the prediction was right or wrong. They should practice identifying how changing a weight—such as increasing the "importance" of a player's height versus their speed—directly changes the model's final output.
S1-DSS-DR-ER-03 Data Ethics & Responsibility	Formulate multiple analytical perspectives to mitigate flaws in data interpretation	Students should understand that looking at data from only one point of view can lead to "tunnel vision" and incorrect conclusions. Students should be able to intentionally step into different roles or use different frameworks to interpret the same dataset. They should practice asking, "Who is missing from this data?" or "How would a different community member explain this result?"
S1-DSS-DR-ID-04 Investigative Dispositions	Use digital tools to refine inferences from large or complex datasets.	Students should understand that as datasets grow in size or complexity, human intuition alone isn't enough to spot subtle trends or verify theories. Students should be able to use digital tools—such as specialized data software, programming libraries (like Pandas), or advanced spreadsheet functions—to test their initial "hunches" (inferences) and refine them into data-backed conclusions. They should practice using these tools to filter out noise, recalculate metrics across different segments, and see if their original ideas hold up under deeper scrutiny.

Creation & Curation

Standard Code	Iowa Academic Standard	Standard Clarification
S1-DSS-CC-MD-05 Measurement & Datafication	Document variables, codes, and data collection procedures in a formal data dictionary.	Students should understand that for data to be useful to others (or even to themselves in the future), it must be accompanied by clear "metadata." Students should be able to document variables, codes, and data collection procedures in a formal data dictionary. This includes defining what each column represents, explaining any shorthand or numerical codes (e.g., $1 = \text{Yes}$, $0 = \text{No}$), and describing exactly how the data was gathered to ensure transparency and reproducibility.
S1-DSS-CC-MD-06 Measurement & Datafication	Design bias-resistant and privacy-protective data collection protocols.	Students should understand that the way data is collected can inadvertently introduce unfairness or compromise individual safety. Students should be able to design data collection protocols that proactively minimize bias and maximize privacy (by using techniques like anonymization, informed consent, and data minimization). They should practice creating "rules of engagement" for their data projects that protect both the integrity of the results and the rights of the participants.
S1-DSS-CC-MD-07 Measurement & Datafication	Choose appropriate data to collect for a data science project based on available tools, skills, and project goals.	Students should analyze a data science project's objectives and make informed decisions about what kind of data to collect. This involves evaluating project goals to determine what questions need to be answered. Students should consider available tools (e.g., libraries for web scraping, APIs, sensor hardware) and their own skills to choose a feasible data collection strategy. For example, if a project's goal is to analyze local air quality, students should consider whether to use a public API, purchase and use a physical sensor, or use an existing government dataset, weighing the pros and cons of each method against their resources and abilities and the nature of the research question. Students are not expected to build data collection tools from scratch (e.g., custom web scrapers). Students are not required to work with large datasets that require memory or processing power beyond what is available on their personal devices. Students are not required to work with data from multiple, disparate sources.
S1-DSS-CC-MD-08 Measurement & Datafication	Interpret metadata when using data collected by others.	Students should identify, interpret, and discuss the metadata associated with a dataset they did not collect themselves. This involves examining and explaining what the metadata tells them about the data's origin, collection methods, variables, and potential limitations before beginning an analysis. For example, when given a dataset, students should analyze a readme file or data dictionary to understand where the data came from, when it was last updated, what each column or variable represents, and which units of measurement were used. Students should use this information to inform their analysis. Students should also discuss potential sources of bias in the data and other factors that will influence data interpretation. Students are not expected to work with datasets that lack any form of metadata. Students are also not expected to perform quality assurance on the metadata and data (e.g., to compare the metadata and data to ensure they align).
S1-DSS-CC-CD-09 Complexity of Data	Develop reproducible workflows documenting all data cleaning procedures.	Students should understand that data cleaning is rarely a one-time event and that others (including their future selves) need to be able to replicate their exact steps to trust the final results. Students should be able to develop reproducible workflows by systematically documenting all data cleaning procedures. This means moving away from "hidden" manual edits (like deleting a row and forgetting why) and toward a transparent log or script that records every transformation, from handling outliers to fixing typos and reformatting dates.

Standard Code	Iowa Academic Standard	Standard Clarification
S1-DSS-CC-DTP-10 Data Transformation and Preprocessing	Create new categorical or quantitative variables from existing data.	Students should be able to derive meaningful new variables from existing data to support analysis — such as calculating a body mass index column from separate height and weight fields, binning a continuous age variable into age groups, or creating a binary indicator variable from a text field. Students are not expected to apply advanced feature engineering techniques such as principal component analysis, polynomial feature expansion, or automated feature selection methods.

Analysis & Modeling Techniques

Standard Code	Iowa Academic Standard	Standard Clarification
S1-DSS-CC-SD-11 Summarizing Data	Adjust analyses and visualizations to account for missing values.	Students should understand that real-world datasets are rarely complete and that "holes" in the data can lead to misleading results if not handled properly. Students should be able to adjust their analyses and visualizations to account for these missing values—whether by removing incomplete records, flagging them, or using basic "imputation" (filling them in with a logical value like the mean). They should practice identifying how missing data might skew a trend line or a summary statistic and choose the most appropriate adjustment to maintain the integrity of their findings.
S1-DSS-CC-SD-12 Summarizing Data	Examine missing data and its impact on data analysis.	Students should examine datasets with missing values to understand the nature and extent of the missing data (e.g., identifying which variables have missing values, how much data is missing, whether there are patterns in what is missing). Students should analyze how missing data affects different analytical approaches, recognizing that some methods require complete data, whereas others can handle missing values. For example, students might explore a housing dataset where income data is partially missing and detect that some visualization techniques (e.g., scatter plots) automatically exclude incomplete cases while summary statistics can be calculated on available data. Students should understand that decisions about handling missing data (e.g., removing incomplete cases, using mean imputation) can affect results and potentially introduce bias. Students are not expected to formally classify missing data mechanisms (i.e., missing completely at random, missing at random, missing not at random) using statistical tests, though discussing these concepts is appropriate. Students are not expected to implement advanced imputation techniques (e.g., k-nearest neighbors imputation, multiple imputation by chained equations) or to perform formal statistical comparisons of model performance with different missing data treatments.
S1-DSS-CC-SD-13 Summarizing Data	Apply appropriate analytic and visualization techniques for categorical and quantitative data.	Students should select and apply appropriate computational methods for analyzing and visualizing categorical data (e.g., bar charts, mosaic plots, frequency tables) and quantitative data (e.g., histograms, scatter plots, box plots, summary statistics). Students should understand how the data type influences the choice of analytic and visualization techniques. Students should also consider who will interpret the visualization when selecting a technique, recognizing that some chart types are more accessible to general audiences than others. For example, students could use computational tools to create a bar chart showing the distribution of car types in a dataset and a scatter plot examining the relationship between engine size and fuel efficiency. Students are not expected to perform inferential statistical tests (e.g., chi-squared tests, t-tests, ANOVA) or statistical modeling techniques that require understanding of probability distributions and statistical significance (e.g., linear regression, logistic regression). Students are not expected to work with multidimensional data requiring techniques like principal component analysis or advanced machine learning models.

Standard Code	Iowa Academic Standard	Standard Clarification
S1-DSS-CC-SD-14 Summarizing Data	Document the origin, structure, and preparation of datasets to support clarity and reproducibility.	Students should create clear and detailed documentation for a dataset they have prepared for analysis, ensuring that collaborators and other analysts can understand and reproduce their work. This includes creating a comprehensive record of the data's entire lifecycle, from its source to its final prepared state. Students should document the data's origin, collection methods, and all steps taken to clean, transform, or organize it for analysis. Students should treat documentation as an ongoing part of the data preparation process, maintaining records as decisions are made rather than reconstructing them after the fact. For example, students could write a report detailing that their dataset came from a specific government website's API, was collected on a certain date, and was then cleaned by removing missing rows and normalizing a date column into a standard format, providing the code snippets used for each step. Students are not expected to use version control systems to track every change. Students are not expected to maintain documentation across multiple simultaneous projects or coordinate documentation standards across a team.
S1-DSS-CC-PR-15 Identifying Patterns & Relationships in Data	Conduct linear regression analyses.	Students should understand that linear regression is a method for modeling the relationship between a dependent variable and one or more independent variables by fitting a linear equation to observed data. Students should be able to conduct linear regression analyses using digital tools to find the "line of best fit" ($y = mx + b$ or $y = \beta_0 + \beta_1x$). They should practice interpreting the resulting model to make predictions and understand the strength of the relationship between variables.
S1-DSS-CC-PR-16 Identifying Patterns & Relationships in Data	Analyze structured categorical and/or quantitative datasets, using computational tools and libraries.	Students should perform exploratory data analysis on structured datasets using computational tools and libraries. They should write and execute code to clean, transform, and aggregate data and use visualization libraries to create charts and graphs that reveal trends, patterns, and relationships within the data. For example, students could use a library to analyze a dataset of global climate information, computing and visualizing average temperature changes over a decade for different continents or grouping temperature data by month to calculate average monthly temperatures. Students are not expected to work with datasets that require memory or processing power beyond what is available on their personal devices. Students are not expected to use distributed computing frameworks or build data analysis tools from scratch.
S1-DSS-CC-PR-17 Identifying Patterns & Relationships in Data	Build models to explain relationships, make predictions, and evaluate the influence of different variables.	Students should apply simple computational models (e.g., linear regression, decision trees, basic simulations) to make predictions and explain relationships within a dataset. They should evaluate how different input variables influence the model's output. For example, students could apply a simple linear regression model to predict runners' race times based on factors like training hours and diet and use the model's output to explain which factors have the most significant influence on performance. Students could also use a decision tree to classify an email as spam or not spam and explain the sequence of decisions the model makes to arrive at its conclusion. Students are not expected to implement these model algorithms from scratch or to understand the underlying mathematical theory in depth. Students are not expected to work with advanced machine learning techniques (e.g., neural networks, ensemble methods, deep learning).

Standard Code	Iowa Academic Standard	Standard Clarification
S1-DSS-CC-VD-18 Variability of Data	Evaluate whether observed differences are meaningful considering natural variability.	Students should understand that data always has "noise" or natural variability—small, random fluctuations that occur even when nothing has truly changed. Students should be able to evaluate whether observed differences between groups or over time are large enough to be considered "meaningful" (statistically significant) rather than just a result of this random noise. They should practice looking at the spread of data to determine if a change represents a real trend or just a typical "wiggle" in the numbers.
S1-DSS-CC-MOD-19 Models of Data	Evaluate linear and non-linear model predictions by comparing them with observed data.	Students should understand that not every relationship in data follows a straight line. Students should be able to evaluate model predictions—whether they come from a linear model (a straight line) or a non-linear model (curves, exponential growth, etc.)—by directly comparing them with observed data. They should practice using visual tools like residual plots or overlap charts to see where a model accurately "hits" the real data points and where it "misses," helping them decide which type of model better represents the real-world phenomenon.
S1-DSS-CC-MOD-20 Models of Data	Analyze unstructured, mixed data type, or high-dimensional datasets using computational tools and libraries.	Students should analyze and derive insights from unstructured data (e.g., text documents) or high-dimensional data where the number of features is very large (e.g., image data where each pixel is a feature, sensor data that is sampled many times per second). They should use appropriate computational libraries and techniques to process, clean, and analyze these complex data formats. For example, students could be given a collection of text documents and use a library to perform a simple analysis (e.g., word frequency counting) to find key themes. For a high-dimensional dataset, students could apply a dimensionality reduction technique to visualize or analyze the data more effectively. Students are not expected to build models for complex tasks (e.g., natural language processing, image recognition, complex signal processing).
S1-DSS-CC-MOD-21 Models of Data	Evaluate the performance of models using established metrics	Students should evaluate and compare the performance of different models using computational tools and established metrics. Students should assess a model's fit by using metrics such as accuracy or precision for classification models or mean squared error or R-squared for regression models. Students should also assess computational efficiency by measuring how long it takes to train or execute a model. Students should use existing library functions to generate evaluation metrics and use those results to make informed judgments about model quality, considering trade-offs between speed and accuracy. For example, after building a model to predict house prices, students could compare its performance to another model with more predictor variables by calculating the R-squared value for each. Students could then decide which model is a better fit for the data and discuss if the inclusion of more variables is worth the extra resources needed to collect additional data. Students are not expected to implement evaluation metrics from scratch or to understand the mathematical derivations of metrics. Students are not expected to perform theoretical algorithmic analysis (e.g., Big O notation) to assess computational complexity.

Standard Code	Iowa Academic Standard	Standard Clarification
S1-DSS-CC-MOD-22 Models of Data	Analyze how adding or removing variables affects model behavior and performance.	Students should analyze how changes in a dataset (e.g., adding, removing, modifying variables) impact model predictions or performance when the model is rerun. Students should examine how adding correlated variables (e.g., number of bedrooms and square footage) can affect how the model uses each variable and may change which variables appear most important. Students should analyze how different combinations of variables affect model accuracy or error. For example, students might start with a model predicting house prices based on square footage alone, then add variables like years since remodel or median neighborhood price to examine how this affects the model's accuracy or changes the relative importance of square footage. Students are not expected to calculate variance inflation factors or other formal measures of multicollinearity. Students are not expected to understand the underlying mathematical reasons for how correlated variables affect model coefficients.

Interpreting Problems & Results

Standard Code	Iowa Academic Standard	Standard Clarification
S1-DSS-IPR-MC-23 Making and Justifying Claims	Address contradictory evidence in written conclusions.	Students should understand that real-world data is rarely perfect and often contains points or trends that seem to go against their main conclusion. Students should be able to acknowledge this contradictory evidence openly in their written reports rather than ignoring it. They should practice explaining why these "counter-points" might exist—such as measurement errors, unique one-time events, or the influence of a different variable—and justify why their primary claim remains the most likely explanation despite these contradictions.
S1-DSS-IPR-MC-24 Making and Justifying Claims	Interpret regression coefficients to explain the effect of categorical variables on model outcomes.	Students should understand that not all data is numerical (like height or price); some data represents categories (like "Season," "Type of Fuel," or "Neighborhood"). Students should be able to interpret regression coefficients for these categorical variables by understanding how they act as "switches" or "offsets" against a reference group. They should practice explaining how a coefficient for a category represents the average change in the outcome variable when moving from the baseline category to the target category.
S1-DSS-IPR-MC-25 Making and Justifying Claims	Report findings in an analysis document, including formal statistical certainty and likelihood evaluations	Students should understand that professional data communication requires more than just sharing a "best guess"; it requires quantifying how sure we are about that guess. Students should be able to write an analysis document that includes formal evaluations of certainty (how reliable the data is) and likelihood (the probability of a result occurring). They should practice using standardized language to describe these concepts, ensuring their audience understands the level of risk or confidence associated with the findings.
S1-DSS-IPR-MC-26 Making and Justifying Claims	Interpret the results of data analyses to explain patterns, anomalies, and trends, and connect them back to the original problem or research question.	Students should interpret existing data analyses (e.g., visualizations, summary statistics, published findings) and explain what the results mean in relation to the original research question or problem. Students should identify key patterns, trends, and anomalies in the data and explain how these findings address the research question. Students should discuss limitations of the analysis and describe alternative explanations for the observed patterns. For example, students might interpret a visualization showing declining bee populations over time, identify the downward trend, describe how this pattern relates to a research question about pollinator health, and discuss possible explanations (e.g., pesticide use, habitat loss) while reporting limitations such as the time period covered or other factors not measured in the dataset. Students are not expected to perform the statistical calculations or create the visualizations themselves for this standard. Students are not expected to conduct formal hypothesis testing, calculate inferential statistics, or replicate the original analysis to validate their interpretations.
S1-DSS-IPR-GA-27 Generalization & Application	Identify scenarios where data-based conclusions could apply and note similarities and differences.	Students should understand that a conclusion drawn from one dataset may or may not be valid in a different context. Students should be able to identify scenarios where their data-based conclusions could reasonably apply (generalization) while carefully noting similarities and differences between the original data source and the new scenario. They should practice evaluating whether the "rules" discovered in one environment (e.g., a specific school) hold true in another (e.g., a different city or age group).

Standard Code	Iowa Academic Standard	Standard Clarification
S1-DSS-IPR-GA-28 Generalization & Application	Identify risks of extending analyses to new scenarios due to missing data or incorrect assumptions.	Students should understand that "copy-pasting" a conclusion from one scenario to another is risky because data environments are rarely identical. Students should be able to identify specific risks involved in extending an analysis, such as missing data (the new scenario lacks a key variable present in the original) or incorrect assumptions (the underlying "rules" of the original scenario don't apply to the new one). They should practice pausing before applying a model to a new situation to ask, "What has changed that might make my previous findings dangerous or wrong?
S1-DSS-IPR-GA-29 Generalization & Application	Evaluate advantages and disadvantages of an automated prediction tool using large datasets.	Students should understand that while automated tools (like machine learning algorithms) can process data at a scale impossible for humans, they are not "magic" and come with significant trade-offs. Students should be able to evaluate the advantages—such as speed, consistency, and the ability to find complex patterns in large datasets—against the disadvantages, such as the lack of human intuition, and the "black box" problem where it is difficult to explain why a tool made a specific prediction. They should practice determining when an automated tool is appropriate and when human oversight is required.

Visualization & Communication

Standard Code	Iowa Academic Standard	Standard Clarification
S1-DSS-VC-RV-30 Representation & Dynamic Visualization	Apply design principles to create clear and engaging visualizations.	Students should understand that a visualization is a form of communication, not just a technical output. Students should be able to apply core design principles to make their data stories easier to "read" and more convincing. They should practice achieving balance (distributing visual weight evenly), creating emphasis (using color or size to draw the eye to the most important data point), and maintaining simplicity (removing "chart junk" like unnecessary gridlines or 3D effects) to ensure the audience focuses on the insight rather than the decoration.
S1-DSS-VC-RV-31 Representation & Dynamic Visualization	Implement basic interactive visualization features for data exploration.	Students should understand that static charts are sometimes insufficient for exploring large or complex datasets. Students should be able to add basic interactive layers to a visualization—such as tooltips (information that pops up when hovering over a data point), zooming (magnifying a specific area of a chart), or filtering (toggling specific data categories on or off). They should practice using these features to move from a high-level overview to a detailed "deep dive," allowing them to discover patterns that might be hidden in a standard view.
S1-DSS-VC-RV-32 Representation & Dynamic Visualization	Compare varying bin sizes in histograms to analyze how granularity influences interpretation.	Students should understand that the appearance and "story" of a histogram can change dramatically depending on how the data is grouped. Students should be able to explain how bin size (the width of the intervals) affects granularity—how much detail is visible. They should practice comparing the same dataset using large bins (which can hide important patterns or "smooth over" gaps) and small bins (which can create "noise" and make it hard to see the overall shape of the distribution), eventually selecting the size that best reveals the underlying truth of the data
S1-DSS-VC-RV-33 Representation & Dynamic Visualization	Analyze how graphical conventions in data visualizations support accurate interpretation and how breaking conventions can mislead.	Students should understand established graphical conventions in data visualization and explain how deviating from them can misrepresent data and mislead audiences. This includes conventions such as Y-axes increasing from bottom to top, meaningful color associations, and appropriate chart selection for data types. For example, students might analyze a chart with an inverted Y-axis, explain how it disrupts interpretation, and create a corrected version with the standard orientation. Students are not expected to analyze or correct 3D or interactive data visualizations, data visualizations that use logarithmic scales, or other more advanced types of data visualizations (e.g., network graphs, radar graphs, sankey diagrams).

Standard Code	Iowa Academic Standard	Standard Clarification
S1-DSS-VC-RV-34 Representation & Dynamic Visualization	Create a visualization that accurately represents data and avoids misleading design choices	Students should create data visualizations while making deliberate design choices to avoid common pitfalls that can mislead viewers. Students should use appropriate axis ranges, maintain consistent scales, select chart types that match the data and message, and avoid visual distortions. Students should refine their visualizations by checking that the visual representation accurately reflects the underlying data. Students should also consider accessibility (e.g., using colorblind-friendly palettes, providing text alternatives) and adhere to appropriate style guides and standards (WCAG). For example, students creating bar charts to visualize SAT scores (200–800 range) and ACT scores (1–36 range) should recognize that using the same axis scale (e.g., 0–800) for both tests would compress ACT score variation and make differences appear negligible, whereas using appropriate scales for each test (200–800 for SAT, 1–36 for ACT) accurately represents the variation within each test. Students are not expected to conduct formal user testing or collect empirical feedback on visualization effectiveness. Students are not expected to create interactive dashboards or use advanced visualization libraries. Students are not expected to master all accessibility standards but should demonstrate awareness of basic considerations.
S1-DSS-VC-DS-35 Data Storytelling	Communicate contextual background and implications for the data to support audience understanding.	Students should understand that data does not speak for itself; without a "backstory," numbers can be easily misunderstood or ignored. Students should be able to provide the necessary contextual background (the who, what, where, when, and why of the data collection) and explain the implications (what the data actually means for the future or for specific people). They should practice moving beyond just describing a chart to explaining its real-world significance, ensuring their audience understands both the "so what?" and the "now what?" of the findings.
S1-DSS-VC-DS-36 Data Storytelling	Construct viable arguments using key features from a data visualization.	Students should understand that a visualization is the evidence base for a claim. Students should be able to identify key features within a chart—such as a specific trend line, a sudden spike, or a significant gap between categories—and use those features as the "premise" for a logical argument. They should practice moving from simply describing what they see to explaining what it proves, ensuring their arguments are grounded directly in the visual data.
S1-DSS-VC-DS-37 Data Storytelling	Clearly define claims so they are specific, measurable, and actionable.	Students should understand that a weak or vague claim makes it impossible to verify with data or use for decision-making. Students should be able to transform general observations into claims that are specific (targeting a precise area), measurable (tied to a number or clear metric), and actionable (suggesting a clear next step or solution). They should practice refining their language so that their data-backed arguments lead to concrete outcomes rather than broad generalities.

Standard Code	Iowa Academic Standard	Standard Clarification
S1-DSS-VC-DS-38 Data Storytelling	Create visualizations that communicate key findings to all potential audiences using appropriate chart types and formatting.	Students should create data visualizations that effectively communicate specific findings to different audiences, demonstrating how visual elements influence comprehension and interpretation. They should intentionally select appropriate chart types (e.g., line graphs for trends, bar charts for categories, scatter plots for relationships) and apply formatting to enhance clarity (e.g., clear titles, labels, meaningful colors). For example, students might create a bar chart showing average height by grade level, using color to distinguish school levels for a general audience. For more data-savvy audiences, they could add error bars or use density plots to show distribution and overlap. Overall, students should design intentionally with an understanding of how visual choices affect interpretation. Students are not expected to create complex data visualizations or interactive dashboards. Students are not expected to user-test and collect feedback on their visualizations.
S1-DSS-VC-BS-39 Acting on Data to Benefit Society	Evaluate ethical, legal, and social considerations when working with large-scale datasets, predictive models, and emerging technologies.	Students should evaluate the ethical, legal, and social implications of data science projects, particularly those that involve large datasets and predictive models, and apply principles of fairness, accountability, and transparency in their own work. Students should actively assess how decisions at each stage, from data collection through model deployment, can cause harm and take steps to prevent it. For example, when building a predictive model, students should identify potential sources of bias in the data, assess the societal consequences of the model's predictions, and debate methods for increasing fair and transparent decisions. Students are not expected to read or interpret specific data privacy laws and regulations (e.g., CCPA, GDPR). Students are not expected to use mathematical techniques to measure fairness or to conduct statistical tests to validate model performance.

Professional Practice

Standard Code	Iowa Academic Standard	Standard Clarification
S1-DSS-PP-40	Assess how data collection and use may create different impacts for different populations.	Students should analyze and articulate the potential impacts of data collection and use on different communities. Students are not expected to use statistical tests to quantify demographic representation or develop bias mitigation algorithms.
S1-DSS-PP-41	Document data analysis results in formats appropriate for all potential audiences.	Students should translate data analysis results into clear narratives for different audiences, using appropriate documentation and communication formats. Students should articulate the purpose, methods, findings, and ethical considerations of their analysis. For example, students could create a presentation for a public audience explaining findings from a community health data analysis and write a technical report for other data scientists detailing the study design, data collection methods, and statistical models used in the analysis. Students are not expected to create data visualizations using professional tools without structured guidance. Students are not expected to produce publication-quality writing or deliver formal public presentations.

Semester 2 Course

Dispositions & Responsibilities

Standard Code	Iowa Academic Standard	Standard Clarification
S2-DSS-DR-ND-01 Nature of Data	Describe how various data formats, including images, can be transformed into numerical information for Machine Learning models.	Students should understand that Machine Learning (ML) models cannot "see" an image or "read" a text file the way humans do; they only understand numbers. Students should be able to describe the process of vectorization or encoding, where non-numerical data is converted into a mathematical format (like a matrix or a list of numbers) that a model can process. They should understand that this transformation must preserve the essential features of the original data, such as representing a 10x10 pixel grayscale image as a grid of 100 numbers ranging from 0 (black) to 255 (white).
S2-DSS-DR-ND-02 Nature of Data	Analyze how multiple data types (quantitative, qualitative, structured, unstructured) can provide complementary insights into a single inquiry.	Students should understand that complex real-world problems can rarely be solved with just one kind of data. Students should be able to explain how combining quantitative data (numbers and metrics) with qualitative data (descriptions and meanings), and structured data (organized tables) with unstructured data (emails, images, or social media posts) creates a more complete "truth." They should practice looking for "complementary insights," where the numbers tell them what is happening, while the unstructured or qualitative data explains why it is happening.
S2-DSS-DR-ND-03 Nature of Data	Evaluate when AI tools are appropriate for analyzing high-dimensional or complex datasets.	Students should be able to determine when a dataset is too "big" or "noisy" for traditional human analysis and requires the speed and pattern-recognition of AI. Students should understand that AI is best used for high-dimensional data (datasets with many different variables) where humans might miss subtle connections, but they should also recognize that AI is not a "magic button." They should practice evaluating whether a problem needs an AI solution, such as deciding that a spreadsheet of 50 student grades is better handled by a human, while a database of 50,000 satellite images of crop yields requires an AI tool.
S2-DSS-DR-ER-04 Data Ethics & Responsibility	Analyze how data-related risks shift based on time, context, and intended purpose.	Students should understand that the risks associated with data are not static; a piece of information that is safe to share today might become dangerous tomorrow or in a different situation. Students should be able to analyze how the "safety level" of data changes based on time (how old the data is), context (who is seeing it and where), and intended purpose (why it was collected). They should practice identifying these shifts, such as explaining why sharing your live GPS location is helpful for a delivery driver but a major security risk if posted publicly on social media.
S2-DSS-DR-ER-05 Data Ethics & Responsibility	Differentiate between implicit and explicit bias to evaluate their effects on data analysis.	Students should understand the difference between biases that are out in the open and those that are hidden beneath the surface. Students should be able to define explicit bias, where prejudices or preferences are clear and intentional, and implicit bias, where unconscious associations or stereotypes affect how data is collected, processed, or interpreted without the researcher realizing it. They should practice evaluating how both types of bias can distort "objective" analysis and lead to unfair or inaccurate conclusions.

Standard Code	Iowa Academic Standard	Standard Clarification
S2-DSS-DR-ER-06 Data Ethics & Responsibility	Determine when quantitative data must be supplemented with qualitative or contextual evidence.	Students should understand that numbers alone often fail to tell the whole story, especially when dealing with human behavior or complex social issues. Students should be able to identify "red flags" in a dataset—such as unexplained outliers, flat trends, or contradictory results—that signal a need for qualitative evidence (interviews, open-ended survey responses) or contextual evidence (historical facts, local news, or cultural background). They should practice determining when "the what" (numbers) requires "the why" (context) to make a valid recommendation.
S2-DSS-DR-ID-07 Investigative Dispositions	Synthesize datasets from a variety of disciplines.	Students should understand that the most innovative solutions often come from combining data from entirely different fields (e.g., combining biology data with economics). Students should be able to take multiple datasets from various disciplines—such as environmental science, sociology, and urban planning—and merge them to find new "interdisciplinary" insights. They should practice the technical and logical steps of alignment, such as using a common variable like "Zip Code" to link a dataset of local asthma rates with a dataset of air quality readings and heavy traffic routes.
S2-DSS-DR-ID-08 Investigative Dispositions	Investigate career pathways that integrate data collection, analysis, communication, and societal impact.	Students should understand that data science is not just a technical field, but a multidisciplinary one that exists in almost every industry. Students should be able to research and describe career roles where the full data lifecycle—from gathering information to communicating its social or ethical importance—is required. They should practice identifying how different jobs balance technical skills (like coding) with "soft" skills (like storytelling and ethics) to create a positive societal impact.

Creation & Curation

Standard Code	Iowa Academic Standard	Standard Clarification
S2-DSS-CC-OP-09 Organization & Processing	Curate complex datasets from multiple sources.	Students should be able to locate, select, combine, and organize data from multiple sources to support analysis and decision-making. Students should evaluate the relevance, reliability, and purpose of each source, align variables across datasets, such as how and why data were included, excluded, or transformed so the combined dataset is usable and transparent. Students should use tools and methods such as spreadsheets, shared folders, basic versioning practices, and clear metadata or notes to track sources and changes and to explain the structure of the curated dataset. Students are not expected to use professional database systems, automate data pipelines, or perform advanced data-cleaning with programming.
S2-DSS-CC-OP-10 Organization & Processing	Assess opportunities to enhance investigative scope.	Students should be able to identify the scope of the initial study, including the limitations in their current data, questions, or methods. Students should be able to analyze what perspectives, variables, populations, time frames, or data sources are missing and explain how including them could lead to more meaningful, valid, or actionable insights. Students are not expected to conduct meta-studies or longitudinal studies, nor to implement experimental or statistical designs.
S2-DSS-CC-OP-11 Organization & Processing	Develop programs to collect and integrate data from multiple sources.	Students should develop programs to collect data from diverse sources (e.g., APIs, web scraping, databases) and integrate datasets that were not originally designed to be combined. Students should identify or create common keys to enable merging (e.g., matching records based on ticker symbols, dates, or other shared attributes) and verify that the merge was performed correctly by checking for expected row counts and examining merged records. They should then transform the combined data (e.g., filtering, grouping, summarizing, calculating new variables, restructuring) to answer more complex and original questions that cannot be answered with a single, precleaned dataset. For example, students might collect real-time stock market data from an API, integrate it with a historical dataset from a file, create a common key based on stock ticker and date, verify the merge, and then group by industry sector and calculate summary statistics to analyze trends and make predictions. Students are not expected to perform complex data matching algorithms (e.g., fuzzy matching for approximate string matches, probabilistic record linkage). Students are not expected to handle unstructured data (e.g., images, audio files, raw text) that requires parsing or machine learning techniques. Students are not expected to write their own API clients or web scrapers from scratch. They may use existing libraries for data collection.

Standard Code	Iowa Academic Standard	Standard Clarification
S2-DSS-CC-OP-12 Organization & Processing	Apply exploratory data analysis techniques to non-hierarchical quantitative data.	Students should apply exploratory data analysis (EDA) techniques to non-hierarchical quantitative data. Students should use computational tools to calculate summary statistics, create visualizations, and identify key characteristics of the data. Students should approach EDA as an iterative process, using initial findings to guide further exploration. For example, students could use a programming environment with a data analysis library to load a file, then use functions to calculate the mean, median, and standard deviation of values for different variables. Students could then generate a histogram to visualize the data distribution for each variable and a scatter plot to examine the relationship between two variables. Students are not expected to analyze or manipulate hierarchical data formats. Students are also not expected to perform statistical analysis beyond generating summary statistics. Students are not expected to account for nesting or clustering of data when generating summary statistics.
S2-DSS-CC-OP-13 Organization & Processing	Apply exploratory data analysis techniques to hierarchical structured data sources.	Students should apply exploratory data analysis techniques to hierarchical structured data sources. This involves navigating nested data, extracting relevant information from different levels of the hierarchy, and applying summary statistics and visualizations to this extracted data. For example, students could be given a JSON file containing nested information about an API response, such as a list of songs, each with a nested object for the artist, including their name, genre, and a list of other albums. Students could parse this data to calculate the average length of songs for a specific genre or to create a bar chart showing the number of songs per artist. Students are not expected to handle deeply nested or graph-structured data.
S2-DSS-CC-MD-14 Measurement & Datafication	Aggregate data across appropriate scales.	Students should understand that data can be viewed at different "levels" or scales (e.g., hourly vs. monthly, individual vs. city-wide) and that the chosen scale can change the story the data tells. Students should be able to aggregate data—combining individual data points into larger groups—using appropriate scales that match the goal of their investigation. They should practice moving between "granular" data (specific details) and "summary" data (the big picture) to find patterns that might be hidden at a single level.
S2-DSS-CC-CD-15 Complexity of Data	Analyze time-series data collected at multiple intervals to detect patterns and trends.	Students should understand that time-series data is a sequence of data points collected or recorded at specific time intervals. Students should be able to analyze time-series data to detect underlying patterns (like seasonality or cycles) and trends (long-term movement up or down). They should practice looking past short-term "noise" to identify whether a variable is generally increasing, decreasing, or staying the same over time, and use this to make informed predictions about future behavior.
S2-DSS-CC-CD-16 Complexity of Data	Validate cleaned datasets using statistical diagnostics and domain expertise.	Students should be able to check if their dataset makes sense by identifying errors, impossible values, and patterns that contradict real-world knowledge. Students should calculate min/max values to spot errors, review frequency tables for unusual patterns, and apply their knowledge to question suspicious findings. Students are not expected to perform advanced statistical tests or use specialized validation software at this grade level.

Standard Code	Iowa Academic Standard	Standard Clarification
S2-DSS-CC-DTP-17 Data Transformation / Preprocessing	Use selection, sampling, and transformation tools to navigate very large datasets.	Students should be able to apply intentional strategies to make large datasets manageable and analysis-ready — such as filtering rows and selecting relevant columns, drawing random or stratified samples, and transforming variables using tools like programming languages or advanced spreadsheet functions. Students should be able to explain why each preprocessing decision was made and how it affects downstream analysis. Students are not expected to build custom sampling algorithms or work with database query optimization techniques.
S2-DSS-CC-DTP-18 Data Transformation / Preprocessing	Develop programs to manipulate and transform data to prepare for analysis.	Students should develop programs to perform common data manipulation and transformation tasks (e.g., filtering, grouping, summarizing, calculating new variables, restructuring, merging datasets) to prepare a dataset for a specific analysis. For example, students could filter a dataset to include only rows that meet specific criteria (e.g., sales from a particular region), group data by a certain category (e.g., sales by product type), and then summarize those groups (e.g., calculate the total sales for each product type). They should also be able to calculate new variables (e.g., product prices converted to a different currency), restructure a dataset (e.g., from a long format to a wide format), and merge two or more datasets based on a common key. Students should work with datasets large enough to require processing with computational tools. They should use existing libraries designed for these purposes. Students are not expected to build their own tools for data manipulation. Students are not expected to work with datasets that require memory or processing power beyond what is available on their personal devices. Students are not expected to optimize code for performance with very large datasets.

Analysis & Modeling Techniques

Standard Code	Iowa Academic Standard	Standard Clarification
S2-DSS-CC-PR-18 Identifying Patterns & Relationships in Data	Apply classification and clustering techniques to make predictions with data.	Students should understand the difference between grouping data based on known labels (classification) and discovering natural groupings within unlabeled data (clustering). Students should be able to apply these techniques to make predictions or identify structures in a dataset. They should practice choosing the right approach based on the problem—using classification when they want to predict a specific outcome (like "Yes/No") and clustering when they want to see how data points "flock" together based on similarities.
S2-DSS-CC-PR-19 Identifying Patterns & Relationships in Data	Explain how dataset size affects model stability and performance.	Students should describe how adding or removing data points (rows) affects model behavior (e.g., output variance) when the model is rerun. Students should recognize that small datasets are more sensitive to changes than large datasets. Adding or removing even a small number of rows from a small dataset can cause substantial changes in model outputs, whereas adding or removing the same number of rows from a large dataset has minimal impact. Students should understand that larger datasets generally produce more stable and reliable models. Students should observe and describe the practical effects of dataset size on model behavior. For example, students might start with a model trained on 20 house sales, observe how predictions can change dramatically when adding or removing 10 sales, then differentiate this from the case of adding or removing 10 sales from a dataset of 1,000 sales where predictions barely change. Students are not expected to calculate formal statistical measures of model stability. Students are not expected to understand the mathematical relationship between sample size and variance.
S2-DSS-CC-VD-20 Variability of Data	Evaluate strategies for handling missing data.	Students should evaluate different strategies for handling missing data in a dataset (e.g., empty cells, null values, placeholder values like "NA"). Students should select and apply various strategies for handling missing data. Common strategies include removing rows or columns with missing data, imputing missing values (e.g., using mean, median, a specified value), or retaining missing values and excluding them from specific calculations. They should consider how their chosen approach affects analysis results when selecting and implementing a strategy. Students should recognize that when data is systematically missing for particular groups or communities, some strategies (e.g., deletion) may remove those groups from the analysis entirely, whereas others (e.g., mean imputation) may mask meaningful differences. Students should make informed decisions about handling missing data based on observed effects on their analysis. For example, students might observe that removing all rows with any missing values dramatically reduces dataset size and then try mean imputation instead, comparing how the two approaches affect summary statistics or visualizations to inform their choice of which strategy to use. Students are not expected to implement advanced imputation algorithms (e.g., k-nearest neighbors imputation, multiple imputation). Students are not expected to use statistical tests to assess the quality of different missing data strategies.

Standard Code	Iowa Academic Standard	Standard Clarification
DS2-SS-CC-MOD-21 Models of Data	Compare predictive structures of decision trees and related models.	Students should understand that different models use different "logic" to arrive at a prediction. Students should be able to compare the predictive structures of a decision tree (which uses a series of binary "if-then" splits) against related models like Random Forests (which average many trees) or Linear Regression (which uses a continuous weighted formula). They should practice identifying which structure is most appropriate for a given problem—for example, using a tree when the data has clear "breakpoints" or categories, and regression when the data is a smooth, continuous trend.
S2-DSS-CC-MOD-22 Models of Data	Build and refine models using computational and machine learning methods.	Students should understand that creating a high-performing model is an iterative process of "train, test, and tweak." Students should be able to build and refine models using computational and machine learning methods (such as automated regression tools, decision tree classifiers, or neural networks in a "no-code" environment). They should practice "refining" by adjusting parameters, selecting different features, or providing more data to see how those changes improve the model's accuracy and reliability.

Interpreting Problems & Results

Standard Code	Iowa Academic Standard	Standard Clarification
S2-DSS-IPR-MC-23 Making and Justifying Claims	Evaluate how changes in the number and combination of variables affect a model by interpreting R^2 and regression coefficients.	Students should understand that adding or removing variables changes how well a model explains the real world. Students should be able to interpret R2 (the "Coefficient of Determination") to see what percentage of the data's variation is explained by the model, and examine regression coefficients to understand the specific strength and direction of each individual variable's influence. They should practice "tuning" a model by adding variables to see if R2 increases meaningfully or if certain coefficients suggest a variable is actually "noise" that should be removed.
S2-DSS-IPR-PI-24 Problem Identification & Question Formation	Investigate alternative explanations for unusual associations or outcomes.	Students should understand that an "unusual" result in a dataset—such as a sudden spike, a dip, or a surprising correlation—is often the starting point for deeper inquiry rather than a final conclusion. Students should be able to brainstorm and investigate alternative explanations (other than the most obvious one) for these outcomes. They should practice looking for external factors, data collection errors, or lurking variables that might actually be responsible for the anomaly, ensuring their final interpretation is thorough and skeptical.
S2-DSS-IPR-PR-25 Problem Identification & Question Formation	Identify counter-arguments or alternative explanations and propose mitigation strategies using additional data or revised methods.	Students should understand that a robust data analysis doesn't just present a single view; it anticipates skepticism. Students should be able to identify potential counter-arguments or alternative explanations that could challenge their findings. Furthermore, they should be able to propose mitigation strategies—such as gathering additional data to fill gaps or using revised methods (like changing a sampling technique or adjusting a model)—to strengthen their original claim and address those concerns proactively.
S2-DSS-IPR-GA-26 Generalization & Application	Analyze the trade-offs between interpretability, accuracy, and generalizability as they relate to model complexity.	Students should analyze how choices in model complexity create trade-offs between interpretability, accuracy, and generalizability. A more complex model may be more accurate on training data but is often more difficult to understand and interpret. Additionally, complex models risk overfitting (e.g., learning the training data too well, including noise and outliers), which reduces their ability to generalize to new, unseen data. Students should articulate why a simpler model that is less accurate but highly interpretable may be more suitable for certain applications. For example, students could compare two models to predict whether a student will pass or fail a course: a simple logistic regression model that uses only study hours and attendance as features and a complex neural network that uses dozens of features. The logistic regression might achieve 80% accuracy and allow educators to see that study hours and attendance are the strongest predictors of passing, with clear numeric weights showing how much each factor contributes, while the neural network might achieve 85% accuracy but function as a "black box" where teachers cannot understand why specific predictions are made. For advising students, the interpretable model may be more valuable despite lower accuracy. Students are not expected to build or train machine learning models from scratch. Students are not expected to understand or derive the mathematical theory behind why these trade-offs exist.

Standard Code	Iowa Academic Standard	Standard Clarification
S2-DSS-IPR-GA-27 Generalization & Application	Explain the appropriateness of predictive models for the specific problem being addressed.	Students should differentiate the suitability of predictive models for varying problem types at a conceptual level. Students should consider the type of data, the nature of the outcome (e.g., categorical vs. continuous), and the potential real-world impact of the model's performance. Students should recognize that selecting an inappropriate model for a high-stakes problem can lead to harmful outcomes for the people affected by the model's predictions. For example, students could be given a problem to predict whether a customer will click on an ad. They should explain why a logistic regression model is more appropriate than a linear regression model for this specific problem, which requires predicting a categorical outcome (yes/no) rather than a continuous numerical value. Students are not expected to build or assess deep learning models. Students are not required to statistically evaluate different models to determine which model has the best fit.

Visualization & Communication

Standard Code	Iowa Academic Standard	Standard Clarification
S2-DSS-VC-RV-28 Representation & Dynamic Visualization	Justify the exclusion of potentially erroneous observations through effective data visualization.	Students should understand that removing data (cleaning) must always be defended with evidence, rather than done in secret. Students should be able to use specific types of visualizations—like scatter plots, box plots, or distribution curves—to "put a spotlight" on data points that are clearly errors. They should practice using these visuals to prove to an audience why a certain observation is physically impossible or a technical glitch, making the final analysis more trustworthy.
S2-DSS-VC-RV-29 Representation & Dynamic Visualization	Analyze culturally influenced or domain-specific conventions in chart elements and adapt visualizations to align with audience expectations.	Students should understand that how people interpret data is often shaped by their professional background (domain) or their cultural upbringing. Students should be able to identify "unwritten rules" of visualization—such as which colors represent "danger" or "growth" in different countries—and adapt their charts to meet the specific expectations of their audience. They should practice moving beyond a "one-size-fits-all" design approach to ensure their message is received accurately by different groups.
S2-DSS-VC-DS-30 Data Storytelling	Combine basic visual summaries with detailed visualizations that reveal features of the dataset.	Students should understand that effective data storytelling often requires a "macro-to-micro" approach. Students should be able to pair high-level visual summaries (like a single KPI card or a basic bar chart showing an average) with detailed visualizations (like scatter plots or heatmaps) that expose the "why" behind the summary. They should practice using this combination to reveal critical features of the dataset, such as showing that while a class average is high, there are significant outliers or overlapping subgroups that the average alone hides.
S2-DSS-VC-DS-31 Data Storytelling	Identify gaps where evidence is insufficient to fully support a claim.	Students should understand that data analysis is as much about what is missing as what is present. Students should be able to critically evaluate a claim by looking for "holes" in the supporting data—such as small sample sizes, missing time periods, or unrepresented demographic groups. They should practice identifying when a conclusion is "jumping the gun" because the current evidence only tells a partial story, and they should be able to specify exactly what additional data would be needed to make the claim fully "viable."
S2-DSS-VC-DS-32 Data Storytelling	Identify potential confounding variables.	Students should understand that "correlation does not equal causation" and that a third, hidden factor—a confounding variable—might be the true reason two things seem related. Students should be able to brainstorm and identify these outside variables that could influence both the independent and dependent variables in a study. They should practice questioning a direct link between two data points by asking, "Is there something else happening in the background that explains this connection?"
S2-DSS-VC-BS-33 Acting on Data to Benefit Society	Explain how data science connects to other disciplines to address global challenges.	Students should understand that data science is a "bridge" discipline that provides the tools to solve problems in fields like medicine, environmental science, and economics. Students should be able to explain how data collection and analysis are used in partnership with experts from other areas to address large-scale "global challenges"—such as climate change, pandemic tracking, or food insecurity. They should practice identifying how a data scientist's skills in pattern recognition and prediction complement a subject matter expert's deep knowledge to create real-world solutions.

Standard Code	Iowa Academic Standard	Standard Clarification
S2-DSS-VC-BS-34 Acting on Data to Benefit Society	Critique a data visualization for misleading elements and their role in spreading misinformation.	Students should evaluate a data visualization and accompanying narrative from public sources (e.g., news articles, social media posts, advertisements, political campaigns) to identify misleading or deceptive elements. They should assess how specific design choices (e.g., truncated or flipped axes, cherry-picked data ranges, counterintuitive color palettes) can distort viewers' understanding. Students should recognize that design choices may affect different audiences differently. Students should debate how misleading visualizations contribute to spreading misinformation or disinformation. For example, students might analyze a social media post showing a dramatic-looking trend line that uses a truncated Y-axis and a selective time range, evaluating how these choices exaggerate the trend, what narrative the visualization promotes, and the potential real-world consequences of its spread. Students are not expected to verify data authenticity or trace the original source of visualizations. Students are not expected to determine the intent behind misleading visualizations (whether deliberate deception or honest mistake).
S2-DSS-VC-BS-35 Acting on Data to Benefit Society	Document data analysis results in formats appropriate for all potential audiences.	Students should translate data analysis results into clear narratives for different audiences, using appropriate documentation and communication formats. Students should articulate the purpose, methods, findings, and ethical considerations of their analysis. For example, students could create a presentation for a public audience explaining findings from a community health data analysis and write a technical report for other data scientists detailing the study design, data collection methods, and statistical models used in the analysis. Students are not expected to create data visualizations using professional tools without structured guidance. Students are not expected to produce publication-quality writing or deliver formal public presentations.
S2-DSS-VC-BS-36 Acting on Data to Benefit Society	Evaluate protective measures in data collection, usage, and governance for privacy, security, and fairness.	Students should evaluate protective measures used in data collection, usage, and governance, including privacy safeguards, security protocols, consent mechanisms, and bias prevention strategies. Students should assess the effectiveness of these measures in specific contexts and examine their interconnectedness. For example, students could evaluate a mobile application's data practices by critiquing its privacy policy and requested permissions, assessing potential privacy risks (e.g., unnecessary location tracking) and evaluating alternative approaches that would better protect user privacy and prevent bias. Students are not expected to implement cryptographic security protocols (e.g., encryption algorithms) or to develop and deploy consent management systems (e.g., software that tracks user consent choices, enforces data usage permissions, generates compliance audit trails).
S2-DSS-VC-BS-37 Acting on Data to Benefit Society	Translate technical results for all potential stakeholders in written reports, presentations, and interpersonal communication.	Students should translate findings from data analyses into clear, actionable insights tailored for different audiences with varying levels of technical expertise. Students should strategically craft messages that resonate with each audience's interests and needs. For example, students could create a presentation for a city council, emphasizing the policy implications of a traffic data analysis, while simultaneously preparing a detailed technical report and code library so other scientists can reproduce the results. Students are not expected to produce publication-quality writing, create publication-ready infographics with custom illustrations, or deliver formal public presentations.

Professional Practice

Standard Code	Iowa Academic Standard	Standard Clarification
S2-DSS-PP-38	Evaluate ethical, legal, and social considerations when working with large-scale datasets, predictive models, and emerging technologies.	Students should evaluate the ethical, legal, and social implications of data science projects, particularly those that involve large datasets and predictive models, and apply principles of fairness, accountability, and transparency in their own work. Students should actively assess how decisions at each stage, from data collection through model deployment, can cause harm and take steps to prevent it. For example, when building a predictive model, students should identify potential sources of bias in the data, assess the societal consequences of the model's predictions, and debate methods for increasing fair and transparent decisions. Students are not expected to read or interpret specific data privacy laws and regulations (e.g., CCPA, GDPR). Students are not expected to use mathematical techniques to measure fairness or to conduct statistical tests to validate model performance.