Skills for Innovation Learning Pathways

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Introduction

To succeed in today's postsecondary environment and workforce, students must use technological skills, along with the critical, creative, and social-emotional mindsets to solve complex problems. We are amidst a Fourth Industrial Revolution in which careers across all fields continue to become more integrated with technology and dependent on using technology systems. These Industry 4.0 skills include the ability to apply artificial intelligence, analyze large data sets, or use computational models (Intel, n.d.). As such, opportunities to learn social-emotional, design, and computational skills are essential to all students—not only the ones who will eventually study computing or engineering or enter the information technology industry.

In the last 30 years, core area content, and state-tested content in particular, captured an increasing amount of instructional time across all grades K-12. This has limited access to the academic, cognitive, and social benefits of learning beyond tested content, decreasing students' opportunity to develop additional skills and knowledge necessary for success in careers and civic life. This imbalance is seen even more strongly in under-resourced schools in historically marginalized communities where high-stakes testing pressures are even more prevalent and teachers and staff are overtaxed.

Exacerbated by learning loss due to the pandemic, educators are challenged to decrease time in core subject areas to create space for learning additional skills and knowledge vital to thrive in the 21st century. Districts and schools need support to develop systems and structures to balance the mandates of standards and testing with emergent emphasis on social-emotional learning, Industry 4.0 skills, and technology integration that will be required to thrive in life and career in our rapidly changing world.

Learning Pathways

To support districts and schools as they provide students equitable access to innovative learning opportunities, Digital Promise has developed and piloted a process to articulate learning pathways that integrate essential technological skills into core subject areas (Digital Promise, 2022). Effective Learning Pathways are guided by three principles:

- **Consistent**: Typically, innovative skills are offered inequitably across schools and districts with learning opportunities isolated to specific teachers, classrooms, or afterschool programs. Effective learning pathways are not dependent on a particular teacher, school, or afterschool club. Rather, they consistently offer innovative skills for all students. Districts and schools design innovative learning opportunities to be adapted and implemented across every school and classroom.

- **Cumulative**. Even when innovative learning opportunities are offered across schools, too often they are implemented as "one off" learning experiences, or identical content is repeated from year to year (Burke, 2019). In effective pathways, learning develops from year to year toward a broader goal, and educators and students alike see their efforts as part of a broader progression. To design cumulative learning pathways, developmentally appropriate competencies are articulated at each grade level and connected to relevant standards across multiple subject areas.
- **Competency-based**. Competencies are specific skills that students will develop. Learning opportunities that emphasize competencies, as opposed to tools (e.g. MIT App Inventor) or stand-alone programs (e.g. Hour-of-Code) are crucial for districts and schools to integrate innovative learning opportunities across content and grade bands. Further, it provides an opportunity for students to develop and exhibit skills and knowledge that are directly applicable for success in careers and civic life.

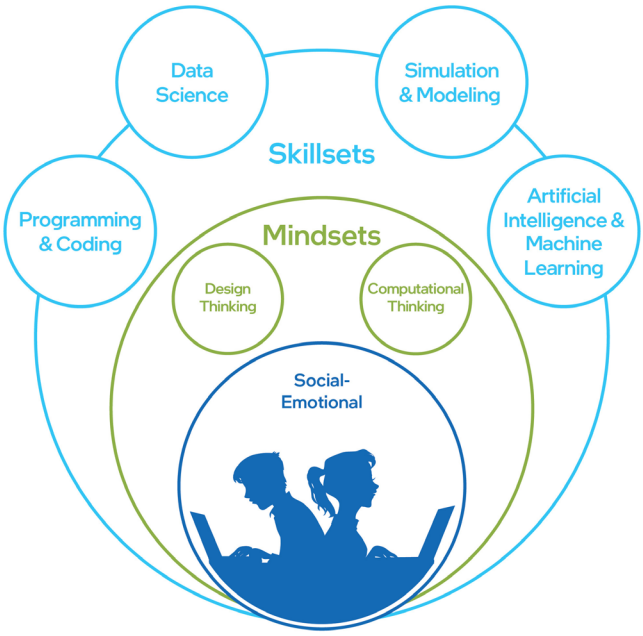
Learning Pathways are a promising approach to integrate skills and knowledge necessary for success in careers and civic life. Intel, a longstanding leader in the technology industry, has defined mindsets and skillsets that will prepare students to innovate and apply emerging technologies to succeed in our future workforce, such as Computational Thinking, Design Thinking, and Social-Emotional Learning. In this paper, we describe Intel's Skills for Innovation Framework and associated competency-based learning resources for district leaders and teachers to design and implement learning pathways to equip students with Industry 4.0 skills. These resources include **competency profiles**, which are used to define specific curricular integration points that both build new skills and enhance learning in core subject areas. Competency profiles, along with example lessons and teacher resources from Intel's StarterPack, lay the foundation for consistent, cumulative, and competency-based learning pathways.

Skills for Innovation Framework

Framework description

Intel's Skills for Innovation Framework defines skillsets and mindsets for K-12 learners to successfully engage in innovative learning experiences. The framework has three concentric circles. In the innermost circle, **Social-Emotional Learning**, are strategies foundational for all learners to understand, express, and manage their emotions as well as to develop relationships with others. In the middle circle, **Mindsets for Innovation** are the cognitive processes necessary to engage in innovative and complex problem solving. These include **Design Thinking**, or processes to innovate new products and services, and **Computational Thinking**, or using computational methods to systematically address and solve interdisciplinary challenges. In the outermost circle, **Skillsets for Innovation** combine computational, design, and social-emotional skills to solve an applied problem, frequently resulting in a computer program, a data visualization, or a computational model that could be used to solve related problems in the future.

Figure 1. Intel Skills for Innovation Framework (Intel, 2022).



In the following sections, we break down each mindset into a set of strategies and describe what each could look like in classroom practice. Then, we describe how these mindsets can be applied to each skillset for teachers to successfully engage learners in innovative learning opportunities.

Social-Emotional Learning

Social-Emotional Learning (SEL) provides the foundational skills for learners to engage in innovative learning opportunities. The development of social-emotional skills, such as self-confidence, empathy, impulse control, and teamwork, enables learners to regulate and process emotions, think critically, maintain positive relationships, and communicate effectively. These skills prepare learners for success in K-12 classrooms and beyond.

To support students' social-emotional well being, teachers should create a positive learning environment, and explicitly integrate strategies for social-emotional awareness and skill building regularly throughout the school year. The table below describes five domains learners can develop and practices teachers can use to support social-emotional learning in their classroom (CASEL, 2020).

Table 1. Description and Examples of Social-Emotional Learning Skills (CASEL, 2020; Intel, n.d.).

SEL Domains	Description	How to Support
Self-awareness	Self-awareness is the ability to understand one's self (e.g., thoughts, feelings, emotions). Individuals with strong self-awareness know their strengths and areas of growth as well as how their values and perspectives shape their experiences.	• Help students understand and explore their strengths • Get to know student interests and cultural identities and find opportunities to connect them to the curriculum • Understand your biases and help students to understand their own • Model and talk explicitly about bias • Practice mindfulness with students • Model and give opportunities for positive self-talk
Self-management	Self-management is the ability to influence your thoughts, feelings, and emotions effectively, across a variety of different settings and situations. Self-management skills allow one to develop a sense of agency and purpose and work toward goals and aspirations.	• Provide students with executive functioning support and a predictable classroom structure • Engage students in goal-setting • Incorporate check ins about students' emotions • Explicitly teach strategies for regulation • Build in opportunities for student agency • Design for learner variability. Some examples might include offering flexible seating, making sure all students can leverage accessibility tools such as text to speech, and using a Universal Design for Learning approach to instruction.
Social awareness	Social awareness is the ability to understand and empathize with others, including those with different lived experiences than one's own. This includes understanding social norms and how they vary across cultures as well as recognizing injustices.	• Model and explicitly teach strategies for perspective taking • Connect to historical content to help students understand inequities so that they might design more equitable solutions
Relationship skills	Relationship skills are the ability to build connections with and maintain healthy relationships with others, such as active listening, clear communication, collaboration, problem solving and navigating conflict.	• Explicit teaching of how to work in a team • Explicit teaching and modeling of strong communication and conflict resolution skills
Responsible decision making and civic engagement	Responsible decision making is the ability to make decisions that are kind and thoughtful and contribute to the larger community. This includes being able to consider the implications of safety, equity, ethics, and the consequences of one's decisions.	• Make cross-curricular connections to help students understand the social and cultural impacts of computer science • Help students make connections between what they're learning to real life scenarios within their communities • Actively include exploring the ethical implications and equity impacts of what students design and build

Mindsets for Innovation

Mindsets for Innovation are strategies for students to engage in innovative problem solving. Social-emotional learning, design thinking, and computational thinking equip students with dispositions (Barefoot Computing, n.d.; Barr & Stephenson, 2011; ISTE & CSTA, 2011) that can be applied to critically, creatively, and collaboratively engage in technology-related problem solving.

It is essential for teachers to support students with building these skills to equip them with the emotional and cognitive tools to engage in innovative problem solving. Teachers may explicitly teach these skills, which can be integrated as thinking or practice routines for students to leverage throughout the year as they engage in skills for innovation.

Design Thinking

Design thinking is a creative problem solving approach to understand experiences and challenges of different perspectives to define problems and develop and improve user-centered products and services (Luchs, 2015). It is based on the premise that every user has unique needs and abilities. To develop the most usable/marketable products, we must seek to understand the experiences and challenges of the range of users we intend to serve instead of using our own limited experiences, which are frequently biased.

The table below describes five stages of design thinking learners can use to engage in the process (d.school, n.d.). Notably, the d.school's updated Equity Centered Design Framework (Clifford, 2017) and Liberatory Design Framework (Anaissie et al., 2021) added essential strategies to combat systemic inequity in the design process, such as "Notice" (e.g. identity, power) and "Reflect" (e.g. actions, emotions, impact).

Table 2. Description Strategies for Design Thinking (Clifford, 2017; d.school, n.d.; Intel, n.d.)

Design Thinking Strategies	Description
Empathize	Understand the experiences, emotions, and motivations of the users you are designing for.
Define	Synthesize needs of the user to articulate the problem and point of view that the design innovation intends to impact.
Ideate	Brainstorm as many unique solutions to the problem as possible.
Prototype	Identify a promising idea to mock up and iteratively develop.
Test	Collect feedback based on specific criteria about how solutions can be improved.

Computational Thinking

Computational thinking has been defined as "a way of solving problems, designing systems, and understanding human behavior that draws on concepts fundamental to computer science … a fundamental skill for everyone, not just computer scientists." (Wing, 2006). When students engage in computational thinking, they are using computational methods to address and solve interdisciplinary problems (Barr & Stephenson, 2011; ISTE & CSTA, 2011; Wing, 2006). Rather than situating itself as a stand-alone subject, computational thinking is inherently integrative in nature, relying on strategies that cross multiple academic subjects. The table below outlines some of the computational strategies that students can leverage to solve problems, either with or without technology.

Table 3. Description of Strategies for Computational Thinking (Barr & Stephenson, 2011; Intel, n.d.; ISTE & CSTA, 2011; Mills et al., 2021).

Computational Thinking Strategies	Description
Abstraction	Filtering aspects of a problem or phenomenon to what is integral or most important.
Algorithms	Articulating and organizing steps in an ordered sequence and applying the sequence within new contexts.
Decomposition	Dividing problems into smaller parts.
Pattern Recognition	Recognizing recurrent features, data, and/or relationships with the intention of better understanding past phenomena and events, as well as making more informed choices going forward.

Skillsets for Innovation

Skillsets for Innovation leverage socioemotional skills, computational thinking, and design thinking to solve an applied problem using technology. The four skillsets—Programming and Coding, Data Science, Simulation and Modeling, and Artificial Intelligence and Machine Learning—represent unique problem-solving approaches that can be used independently or in any combination to design a solution. Below, we describe each skillset and break it down into a set of competencies that students can demonstrate through innovative learning opportunities. We also explain how teachers can facilitate relevant mindsets to support learners with successfully engaging in innovative learning opportunities, and we provide an example of a classroom activity that would provide K-12 learners an opportunity to engage in each skillset.

Programming and Coding

Students engage in programming and coding when they develop a systematic set of instructions for a computer to carry out a task more often, more efficiently, and/or more accurately than a human could routinely accomplish. Programming and coding includes designing a computer program (including decomposing a problem and identifying essential steps), creating a computer program (e.g., translating algorithmic steps into instructions for a computer through block-based or text code), and improving a computer program (e.g., debugging the program to identify and repair errors and improve efficiency) (Digital Promise, 2020; Intel, n.d.). Below, we break down these practices into programming and coding competencies, describe how teachers can facilitate relevant design thinking and computational thinking skills supporting students as they engage in these competencies, and provide examples of programming and coding across different grade bands in K-12 classrooms.

Table 4. Programming and Coding Competencies, Supporting Mindset Strategies, and Examples.

<table>
<tr><th colspan="2">Programming and Coding</th></tr>
<tr><td colspan="2">Competencies:
• Defining Procedures as Algorithms
• Programming
• Testing and Debugging</td></tr>
<tr><td>Design Thinking
• Ideate. Introduce students to different programmable platforms, tools, and languages (e.g. Scratch, MIT App Inventor, Python) to allow them to consider benefits or drawbacks to each when designing a solution or product and select the most appropriate tool or platform.
• Prototype. Prompt students to create and test each part of their program as they develop it.
• Test. Facilitate students to work in pairs and provide prompts to review the code for accuracy and efficiency.</td><td>Computational Thinking
• Algorithms. Provide students with tools to visualize and scaffold the design of a potential computer program, such as pseudocode (i.e., simple variables and conditional statements) and/or a graphic flowchart
• Decomposition. Prompt students to recognize the inherent key steps of such a program and organize their code into smaller chunks that they can operate and test independently of the larger programming sequence.</td></tr>
<tr><td colspan="2">Examples:
• Students in grades K-2 may put different parts of a story (for example, a box-by-box comic strip) in the correct sequence (Ruiz et al., 2021) and subsequently play with such a sequence to see how it can change story dynamics and outcomes.
• Students in grades 3-5 might be provided with block-based code that calculates the area of a rectangle using addition rather than multiplication. Students might then debug the algorithm to correctly calculate the area based on user input (Everyday Computing, 2021).
• Middle school students might design a “choose your own adventure” story using block-based code and choose key conditional statements that “branch” narratives and frame narrative outcomes.
• High school students might create a mobile application that taps existing GPS retailer data within their local neighborhoods, sorts retailers by the products they sell, and produces a platform that helps community members find the nearest stores that sell fresh fruits and vegetables, thus promoting healthy eating.</td></tr>
</table>

Data Science

Data science involves leveraging computational models and methods to collect, analyze, and visualize data. This could include using computational tools to collect data, describing relationships between data sets, making predictions, identifying bias within data sets, and/or designing a visual representation of data (Digital Promise, 2020; Intel, n.d.). In the table below, we break down these practices into data science competencies, describe how teachers can facilitate relevant mindsets supporting students as they engage in these competencies, and provide examples of data science across different grade bands in K-12 classrooms.

Table 5. Data Science Competencies, Supporting Mindset Strategies, and Examples.

<table>
<tr><th colspan="2">Data Science</th></tr>
<tr><td colspan="2">Competencies:

• Collecting Data
• Analyzing Data
• Evaluating Data
• Communicating Data</td></tr>
<tr><td>Design Thinking

• Empathize. Prior to designing an investigation that involves people, seek to understand the experiences and perspectives of different stakeholders, which may inform the type of data that is important to collect.
• Ideate. Provide students with different options of data collection tools (e.g. survey, observation) to allow them to consider benefits or drawbacks to each.
• Prototype. After students develop a tool to collect data, prompt them to consider affordances or limitations of the tool. Can the method be modified to collect data points that could be missing?</td><td>Computational Thinking

• Abstraction. Support students with defining categories/subcategories that will facilitate data analysis.
• Pattern Recognition. Support students with using data visualization and analysis software to identify patterns and relationships in data sets.</td></tr>
<tr><td colspan="2">Examples:

• Students in grades K-2 might create a class histogram or glyph of their characteristics and share with their classmates to identify similarities and differences and generate a visual representation of who they are as a community.
• Students in grades 3-5 could analyze weather data (e.g. temperature, humidity, rainfall) for different locations on Earth to identify patterns in different biomes.
• Middle school students could design a solution for reducing food waste by investigating how much food waste is generated during their lunch and why.
• High school students might analyze and evaluate bias in secondhand data about socioscientific issues (e.g. cancer, pollution).</td></tr>
</table>

Simulation and Modeling

Students engage in Simulation and Modeling when they are representing relationships within complex systems, particularly phenomena that cannot be otherwise thoroughly examined due to constraints of time, size, and/or visibility. This could include considering how a model represents a real-world system, using a computational model to explore a question, and identifying different parts of a system to represent in a model and defining relationships between them (Digital Promise, 2020; Intel, n.d.). The table below breaks down these practices into simulation and modeling competencies, describes how teachers can facilitate relevant mindsets supporting students as they engage in these competencies, and provides examples of simulation and modeling across different grade bands in K-12 classrooms.

Table 6. Simulation and Modeling Competencies, Supporting Mindset Strategies, and Examples.

<table>
<tr><th colspan="2">Simulation and Modeling</th></tr>
<tr><td colspan="2">Competencies:

• Exploring Phenomena Using Models
• Creating Computational Models
• Creating 3D Models
• Assessing Models</td></tr>
<tr><td>Design Thinking

• Define. Articulate the problem the model or simulation is seeking to solve and the audience the model is being created for.
• Prototype. Students use iterative design to develop their own model of a real-world system using age-appropriate tools and processes. Prompt students to begin with an initial prototype to test the functionality of the model before adding additional graphics and features.
• Test. Prompt students to identify criteria that they will use to test their simulation or model and to identify trade offs that occur as they iteratively improve the design. Consider how the simulation or model is similar to or different from the real world.</td><td>Computational Thinking

• Abstraction. Prompt students to consider how a model is an abstraction of a real-world system by asking them to compare how one particular model is similar or different from the real world it purports to explain, as well as how they could change the model to make it more congruent to the real world.
• Decomposition. Provide opportunities for students to identify parts of the model and how they work together, or to identify the relationships between them.
• Pattern Recognition. Coach students to systematically collect data from multiple and different scenarios to identify relationships between variables in the model.</td></tr>
<tr><td colspan="2">Examples:

• Students in grades K-2 may create a model of the earth, moon, and sun and discuss similarities and differences between the model and the real world.
• Students in grades 3-5 might participate in an activity that models the relationships between predator and prey populations.
• Middle school students might explore phases of matter using a simulation to manipulate temperature in a solid, liquid, or gas and observe the speed and distance of molecules in each phase.
• High school students might apply knowledge of exothermic reactions to create a 3D model of a flame and manipulate particle parameters in the model.</td></tr>
</table>

Artificial Intelligence and Machine Learning

Artificial Intelligence (AI) and Machine Learning (ML) enable computers to reason and adapt based on sets of rules, the environment, and previously collected information (Ng et al., 2021). AI and ML technologies are becoming more pervasive in our everyday lives, for example voice assistants, facial recognition, smart home appliances, and targeted advertising. Students can engage in AI and ML when they learn about and test existing AI and ML systems, train their own AI and ML algorithms, and/or evaluate AI and ML systems, particularly for bias, discrimination, and unfairness perpetuated by these algorithmic systems (AI4K12.org, 2022; Denton et al., 2021; Intel, n.d.). The table below breaks down into competencies the practices required for students to engage productively with AI and ML systems, describes how teachers can facilitate relevant mindsets supporting students as they engage in these competencies, and provides examples of AI and ML across different grade bands in K-12 classrooms.

Table 7. Artificial Intelligence and Machine Learning Competencies, Supporting Mindset Strategies, and Example.

<table>
<tr><th colspan="2">Artificial Intelligence and Machine Learning</th></tr>
<tr><td colspan="2">Competencies:
• Investigating Artificial Intelligence and Machine Learning Systems
• Training Artificial Intelligence and Machine Learning Algorithms
• Assessing and Auditing Artificial Intelligence and Machine Learning Systems</td></tr>
<tr><td>Design Thinking
• Empathize. Collect information about the experiences and perspectives of different users to prepare a diverse and representative training set for the algorithm.
• Define. Understand the role of input and how such input can be harnessed algorithmically to understand and address challenges, articulate the problem the algorithm is seeking to solve, and carefully consider the audience that the algorithm is being trained for.
• Test. Prompt students to compare the expected results of the algorithm to the actual results. Are there specific cases that the algorithm might not be accurately responding to? How could we diversify the training data to ensure broad representation?</td><td>Computational Thinking
• Abstraction. Prompt students to consider the methods the AI is using to categorize data. What are essential features within the data set that are the most critical for the AI to perform a task? What features might the AI system be identifying as critical even when they are not?
• Algorithms. Provide students with tools (e.g. flowcharts, illustrations) to understand how the AI is automatically categorizing data (i.e., learning).
• Pattern Recognition. Consider patterns that emerge from the testing data set. Ask students if the patterns are representative of a diverse set of cases or whether they could be introducing bias.</td></tr>
<tr><td colspan="2">Example:
• Students in grades K-2 may learn about how humans experience the world through their senses (e.g. sight, smell, touch, taste) and consider the role of input and the concept of modalities.
• Students in grades 3-5 might test a text to speech system to see if it can differentiate between homonyms.
• Middle school students could train a machine learning system to recognize different categories (e.g., high five or thumbs up)
• High school students might train an algorithm to solve a real-world problem, such as sorting recycling, and anticipate problems of bias by ensuring there is diverse and broad representation in the training data set.</td></tr>
</table>

Competency Profiles

Competency profiles offer educators, administrators, and district leaders a set of resources to identify, design, and connect to innovative learning opportunities for K-12 classrooms. The profiles are intended to provide guidance for schools and districts to customize a consistent, cumulative, and competency-based sequence of learning experiences aligned to standards and their ongoing school and community initiatives. Using a competency profile, schools and districts can design learning opportunities that are **developmentally appropriate** along a learning progression, **aligned** with standards, initiatives and existing curricula, and **integrated** with core content areas (e.g. math/reading) for synergistic disciplinary learning.

Competency profiles offer grade band specific guidance for each competency within the skillsets described above. The components of a competency profile include:

- **Competencies** describe developmentally appropriate learning outcomes within each grade band, articulating a learning progression that builds cumulatively in K-12.
- **Look Fors** are actions that teachers may observe when students are engaged in each competency. These are intended to support educators with identifying and designing opportunities for integration.
- **Aligned Standards** identify relevant practices from nationally recognized standards in the United States to support educators with identifying synergistic integration points.
- **Starter Pack Examples** provide illustrative example lessons from Intel's Starter Pack of each Skillset for Innovation integrated into classrooms in elementary, middle, and high school.

The figure below illustrates a sample of a competency profile for "Exploring Phenomena Using Models" in grades K-2. The complete competency profile document, containing guidance for each competency and each grade band, can be found at the end of this paper.

Figure 2. Sample of a Competency Profile for "Exploring Phenomena Using Models" in Grades K-2.

Grades K-2: By the end of Grade 2, what will ALL students know and be able to do?

Competency	Look Fors	Aligned Standards
Simulation and Modeling		
Exploring Phenomena Using Models Interact with various physical and/or computational models that represent real-world systems to understand that systems are made of smaller parts.	• Exploring a physical or computational model. • Identifying the smaller parts of a system represented by a physical or computational model. • Explaining a system using a physical or computational model.	**C3 Framework for Social Studies State Standards** • D4.2.K-2. Construct explanations using correct sequence and relevant information. **Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP3 Construct viable arguments and critique the reasoning of others. **Common Core English Language Arts Anchor Standards** • CCSS.ELA-LITERACY.CCRA.R.7 Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words. • CCSS.ELA-LITERACY.CCRA.LS2 Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. **Computer Science Teachers Association** • 1A-AP-11 Decompose (break down) the steps needed to solve a problem into a precise sequence of instructions. (P3.2) **Next Generation Science Standards** **Developing and Using Models:** • Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s). **Obtaining, Evaluating, and Communicating Information:** • Describe how specific images (e.g., a diagram showing how a machine works) support a scientific or engineering idea.
Creating Computational Models and Creating 3D Models With teacher or peer support, create physical models of real-world systems, objects, or locations.	• Representing relationships between smaller parts of a real-world system, object, or location in a physical model with the support of a teacher or peers.	**C3 Framework for Social Studies State Standards** • D4.2.K-2. Construct explanations using correct sequence and relevant information. **Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP3 Construct viable arguments and critique the reasoning of others. • CCSS.MATH.PRACTICE.MP6 Attend to precision. **Computer Science Teachers Association** • 1A-AP-11 Decompose (break down) the steps needed to solve a problem into a precise sequence of instructions. (P3.2) **Next Generation Science Standards** **Developing and Using Models:** • Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s). • Develop a simple model based on evidence to represent a proposed object or tool. **Constructing Explanations and Designing Solutions:** • Use tools and/or materials to design and/or build a device that solves a specific problem or a solution to a specific problem. **Obtaining, Evaluating, and Communicating Information:** • Communicate information or design ideas and/or solutions with others in oral and/or written forms using models, drawings, writing, or numbers that provide detail about scientific ideas, practices, and/or design ideas.

Using Competency Profiles to Design Innovative Learning Pathways

The competency profiles provide a strong foundation of resources for schools and districts to design K-12 innovative learning pathways. Digital Promise has designed and piloted a research-based process for schools and districts to design learning pathways (Burke et al., 2019). This process, detailed in the CT Pathways Toolkit (Digital Promise, 2022), includes three phases, outlined below. Within each phase, we describe how competency profiles can support educators in the pathway development process.

- **Plan**. Begin to create a pathway by compiling a team of district, school, and teacher leaders to lead the work. Use the competencies and look fors to identify where innovative learning is already happening and examine relevant data to notice inequities in participation or performance.
- **Build**. Use the competency profiles to adopt, modify, or design innovative learning experiences at the integration points between existing curricula and skills for innovation. Document the identified integration points in a competency map, which documents learning opportunities across multiple disciplines along the K-12 progression. The leadership team should engage external stakeholders (e.g. teachers, leaders) to support the design of the competency profile and provide feedback for revision.
- **Implement**. Begin implementing your pathway with a small group of pilot schools or grade levels, and grow within the district based on continuous improvement of each implementation. Prior to innovative learning opportunities across classrooms, it is essential to provide effective and ongoing professional learning for teachers. The learning objectives and look fors articulated within the competency profiles can be useful resources for teachers to understand how to facilitate innovative learning in their classrooms.

Conclusion

Skillsets for Innovation are essential for youth to succeed in today's world and workforce. Yet there are limited, inequitable opportunities for innovative learning in most classrooms today. Intel's Skills for Innovation Framework, along with the competency profiles described in this paper, support schools and districts as they design learning pathways to implement innovative learning opportunities for students across disciplines in consistent and cumulative ways. These competencies are foundational for developing genuinely innovative learning experiences for students as well as the necessary digital tools and pedagogies for teachers to enact them.

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Intel Skills for Innovation Skillset Competency Profile

Competency	Look Fors	Aligned Standards
Simulation and Modeling		
Exploring Phenomena Using Models Interact with various physical and/or computational models that represent real-world systems to understand that systems are made of smaller parts.	• Exploring a physical or computational model. • Identifying the smaller parts of a system represented by a physical or computational model. • Explaining a system using a physical or computational model.	**C3 Framework for Social Studies State Standards** • D4.2.K-2. Construct explanations using correct sequence and relevant information. **Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP3 Construct viable arguments and critique the reasoning of others. **Common Core English Language Arts Anchor Standards** • CCSS.ELA-LITERACY.CCRA.R.7 Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words. • CCSS.ELA-LITERACY.CCRA.LS2 Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. **Computer Science Teachers Association** • 1A-AP-11 Decompose (break down) the steps needed to solve a problem into a precise sequence of instructions. (P3.2) **Next Generation Science Standards** **Developing and Using Models:** • Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s). **Obtaining, Evaluating, and Communicating Information:** • Describe how specific images (e.g., a diagram showing how a machine works) support a scientific or engineering idea.
Creating Computational Models and Creating 3D Models With teacher or peer support, create physical models of real-world systems, objects, or locations.	• Representing relationships between smaller parts of a real-world system, object, or location in a physical model with the support of a teacher or peers.	**C3 Framework for Social Studies State Standards** • D4.2.K-2. Construct explanations using correct sequence and relevant information. **Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP3 Construct viable arguments and critique the reasoning of others. • CCSS.MATH.PRACTICE.MP6 Attend to precision. **Computer Science Teachers Association** • 1A-AP-11 Decompose (break down) the steps needed to solve a problem into a precise sequence of instructions. (P3.2) **Next Generation Science Standards** **Developing and Using Models:** • Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s). • Develop a simple model based on evidence to represent a proposed object or tool. **Constructing Explanations and Designing Solutions:** • Use tools and/or materials to design and/or build a device that solves a specific problem or a solution to a specific problem. **Obtaining, Evaluating, and Communicating Information:** • Communicate information or design ideas and/or solutions with others in oral and/or written forms using models, drawings, writing, or numbers that provide detail about scientific ideas, practices, and/or design ideas.

Grades K-2: By the end of Grade 2, what will ALL students know and be able to do?

Competency	Look Fors	Aligned Standards
Assessing Models Compare a physical or computational model to the real-world system it represents to notice similarities and differences.	• Considering how a physical or computational model represents a real-world system. • Identifying similarities and differences between a physical or computational model and the real-world system it represents.	**Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP3 Construct viable arguments and critique the reasoning of others. • Common Core English Language Arts Anchor Standards • CCSS.ELA-LITERACY.CCRA.R.7 Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words. • CCSS.ELA-LITERACY.CCRA.SL.2 Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. **Next Generation Science Standards** **Developing and Using Models:** • Distinguish between a model and the actual object, process, and/or events the model represents

K-2 Simulation and Modeling Aligned Starter Pack Lessons
Agriculture: Farm to Table **(Humanities: Social Studies)** Demonstrate the importance of food production and agriculture in ensuring a sustainable community through game-based learning. Citybuilding for Sustainability **(Humanities: Geography)** Build a liveable city with the resources provided in this game-based activity. My 3D Volcano **(Humanities: Geography)** Have fun demonstrating the various layers of a volcano by creating a 3D model. Orbital Simulation **(STEM: Physics)** Gather data about Earth and produce an animation demonstrating planetary movements around the Sun. VR Science Museum **(STEM: Biology)** Create a virtual reality simulation of a science museum featuring the diversity of living things.

Grades K-2: By the end of Grade 2, what will ALL students know and be able to do?

Competency	Look Fors	Aligned Standards
Programming and Coding		
Defining Procedures as Algorithms Develop an algorithm that decomposes a simple problem or task into smaller parts and uses precise statements.	• Decomposing a simple problem or task. • Identifying essential steps to solve a simple problem or complete a simple task. • Refining language within steps to be precise.	**C3 Framework for Social Studies State Standards** • D4.2.K-2. Construct explanations using correct sequence and relevant information. **Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP6 Attend to precision. **Computer Science Teachers Association** • 1A-AP-08 Model daily processes by creating and following algorithms (sets of step-by-step instructions) to complete tasks. (P4.4) • 1A-AP-11 Decompose (break down) the steps needed to solve a problem into a precise sequence of instructions. (P3.2) • 1A-AP-12 Develop plans that describe a program's sequence of events, goals, and expected outcomes. (P5.1, P7.2) **Next Generation Science Standards** **Asking Question and Defining Problems:** • Define a simple problem that can be solved through the development of a new or improved object or tool.
Programming Use a basic visual programming environment (e.g., Scratch Jr.) or tactile programming tool (e.g., Kibo, Bee Bot, Code-a-Pillar) to automate a basic procedure.	• Planning code with physical or written tools (e.g., graphic organizers, sequenced cards/ manipulatives). • Writing an algorithm in a language understandable by a computer using a basic visual programming environment or tactile tool. • Creating a basic procedure for a computer or computational tool to carry out.	**Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP5 Use appropriate tools strategically. • CCSS.MATH.PRACTICE.MP6 Attend to precision. **Computer Science Teachers Association** • 1A-CS-01 Select and operate appropriate software to perform a variety of tasks, and recognize that users have different needs and preferences for the technology they use. (P1.1) • 1A-AP-08 Model daily processes by creating and following algorithms (sets of step-by-step instructions) to complete tasks. (P4.4) • 1A-AP-10 Develop programs with sequences and simple loops, to express ideas or address a problem. (P5.2) • 1A-AP-11 Decompose (break down) the steps needed to solve a problem into a precise sequence of instructions. (P3.2) • 1A-AP-12 Develop plans that describe a program's sequence of events, goals, and expected outcomes. (P5.1, P7.2) **Next Generation Science Standards** **Constructing Explanations and Designing Solutions:** • Use tools and/or materials to design and/or build a device that solves a specific problem or a solution to a specific problem.
Testing and Debugging Understand that outcomes of an algorithm can be used to determine if there are errors in the algorithm and iteratively refine to fix errors.	• Observing outputs that are different than intended. • Discussing how an outcome is similar or different than intended. • Making iterative changes to fix errors.	**Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP6 Attend to precision. **Computer Science Teachers Association** • 1A-CS-03 Describe basic hardware and software problems using accurate terminology. (P6.2, P7.2) • 1A-AP-14 Debug (identify and fix) errors in an algorithm or program that includes sequences and simple loops. (P6.2)

K-2 Programming and Coding Aligned Starter Pack Lessons
Orbital Simulation **(STEM: Physics)** Gather data about Earth and produce an animation demonstrating planetary movements around the Sun. Plant Food **(STEM: Biology)** Create an animated story using block programming to demonstrate the process of photosynthesis. Robot Geometry **(STEM: Mathematics)** Learn how to program a virtual robot that can move in different geometrical shapes. Storytelling with Scratch **(Language Arts: Language)** Explore how coding can be used to create an animated story. Water Cycle **(STEM: Biology)** Demonstrate the water cycle by animating the process using block programming.

Grades K-2: By the end of Grade 2, what will ALL students know and be able to do?

Competency	Look Fors	Aligned Standards
Data Science		
Collecting Data Collect numerical data by categorizing objects and sorting them into groups.	• Grouping objects based on shared characteristics. • Counting objects categorized within the same groups.	**Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. **Next Generation Science Standards** **Planning and Carrying Out Investigations:** • With guidance, plan and conduct an investigation in collaboration with peers (for K). • Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question. • Make observations (firsthand or from media) and/or measurements to collect data that can be used to make comparisons. **Analyzing and Interpreting Data:** • Record information (observations, thoughts, and ideas). **Using Mathematics and Computational Thinking:** • Describe, measure, and/or compare quantitative attributes of different objects and display the data using simple graphs.
Analyzing Data As a class, discuss patterns and relationships in basic numerical data sets, categories, or groups.	• Recognizing patterns across objects/data within a group or category. • Drawing conclusions about basic numerical data, categories, or groups.	**Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP5 Use appropriate tools strategically. • CCSS.MATH.PRACTICE.MP7 Look for and make use of structure. • CCSS.MATH.PRACTICE.MP8 Look for and express regularity in repeated reasoning. **Common Core English Language Arts Anchor Standards** • CCSS.ELA-LITERACY.CCRA.SL.1 Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively. **Next Generation Science Standards** **Analyzing and Interpreting Data:** • Use observations (firsthand or from media) to describe patterns and/or relationships in the natural and designed world(s) in order to answer scientific questions and solve problems. **Using Mathematics and Computational Thinking:** • Use counting and numbers to identify and describe patterns in the natural and designed world(s). • Describe, measure, and/or compare quantitative attributes of different objects and display the data using simple graphs.
Evaluating Data Identify data points that don't follow a predicted or identified pattern. Consider questions that arise based on the data set.	• Identifying data points that are unexpected based on identified patterns. • Asking questions about data that is being analyzed.	**Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP6 Attend to precision. **Common Core English Language Arts Anchor Standards** • CCSS.ELA-LITERACY.CCRA.SL.2 Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. **Next Generation Science Standards** **Engaging in Argument From Evidence:** • Analyze why some evidence is relevant to a scientific question and some is not.

Grades K-2: By the end of Grade 2, what will ALL students know and be able to do?

Competency	Look Fors	Aligned Standards
Communicating Data Create a basic visualization (e.g., bar graph) visualizing data and describe the patterns in the visualization.	• Designing a basic visualization of data. • Describing patterns in data represented by the data visualization orally or in writing.	**C3 Framework for Social Studies State Standards** • D4.1.K-2. Construct an argument with reasons. • D4.2.K-2. Construct explanations using correct sequence and relevant information. • D4.3.K-2. Present a summary of an argument using print, oral, and digital technologies. **Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP3 Construct viable arguments and critique the reasoning of others. • CCSS.MATH.PRACTICE.MP5 Use appropriate tools strategically. • CCSS.MATH.PRACTICE.MP6 Attend to precision. • CCSS.MATH.PRACTICE.MP7 Look for and make use of structure. • CCSS.MATH.PRACTICE.MP8 Look for and express regularity in repeated reasoning. **Common Core English Language Arts Anchor Standards** • CCSS.ELA-LITERACY.CCRA.W.1 Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence. • CCSS.ELA-LITERACY.CCRA.W.2 Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content. • CCSS.ELA-LITERACY.CCRA.W.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. • CCSS.ELA-LITERACY.CCRA.SL.2 Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. • CCSS.ELA-LITERACY.CCRA.SL.4 Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience. • CCSS.ELA-LITERACY.CCRA.SL.5 Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations. **Computer Science Teachers Association** • 1A-DA-06 Collect and present the same data in various visual formats. (P7.1, P4.4) • 1A-DA-07 Identify and describe patterns in data visualizations, such as charts or graphs, to make predictions. (P4.1) **Next Generation Science Standards** **Analyzing and Interpreting Data:** • Use and share pictures, drawings, and/or writings of observations. **Obtaining, Evaluating, and Communicating Information:** • Communicate information or design ideas and/or solutions with others in oral and/or written forms using models, drawings, writing, or numbers that provide detail about scientific ideas, practices, and/or design ideas.

K-2 Data Science Aligned Starter Pack Lessons
Citybuilding for Sustainability **(Humanities: Geography)** Build a liveable city with the resources provided in this game-based activity.

Competency	Look Fors	Aligned Standards
Artificial Intelligence and Machine Learning		
Investigating Artificial Intelligence and Machine Learning Systems Locate sensors on phones, computers, robots, and other technological devices, and identify what the sensors allow the technology to perceive.	• Finding different types of sensors on phones, computers, robots, and other technological devices. • Identifying the purpose and function of different types of sensors.	**Computer Science Teachers Association** • 1A-CS-02 Use appropriate terminology in identifying and describing the function of common physical components of computing systems (hardware). (P7.2)
Training Artificial Intelligence and Machine Learning Algorithms Label a set of objects or pictures with features that could be used to classify them.	• Identifying features of objects or pictures that could be used to classify them (e.g., color, shape). • Sorting objects or pictures based on features that could be used to classify them. • Labeling features of objects or pictures to classify them.	**Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP7 Look for and make use of structure. • CCSS.MATH.PRACTICE.MP8 Look for and express regularity in repeated reasoning. **Next Generation Science Standards** **Analyzing and Interpreting Data:** • Record information (observations, thoughts, and ideas).
Assessing and Auditing Artificial Intelligence and Machine Learning Systems Discuss the ways that AI and Machine Learning technologies can be inaccessible to some people (e.g., only understanding English). With peer and/or teacher support, develop an ethical matrix for a simple algorithm solving a problem or completing a task to identify who the algorithm affects and related values. Discuss how these values might be similar or different across groups.	• Explaining inequities that arise when AI/ML technologies are inaccessible to some people. • Explaining and discussing how and why values for an algorithm are different for different people.	**C3 Framework for Social Studies State Standards** • D2.Civ.10.K-2. Compare their own point of view with others' perspectives. • D4.1.K-2. Construct an argument with reasons. **Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP3 Construct viable arguments and critique the reasoning of others. **Common Core English Language Arts Anchor Standards** • CCSS.ELA-LITERACY.CCRA.SL.1 Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively. • CCSS.ELA-LITERACY.CCRA.SL.4 Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience. **Computer Science Teachers Association** • 1A-CS-01 Select and operate appropriate software to perform a variety of tasks, and recognize that users have different needs and preferences for the technology they use. (P1.1) **Next Generation Science Standards** **Constructing Explanations and Designing Solutions:** • Generate and/or compare multiple solutions to a problem **Obtaining, Evaluating, and Communicating Information:** • Communicate information or design ideas and/or solutions with others in oral and/or written forms using models, drawings, writing, or numbers that provide detail about scientific ideas, practices, and/or design.

K-2 Artificial Intelligence and Machine Learning Aligned Starter Pack Lessons
Are You Happy? **(Language Arts: Language)** Use natural language processing to create a machine that can detect emotion through spoken text. Green Screen Newscast **(Language Arts: Language)** Make use of a green screen and fundamental video editing skills to put together an engaging newscast.

Competency	Look Fors	Aligned Standards
Simulation and Modeling		
Exploring Phenomena Using Models Manipulate a participatory simulation and/or computational model to set up multiple and different scenarios to answer a driving question.	• Identifying a question to explore using a participatory simulation or computational model. • Setting up multiple different scenarios to collect data from a participatory simulation and/or computational model. • Using data collected from a participatory simulation and/or computational model to support a claim about a real-world system.	**C3 Framework for Social Studies State Standards** • D4.2.3-5. Construct explanations using reasoning, correct sequence, examples, and details with relevant information and data. **Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP3 Construct viable arguments and critique the reasoning of others. • CCSS.MATH.PRACTICE.MP7 Look for and make use of structure. • CCSS.MATH.PRACTICE.MP8 Look for and express regularity in repeated reasoning. **Common Core English Language Arts Anchor Standards** • CCSS.ELA-LITERACY.CCRA.R.7 Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words. • CCSS.ELA-LITERACY.CCRA.W.1 Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence. • CCSS.ELA-LITERACY.CCRA.SL.2 Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. **Computer Science Teachers Association** • 1B-DA-07 Use data to highlight or propose cause- and-effect relationships, predict outcomes, or communicate an idea. (P7.1) **Next Generation Science Standards** **Asking Questions and Defining Problems:** • Ask questions about what would happen if a variable is changed. • Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. **Developing and Using Models** • Develop and/or use models to describe and/or predict phenomena. • Use a model to test cause and effect relationships or interactions concerning the functioning of a natural or designed system.
Creating Computational Models With teacher or peer support, develop or modify a participatory simulation or computational model that represents a real-world system.	• Representing relationships between smaller parts of a real world system in a participatory simulation and/or computational model with the support of a teacher or peers. • Identifying different parts of a real world system that a participatory simulation and/or computational model is representing. • Defining relationships between different parts of a real world system.	**C3 Framework for Social Studies State Standards** • D4.2.3-5. Construct explanations using reasoning, correct sequence, examples, and details with relevant information and data. **Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP3 Construct viable arguments and critique the reasoning of others. • CCSS.MATH.PRACTICE.MP5 Use appropriate tools strategically. • CCSS.MATH.PRACTICE.MP6 Attend to precision. • Common Core English Language Arts Anchor Standards • CCSS.ELA-LITERACY.CCRA.SL.5 Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations. **Computer Science Teachers Association** • 1B-AP-11 Decompose (break down) problems into smaller, manageable sub-problems to facilitate the program development process. (P3.2) **Next Generation Science Standards** **Developing and Using Models:** • Collaboratively develop and/or revise a model based on evidence that shows the relationships among variables for frequent and regular occurring events. • Develop a model using an analogy, example, or abstract representation to describe a scientific principle or design solution.

Grades 3-5: By the end of Grade 5, what will ALL students know and be able to do?

Competency	Look Fors	Aligned Standards
Creating 3D Models Create 2D or 3D physical models representing a real-world system, object, or location.	• Defining relationships between different parts of a real-world system, object, or location. • Representing relationships between smaller parts of a real-world system, object, or location in a 2D or 3D physical model. • Identifying different parts of a real-world system, object, or location that a 2D or 3D physical model is representing.	**C3 Framework for Social Studies State Standards** • D4.2.3-5. Construct explanations using reasoning, correct sequence, examples, and details with relevant information and data. **Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP3 Construct viable arguments and critique the reasoning of others. • CCSS.MATH.PRACTICE.MP5 Use appropriate tools strategically. • CCSS.MATH.PRACTICE.MP6 Attend to precision. **Computer Science Teachers Association** • 1B-AP-11 Decompose (break down) problems into smaller, manageable subproblems to facilitate the program development process. (P3.2) **Next Generation Science Standards** **Developing and Using Models:** • Collaboratively develop and/or revise a model based on evidence that shows the relationships among variables for frequent and regular occurring events. • Develop a model using an analogy, example, or abstract representation to describe a scientific principle or design solution.
Assessing Models Compare a participatory simulation or computational model that is used or developed to the real-world system it represents to notice similarities and differences.	• Testing and debugging a participatory simulation and/or computational model. • Considering how a participatory simulation and/or computational model represents a real-world system. • Identifying similarities and differences between a participatory simulation and/or computational model and the real world system it represents.	**C3 Framework for Social Studies State Standards** • D4.4.3-5. Critique arguments. • D4.5.3-5. Critique explanations. **Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP3 Construct viable arguments and critique the reasoning of others. • CCSS.MATH.PRACTICE.MP6 Attend to precision. **Common Core English Language Arts Anchor Standards** • CCSS.ELA-LITERACY.CCRA.R.7 Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words. • CCSS.ELA-LITERACY.CCRA.SL.2 Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. **Computer Science Teachers Association** • 1B-AP-15 Test and debug (identify and fix errors) a program or algorithm to ensure it runs as intended. (P6.1, P6.2) **Next Generation Science Standards** **Developing and Using Models:** • Identify limitations of models. **Analyzing and Interpreting Data:** • Use data to evaluate and refine design solutions.

3–5 Simulation and Modeling Aligned Starter Pack Lessons
Agriculture: Farm to Table **(Humanities: Social Studies)** Demonstrate the importance of food production and agriculture in ensuring a sustainable community through game-based learning. Citybuilding for Sustainability **(Humanities: Geography)** Build a liveable city with the resources provided in this game-based activity. Catapult Toss **(STEM: Physics)** Create a catapult game which uses projectiles with different properties for launches. My 3D Volcano **(Humanities: Geography)** Have fun demonstrating the various layers of a volcano by creating a 3D model. Orbital Simulation **(STEM: Physics)** Gather data about Earth and produce an animation demonstrating planetary movements around the Sun. VR Science Museum **(STEM: Biology)** Create a virtual reality simulation of a science museum featuring the diversity of living things.

Competency	Look Fors	Aligned Standards
Programming and Coding		
Defining Procedures as Algorithms Develop an algorithm that decomposes a complex problem, process, or task into smaller parts and uses precise statements.	• Decomposing a complex problem or task. • Identifying essential steps to solve a complex problem or complete a complex task. • Refining language within steps to be precise.	**C3 Framework for Social Studies State Standards** • D4.2.3-5. Construct explanations using reasoning, correct sequence, examples, and details with relevant information and data. **Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP6 Attend to precision. **Computer Science Teachers Association** • 1B-AP-10 Create programs that include sequences, events, loops, and conditionals. (P5.2) • 1B-AP-11 Decompose (break down) problems into smaller, manageable subproblems to facilitate the program development process. (P3.2)
Programming Use a block-based programming language to automate a procedure that solves a problem/ completes a task.	• Planning code with physical or written tools (e.g., graphic organizers, sequenced cards/ manipulatives, flow charts). • Writing an algorithm in a block-based language understandable by a computer. • Creating a procedure for a computer to carry out.	**Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP5 Use appropriate tools strategically. • CCSS.MATH.PRACTICE.MP6 Attend to precision. **Computer Science Teachers Association** • 1B-AP-10 Create programs that include sequences, events, loops, and conditionals. (P5.2) • 1B-AP-11 Decompose (break down) problems into smaller, manageable subproblems to facilitate the program development process. (P3.2)
Testing and Debugging Use intermediate results to help find and fix errors, not only in what is incorrect within an algorithm but also what might be missing.	• Discussing how an outcome is similar or different than intended. • Making iterative changes to fix errors. • Running small parts of a program to find and fix errors. • Considering not only what is incorrect within an algorithm, but also what is missing.	**Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP6 Attend to precision. **Computer Science Teachers Association** • 1B-CS-03 Determine potential solutions to solve simple hardware and software problems using common troubleshooting strategies. (P6.2) • 1B-AP-15 Test and debug (identify and fix errors) a program or algorithm to ensure it runs as intended. (P6.1, P6.2)

3–5 Programming and Coding Aligned Starter Pack Lessons
Coding Algorithms **(STEM: Mathematics)** Learn about algorithms and how they can be applied to computer programs such as Python. Music Through Coding **(Humanities: Music)** Create a music machine by coding a simple score using a coding platform. Orbital Simulation **(STEM: Physics)** Gather data about Earth and produce an animation demonstrating planetary movements around the Sun. Plant Food **(STEM: Biology)** Create an animated story using block programming to demonstrate the process of photosynthesis. Robot Geometry **(STEM: Mathematics)** Learn how to program a virtual robot which can move in different geometrical shapes. Storytelling with Scratch **(Language Arts: Language)** Explore how coding can be used to create an animated story. Water Cycle **(STEM: Biology)** Demonstrate the water cycle by animating the process using block programming.

Grades 3-5: By the end of Grade 5, what will ALL students know and be able to do?

Competency	Look Fors	Aligned Standards
Data Science		
Collecting Data Collect numerical data using computational tools (e.g. probes, sensor).	• Using computational tools to collect data that can be quantified.	**Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP5 Use appropriate tools strategically. • CCSS.MATH.PRACTICE.MP6 Attend to precision. **Next Generation Science Standards** **Planning and Carrying Out Investigations:** • Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. • Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.
Analyzing Data Use computational tools to manipulate, organize, and reveal patterns and relationships within data.	• Using computational tools to manipulate data with data moves (Erickson et al., 2019). • Describing relationships between variables. • Drawing conclusions about the relationship between variables in a numerical data set.	**Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP4 Model with mathematics. • CCSS.MATH.PRACTICE.MP5 Use appropriate tools strategically. • CCSS.MATH.PRACTICE.MP6 Attend to precision. • CCSS.MATH.PRACTICE.MP7 Look for and make use of structure. • CCSS.MATH.PRACTICE.MP8 Look for and express regularity in repeated reasoning. **Computer Science Teachers Association** • 1B-DA-07 Use data to highlight or propose cause- and-effect relationships, predict outcomes, or communicate an idea. (P7.1) **Next Generation Science Standards** **Analyzing and Interpreting Data:** • Represent data in tables and/or various graphical displays (bar graphs, pictographs and/or pie charts) to reveal patterns that indicate relationships. • Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation. **Using Mathematics and Computational Thinking:** • Organize simple data sets to reveal patterns that suggest relationships. • Describe, measure, estimate, and/or graph quantities (e.g., area, volume, weight, time) to address scientific and engineering questions and problems.
Evaluating Data Identify data points that don't follow a predicted or identified pattern. Consider questions that arise based on the data set.	• Identifying data points that are unexpected based on identified patterns. • Asking questions about data that is being analyzed.	**Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP6 Attend to precision. **Common Core English Language Arts Anchor Standards** • CCSS.ELA-LITERACY.CCRA.SL.2 Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. **Next Generation Science Standards** **Planning and Carrying Out Investigations:** • Evaluate appropriate methods and/or tools for collecting data.

Grades 3-5: By the end of Grade 5, what will ALL students know and be able to do?

Competency	Look Fors	Aligned Standards
Communicating Data Create a data visualization with 2+ variables illustrating patterns and relationships from a data set. Describe the data to a target audience.	• Designing a visual representation of data. • Discussing affordances and disaffordances of visualization methods. • Describing patterns in data represented by the data visualization orally or in writing. • Connecting data to real-world phenomena and concepts. • Making a data-supported claim or argument.	**C3 Framework for Social Studies State Standards** • D3.4.3-5. Use evidence to develop claims in response to compelling questions. • D4.2.3-5. Construct explanations using reasoning, correct sequence, examples, and details with relevant information and data. **Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP3 Construct viable arguments and critique the reasoning of others. • CCSS.MATH.PRACTICE.MP5 Use appropriate tools strategically. • CCSS.MATH.PRACTICE.MP6 Attend to precision. • CCSS.MATH.PRACTICE.MP7 Look for and make use of structure. • CCSS.MATH.PRACTICE.MP8 Look for and express regularity in repeated reasoning. **Common Core English Language Arts Anchor Standards** • CCSS.ELA-LITERACY.CCRA.W.1 Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence. • CCSS.ELA-LITERACY.CCRA.W.2 Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content. • CCSS.ELA-LITERACY.CCRA.W.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. • CCSS.ELA-LITERACY.CCRA.SL.2 Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. • CCSS.ELA-LITERACY.CCRA.SL.4 Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience. • CCSS.ELA-LITERACY.CCRA.SL.5 Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations. **Computer Science Teachers Association** • 1B-DA-06 Organize and present collected data visually to highlight relationships and support a claim. (P7.1) **Next Generation Science Standards** **Analyzing and Interpreting Data:** • Represent data in tables and/or various graphical displays (bar graphs, pictographs and/or pie charts) to reveal patterns that indicate relationships. **Obtaining, Evaluating, and Communicating Information:** • Communicate scientific and/or technical information orally and/or in written formats, including various forms of media as well as tables, diagrams, and charts.

3–5 Data Science Aligned Starter Pack Lessons
Citybuilding for Sustainability **(Humanities: Geography)** Build a liveable city with the resources provided in this game-based activity.

Competency	Look Fors	Aligned Standards
Artificial Intelligence and Machine Learning		
Investigating Artificial Intelligence and Machine Learning Systems Experiment with AI/ML systems such as generative AI, Generative Adversarial Networks, speech to text, natural language processing programs, etc. Discuss instances where the systems perform well and where systems struggle to interact naturally. Investigate how computers perceive different types of information and identify differences between human sensing and computer perception (e.g., lack of taste, images perceived as pixels, words as sounds, touch as haptics).	• Creating artifacts using a variety of AI/ML systems. • Asking questions about how AI/ML systems work based on experiences with them. • Discussing instances when systems struggle to interact naturally with humans and/or use human language incorrectly. • Discussing how computer sensing is similar to and different from human sensing. • Explaining how computers perceive and process different types of information.	**C3 Framework for Social Studies State Standards** • D4.2.3-5. Construct explanations using reasoning, correct sequence, examples, and details with relevant information and data. **Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. **Common Core English Language Arts Anchor Standards** • CCSS.ELA-LITERACY.CCRA.SL.2 Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. **Computer Science Teachers Association** • 1B-CS-01 Describe how internal and external parts of computing devices function to form a system. (P7.2) **Next Generation Science Standards** **Asking Questions and Defining Problems:** • Ask questions about what would happen if a variable is changed. **Constructing Explanations and Designing Solutions:** • Construct an explanation of observed relationships (e.g., the distribution of plants in the backyard). • Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation or design a solution to a problem.
Training Artificial Intelligence and Machine Learning Algorithms Train an existing machine learning classification model (e.g., Teachable Machine, Machine Learning for Kids) using a database of images or sounds. Test the model and discuss its accuracy.	• Developing a set of training data. • Inputting training data into an existing machine learning classification model. • Testing a student-trained model and discussing the accuracy of the model.	**Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP6 Attend to precision. • CCSS.MATH.PRACTICE.MP7 Look for and make use of structure. • CCSS.MATH.PRACTICE.MP8 Look for and express regularity in repeated reasoning.

Grades 3-5: By the end of Grade 5, what will ALL students know and be able to do?

Competency	Look Fors	Aligned Standards
Assessing and Auditing Artificial Intelligence and Machine Learning Systems Examine a labeled data set to determine if features of the data set or the selected labels could lead to bias. Develop an ethical matrix for a complex algorithm solving a problem or completing a task to identify who the algorithm affects and related values. Discuss how these values might be similar or different across groups.	• Discussing if the category labels used on a data set are inclusive of all identities (e.g., gender identities, racial identities). • Analyzing a labeled data set to determine if it has a balanced representation of all categories. • Identifying missing labels or features of data that could cause bias. • Creating an ethical matrix identifying who a complex algorithm affects and what their values are. • Analyzing how values for an algorithm are different for different people. • Discussing how algorithms align or do not align with different people on the ethical matrix. • Talking to people who might use an algorithm or program to learn about their needs and wants.	**C3 Framework for Social Studies State Standards** • D4.2.3-5. Construct explanations using reasoning, correct sequence, examples, and details with relevant information and data. **Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP3 Construct viable arguments and critique the reasoning of others. • CCSS.MATH.PRACTICE.MP7 Look for and make use of structure. • CCSS.MATH.PRACTICE.MP8 Look for and express regularity in repeated reasoning. **Common Core English Language Arts Anchor Standards** • CCSS.ELA-LITERACY.CCRA.SL.1 Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively. • CCSS.ELA-LITERACY.CCRA.SL.2 Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. • CCSS.ELA-LITERACY.CCRA.SL.4 Present information, findings, and supporting evidence such that listeners can follow the line of reasoning, and the organization, development, and style are appropriate to task, purpose, and audience. • CCSS.ELA-LITERACY.CCRA.SL.5 Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations. **Computer Science Teachers Association** • 1B-AP-13 Use an iterative process to plan the development of a program by including others' perspectives and considering user preferences. (P1.1, P5.1) • 1B-IC-19 Brainstorm ways to improve the accessibility and usability of technology products for the diverse needs and wants of users. (P1.2) • 1B-IC-20 Seek diverse perspectives for the purpose of improving computational artifacts. (P1.1) **Next Generation Science Standards** **Analyzing and Interpreting Data:** • Use data to evaluate and refine design solutions.

3–5 Artificial Intelligence and Machine Learning Aligned Starter Pack Lessons
Are You Happy? **(Language Arts: Language)** Use natural language processing to create a machine that can detect emotion through spoken text. Green Screen Newscast **(Language Arts: Language)** Make use of a green screen and fundamental video editing skills to put together an engaging newscast. Invisible Animals **(STEM: Biology)** Use computer vision to create a digital octopus that camouflages itself to match its background.

Competency	Look Fors	Aligned Standards
Simulation and Modeling		
Exploring Phenomena Using Models Manipulate a computational model to set up multiple and different scenarios to answer a driving question.	• Identifying a question to explore using a computational model. • Setting up multiple different scenarios to collect data from a computational model. • Using data collected from a computational model to support a claim about a real-world system.	**C3 Framework for Social Studies State Standards** • D4.2.6-8. Construct explanations using reasoning,correct sequence, examples, and details with relevant information and data, while acknowledging the strengths and weaknesses of the explanations. **Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP3 Construct viable arguments and critique the reasoning of others. • CCSS.MATH.PRACTICE.MP7 Look for and make use of structure. • CCSS.MATH.PRACTICE.MP8 Look for and express regularity in repeated reasoning. **Common Core English Language Arts Anchor Standards** • CCSS.ELA-LITERACY.CCRA.R.7 Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words. • CCSS.ELA-LITERACY.CCRA.W.1 Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence. • CCSS.ELA-LITERACY.CCRA.SL.2 Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. **Computer Science Teachers Association** • 2-DA-08 Collect data using computational tools and transform the data to make it more useful and reliable. (P6.3) **Next Generation Science Standards** **Asking Questions and Defining Problems:** • Ask questions that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information. **Developing and Using Models:** • Develop and/or use a model to predict and/or describe phenomena. • Develop and/or use a model to generate data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs, and those at unobservable scales. **Planning and Carrying Out Investigations:** • Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions.

Competency	Look Fors	Aligned Standards
Creating Computational Models Develop or modify a computational model based on mathematical relationships between key components of a real-world system.	• Representing relationships between smaller parts of a real-world system in a computational model. • Identifying different parts of a real-world system that a computational model is representing.	**C3 Framework for Social Studies State Standards** D4.3.6-8. Present adaptations of arguments and explanations on topics of interest to others to reach audiences and venues outside the classroom using print and oral technologies (e.g., posters, essays, letters, debates, speeches, reports, and maps) and digital technologies (e.g., Internet, social media, and digital documentary). **Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP3 Construct viable arguments and critique the reasoning of others. • CCSS.MATH.PRACTICE.MP4 Model with mathematics. • CCSS.MATH.PRACTICE.MP5 Use appropriate tools strategically. • CCSS.MATH.PRACTICE.MP6 Attend to precision. **Common Core English Language Arts Anchor Standards** • CCSS.ELA-LITERACY.CCRA.SL.5 Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations. **Computer Science Teachers Association** • 2-DA-09 Refine computational models based on the data they have generated. (P5.3, P4.4) • 2-AP-13 Decompose problems and subproblems into parts to facilitate the design, implementation, and review of programs. (P3.2) **Next Generation Science Standards** **Developing and Using Models:** • Develop or modify a model—based on evidence—to match what happens if a variable or component of a system is changed. • Use and/or develop a model of simple systems with uncertain and less predictable factors. • Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena. • Develop and/or use a model to predict and/or describe phenomena. • Develop and/or use a model to generate data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs, and those at unobservable scales. **Constructing Explanations and Designing Solutions:** • Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints. • Optimize performance of a design by prioritizing criteria, making tradeoffs, testing, revising, and re-testing.

Competency	Look Fors	Aligned Standards
Creating 3D Models Develop or modify a 3D model based on spatial relationships between key components of a real-world system, object, or location.	• Defining different parts of a real-world system, object, or location. • Representing relationships between smaller parts of a real-world system, object, or location in a digital 3D model. • Identifying different parts of a real-world system, object, or location that a 3D model is representing. • Creating an accurate representation of a real-world system, object, or location using appropriate scaling and dimensions.	**C3 Framework for Social Studies State Standards** D4.3.6-8. Present adaptations of arguments and explanations on topics of interest to others to reach audiences and venues outside the classroom using print and oral technologies (e.g., posters, essays, letters, debates, speeches, reports, and maps) and digital technologies (e.g., Internet, social media, and digital documentary). **Common Core English Language Arts Anchor Standards** • CCSS.ELA-LITERACY.CCRA.SL.5 Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations. • Common Core Standards for Mathematical Practice • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP3 Construct viable arguments and critique the reasoning of others. • CCSS.MATH.PRACTICE.MP4 Model with mathematics. • CCSS.MATH.PRACTICE.MP5 Use appropriate tools strategically. • CCSS.MATH.PRACTICE.MP6 Attend to precision. **Computer Science Teachers Association** • 2-AP-13 Decompose problems and subproblems into parts to facilitate the design, implementation, and review of programs. (P3.2) **Next Generation Science Standards** **Developing and Using Models:** • Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena. • Develop and/or use a model to predict and/or describe phenomena. • Develop and/or use a model to generate data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs, and those at unobservable scales. **Constructing Explanations and Designing Solutions** • Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints. • Optimize performance of a design by prioritizing criteria, making tradeoffs, testing, revising, and re-testing.

Grades 6-8: By the end of Grade 8, what will ALL students know and be able to do?

Competency	Look Fors	Aligned Standards
Assessing Models Compare a computational model that is used or developed to the real-world system it represents to notice: similarities and differences, explicit decisions made about what is included and excluded in the model and other choices made by the creator, and areas where creator bias could affect the model.	• Testing and debugging a computational model. • Considering how a computational model represents a real-world system. • Identifying similarities and differences between a computational model and the real-world system it represents. • Identifying creator decisions made when developing a computational model (e.g., what is included and excluded). • Considering bias in the outputs of a computational model.	**C3 Framework for Social Studies State Standards** • D3.2.6-8. Evaluate the credibility of a source by determining its relevance and intended use. • D4.4.6-8. Critique arguments for credibility. • D4.5.6-8. Critique the structure of explanations. **Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP3 Construct viable arguments and critique the reasoning of others. • CCSS.MATH.PRACTICE.MP6 Attend to precision. **Common Core English Language Arts Anchor Standards** • CCSS.ELA-LITERACY.CCRA.R.7 Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words. • CCSS.ELA-LITERACY.CCRA.SL.2 Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. **Computer Science Teachers Association** • 2-DA-09 Refine computational models based on the data they have generated. (P5.3, P4.4) • 2-AP-13 Decompose problems and subproblems into parts to facilitate the design, implementation, and review of programs. (P3.2) • 2-IC-21 Discuss issues of bias and accessibility in the design of existing technologies. (P1.2) **Next Generation Science Standards** **Developing and Using Models:** • Evaluate limitations of a model for a proposed object or tool. **Engaging in Argument From Evidence:** • Make an oral or written argument that supports or refutes the advertised performance of a device, process, or system based on empirical evidence concerning whether or not the technology meets relevant criteria and constraints.

6–8 Simulation and Modeling Aligned Starter Pack Lessons

3D Repair **(STEM: Physics)**
Explore how physics can be applied to 3D models which are printed to repair broken parts in simple machines.

Rapid Prototyping **(STEM: Physics)**
Apply the concept of center of gravity to create a useful tool using 3D modeling software and a 3D printer.

Roller Coaster Physics **(STEM: Physics)**
Create simulations of roller coasters within safety limits for G-forces.

Saltwater Circuit **(STEM: Physics)**
Plan and design a saltwater circuit using Tinkercad to demonstrate how one works.

Terrain Visualization **(Humanities: Geography)**Generate 3D city models using GIS software to better understand how city planners use data for planning.

Virtual Tourism **(Humanities: Social Studies)**
Create a virtual reality tour of a local attraction using an online 3D creation tool.

Wrecking Ball Physics **(STEM: Physics)**
Investigate how energy is conserved using 3D Rigidbody simulations of wrecking balls.

Writing Braille **(Language Arts: Language)**
Learn to translate written language to Braille, which can be etched in wood using a laser cutter.

Grades 6-8: By the end of Grade 8, what will ALL students know and be able to do?

Competency	Look Fors	Aligned Standards
Programming and Coding		
Defining Procedures as Algorithms Develop an algorithm that decomposes a complex problem, process, or task into smaller parts and uses precise statements. Develop an algorithm that uses conditional logic to produce different outputs.	• Decomposing a complex problem or task. • Identifying essential steps to solve a complex problem or complete a complex task. • Refining language within steps to be precise. • Using conditional logic to produce different outputs of an algorithm.	**Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP6 Attend to precision. **Computer Science Teachers Association** • 2-AP-10 Use flowcharts and/or pseudocode to address complex problems as algorithms. (P4.4, P4.1) • 2-AP-13 Decompose problems and subproblems into parts to facilitate the design, implementation, and review of programs. (P3.2)
Programming Use a block-based programming language to automate a procedure that solves a problem/ completes a task. Use a text-based programming language to automate a procedure that solves a problem/ completes a task.	• Planning code with physical or written tools (e.g., graphic organizers, sequenced cards/ manipulatives, flow charts). • Writing an algorithm in a block-based or text language understandable by a computer. • Creating a procedure for a computer to carry out.	**Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP5 Use appropriate tools strategically. • CCSS.MATH.PRACTICE.MP6 Attend to precision. **Computer Science Teachers Association** • 2-AP-12 Design and iteratively develop programs that combine control structures, including nested loops and compound conditionals. (P5.1, P5.2) • 2-AP-13 Decompose problems and subproblems into parts to facilitate the design, implementation, and review of programs. (P3.2) **Next Generation Science Standards** **Asking Questions and Defining Problems:** • Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. **Constructing Explanations and Designing Solutions:** • Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints. • Optimize performance of a design by prioritizing criteria, making tradeoffs, testing, revising, and re-testing.
Testing and Debugging Strategically choose methods (e.g., using intermediate results, reproduce errors) to find and fix errors in a purposeful order (e.g., in order they are reported by a compiler) to get expected results.	• Discussing how an outcome is similar or different than intended. • Purposefully and strategically selecting the most effective methods to fix errors. • Fixing errors in a logical and purposeful order.	**Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP6 Attend to precision. **Computer Science Teachers Association** • 2-AP-13 Decompose problems and subproblems into parts to facilitate the design, implementation, and review of programs. (P3.2) **Next Generation Science Standards** **Planning and Carrying Out Investigations:** • Collect data about the performance of a proposed object, tool, process or system under a range of conditions. **Constructing Explanations and Designing Solutions:** • Optimize performance of a design by prioritizing criteria, making tradeoffs, testing, revising, and re-testing.

Grades 6-8: By the end of Grade 8, what will ALL students know and be able to do?

6–8 Programming and Coding Aligned Starter Pack Lessons
Beef or Beans (STEM: Biology) Harness the power of data visualization to meet the world's growing needs for food. **Better Sensing Makes Good Sense (Social Studies)** Explore how mobile apps are designed to help translate images to speech to aid the visually impaired. **Coding Macbeth (Language Arts: Language)** Create a chatbot which is able to respond in the way Lady Macbeth does. **Motion Behavior Robots (STEM: Biology)** Create step-by-step motion instructions for robots in real-time physics simulations. **Volume Change (STEM: Mathematics)** Create a virtual game that tests the concept of surface area and volume of 3D figures. **Water Pollution (STEM: Biology)** Investigate the effects of water pollution and propose solutions using Scratch to demonstrate your ideas.

Competency	Look Fors	Aligned Standards
Data Science		
Collecting Data Collect data that can be automated and recorded through computational tools (e.g. probes, sensor).	• Using computational tools to collect data that can be quantified. • Automating data collection and recording using computational tools.	**Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP5 Use appropriate tools strategically. • CCSS.MATH.PRACTICE.MP6 Attend to precision. **Computer Science Teachers Association** • 2-CS-02 Design projects that combine hardware and software components to collect and exchange data. (P5.1) • 2-DA-08 Collect data using computational tools and transform the data to make it more useful and reliable. (P6.3) **Next Generation Science Standards** **Planning and Carrying Out Investigations:** • Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions.
Analyzing Data Use computational tools to manipulate, organize, and reveal patterns and relationships within complex or large data sets.	• Using computational tools to manipulate complex or large data sets with data moves (Erickson et al., 2019). • Describing relationships between variables in a complex or large data set. • Drawing conclusions about the relationship between variables in a complex or large numerical data set.	**Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP4 Model with mathematics. • CCSS.MATH.PRACTICE.MP5 Use appropriate tools strategically. • CCSS.MATH.PRACTICE.MP6 Attend to precision. • CCSS.MATH.PRACTICE.MP7 Look for and make use of structure. • CCSS.MATH.PRACTICE.MP8 Look for and express regularity in repeated reasoning. **Computer Science Teachers Association** • 2-DA-08 Collect data using computational tools and transform the data to make it more useful and reliable. (P6.3) **Next Generation Science Standards** **Analyzing and Interpreting Data:** • Construct, analyze, and/or interpret graphical displays of data and/or large data sets to identify linear and nonlinear relationships. • Use graphical displays (e.g., maps, charts, graphs, and/or tables) of large data sets to identify temporal and spatial relationships. • Analyze and interpret data to provide evidence for phenomena. • Apply concepts of statistics and probability (including mean, median, mode, and variability) to analyze and characterize data, using digital tools when feasible. **Using Mathematics and Computational Thinking:** • Use digital tools (e.g., computers) to analyze very large data sets for patterns and trends. **Constructing Explanations and Designing Solutions:** • Construct an explanation that includes qualitative or quantitative relationships between variables that predict(s) and/or describe(s) phenomena.

Grades 6-8: By the end of Grade 8, what will ALL students know and be able to do?

Competency	Look Fors	Aligned Standards
Evaluating Data Identify data points that don't follow a predicted or identified pattern. Consider questions that arise based on the data set. Evaluate data for trustworthiness and potential biases.	• Identifying data points that are unexpected based on identified patterns. • Asking questions about data that is being analyzed. • Considering if/how data sources are comparable. • Identifying bias in data collection and reporting. • Questioning the origins, history, and intents of a data set and/or the people who collected it.	**C3 Framework for Social Studies State Standards** • D3.2.6-8. Evaluate the credibility of a source by determining its relevance and intended use. **Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP6 Attend to precision. **Common Core English Language Arts Anchor Standards** • CCSS.ELA-LITERACY.CCRA.SL.2 Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. **Next Generation Science Standards** **Asking Questions and Defining Problems:** • Ask questions that challenge the premise(s) of an argument or the interpretation of a data set. **Planning and Carrying Out Investigations:** • Evaluate the accuracy of various methods for collecting data. **Analyzing and Interpreting Data:** • Consider limitations of data analysis (e.g., measurement error), and/or seek to improve precision and accuracy of data with better technological tools and methods (e.g., multiple trials).

6–8 Data Science Aligned Starter Pack Lessons
Beef or Beans **(STEM: Biology)** Harness the power of data visualization to meet the world's growing needs for food. Climate Anomalies **(Humanities: Geography)** Analyze the impact of climate change through the use of GIS. History and Uses of Democracy **(Humanities: History)** Explore how democracy has evolved since ancient times and uncover insights from data derived from the UK EU referendum results. Income Gap **(Humanities: Social Studies)** Use statistical analysis to explore income inequality in a population. Investigating Wildfires **(STEM: Chemistry)** Investigate the conditions that lead to wildfires and use GIS to identify patterns in the location of wildfires in Indonesia. Mapping Foot to Food **(Humanities: Geography)** Learn how urban planners use variable constraining to reduce food deserts and improve access to farmers' markets using maps. Mining Words **(Language Arts: Language)** Explore how people leave behind a digital footprint through text mining using Python programming. Rising Seas **(Humanities: Geography)** Learn about the threat of forced migration from rising sea levels due to climate change and visualize areas at risk.

Grades 6-8: By the end of Grade 8, what will ALL students know and be able to do?

Competency	Look Fors	Aligned Standards
Communicating Data Create a data visualization with 2+ variables illustrating patterns and relationships from a data set. Describe the data to a target audience. Consider creative visualizations of data and design features for a particular audience.	• Designing a visual representation of data. • Discussing affordances and disaffordances of visualization methods. • Describing patterns in data represented by the data visualization orally or in writing. • Connecting data to real-world phenomena and concepts. • Making a data-supported claim or argument. • Selecting design features to communicate to a particular audience.	**C3 Framework for Social Studies State Standards** • D4.2.6-8. Construct explanations using reasoning, correct sequence, examples, and details with relevant information and data, while acknowledging the strengths and weaknesses of the explanations. • D4.3.6-8. Present adaptations of arguments and explanations on topics of interest to others to reach audiences and venues outside the classroom using print and oral technologies (e.g., posters, essays, letters, debates, speeches, reports, and maps) and digital technologies (e.g., Internet, social media, and digital documentary). **Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP3 Construct viable arguments and critique the reasoning of others. • CCSS.MATH.PRACTICE.MP5 Use appropriate tools strategically. • CCSS.MATH.PRACTICE.MP6 Attend to precision. • CCSS.MATH.PRACTICE.MP7 Look for and make use of structure. • CCSS.MATH.PRACTICE.MP8 Look for and express regularity in repeated reasoning. **Common Core English Language Arts Anchor Standards** • CCSS.ELA-LITERACY.CCRA.W.1 Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence. • CCSS.ELA-LITERACY.CCRA.W.2 Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content. • CCSS.ELA-LITERACY.CCRA.W.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. • CCSS.ELA-LITERACY.CCRA.SL.2 Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. • CCSS.ELA-LITERACY.CCRA.SL.4 Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience. • CCSS.ELA-LITERACY.CCRA.SL.5 Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations. **Next Generation Science Standards** **Engaging in Argument From Evidence:** • Construct, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. **Obtaining, Evaluating, and Communicating Information:** • Communicate scientific and/or technical information (e.g. about a proposed object, tool, process, system) in writing and/or through oral presentations.

Grades 6-8: By the end of Grade 8, what will ALL students know and be able to do?

Competency	Look Fors	Aligned Standards
Artificial Intelligence and Machine Learning		
Investigating Artificial Intelligence and Machine Learning Systems Experiment with AI/ML systems such as generative AI, Generative Adversarial Networks, speech to text, natural language processing programs, etc. Discuss instances where the systems perform well and where systems struggle to interact naturally. Investigate how computers perceive different types of information and identify differences between human sensing and computer perception (e.g., lack of taste, images perceived as pixels, words as sounds, touch as haptics). Investigate deep learning models such as unsupervised neural networks.	• Systematically exploring and experimenting with a variety of AI/ML systems, including deep learning models, and producing artifacts. • Asking questions about how AI/ML systems work based on experiences with them and exploring the AI/ML systems to answer those questions. • Discussing instances when systems struggle to interact naturally with humans and/or use human language incorrectly. • Discussing how computer sensing is similar to and different from human sensing. • Explaining how computers perceive and process different types of information.	**C3 Framework for Social Studies State Standards** • D4.2.6-8. Construct explanations using reasoning, correct sequence, examples, and details with relevant information and data, while acknowledging the strengths and weaknesses of the explanations. **Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP3 Construct viable arguments and critique the reasoning of others. • CCSS.MATH.PRACTICE.MP6 Attend to precision. • CCSS.MATH.PRACTICE.MP7 Look for and make use of structure. • CCSS.MATH.PRACTICE.MP8 Look for and express regularity in repeated reasoning. **Common Core English Language Arts Anchor Standards** • CCSS.ELA-LITERACY.CCRA.SL.1 Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively. • CCSS.ELA-LITERACY.CCRA.SL.2 Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. • CCSS.ELA-LITERACY.CCRA.SL.4 Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience. **Computer Science Teachers Association** • 2-DA-08 Collect data using computational tools and transform the data to make it more useful and reliable. (P6.3) **Next Generation Science Standards** **Asking Questions and Defining Problems:** • Ask questions that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information. **Planning and Carrying Out Investigations:** • Collect data about the performance of a proposed object, tool, process or system under a range of conditions. **Analyzing and Interpreting Data:** • Analyze and interpret data to provide evidence for phenomena. • Constructing Explanations and Designing Solutions • Construct an explanation that includes qualitative or quantitative relationships between variables that predict(s) and/or describe(s) phenomena. • Optimize performance of a design by prioritizing criteria, making tradeoffs, testing, revising, and re-testing. **Engaging in Argument From Evidence:** • Make an oral or written argument that supports or refutes the advertised performance of a device, process, or system based on empirical evidence concerning whether or not the technology meets relevant criteria and constraints.

Competency	Look Fors	Aligned Standards
Training Artificial Intelligence and Machine Learning Algorithms Program sensors within a computing tool to respond to an environment or activity. Develop a real-world data set that is ready to be used to train a supervised learning model. Develop a chatbot. Train an existing machine learning model using a database of images or sounds. Test the model and discuss its accuracy.	• Writing an algorithm that uses sensors to respond to an environment or activity. • Compiling and labeling a data set appropriate for training a supervised learning model. • Planning, coding, testing, and debugging a chat bot algorithm. • Inputting training data into an existing machine learning model. • Testing a student-trained model and discussing the accuracy of the model.	**Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP5 Use appropriate tools strategically. • CCSS.MATH.PRACTICE.MP6 Attend to precision. • CCSS.MATH.PRACTICE.MP7 Look for and make use of structure. • CCSS.MATH.PRACTICE.MP8 Look for and express regularity in repeated reasoning. **Computer Science Teachers Association** • 2-AP-11 Create clearly named variables that represent different data types and perform operations on their values. (P5.1, P5.2) • 2-AP-12 Design and iteratively develop programs that combine control structures, including nested loops and compound conditionals. (P5.1, P5.2) • 2-AP-13 Decompose problems and subproblems into parts to facilitate the design, implementation, and review of programs. (P3.2) • 2-AP-17 Systematically test and refine programs using a range of test cases. (P6.1) **Next Generation Science Standards** **Asking Questions and Defining Problems:** • Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. **Constructing Explanations and Designing Solutions:** • Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints. • Optimize performance of a design by prioritizing criteria, making tradeoffs, testing, revising, and re-testing.

Competency	Look Fors	Aligned Standards
Assessing and Auditing Artificial Intelligence and Machine Learning Systems Examine a labeled data set to determine if features of the data set or the selected labels could lead to bias. Evaluate impacts of AI/ML on the environment and natural world. Create a data visualization of bias in terms of gender, age, ethnicity, or other demographic categories within an existing training data set.	• Discussing if the category labels used on a data set are inclusive of all identities (e.g., gender identities, racial identities). • Analyzing a labeled data set to determine if it has a balanced representation of all categories. • Identifying missing labels or features of data that could cause bias. • Investigating and discussing the impact of AI/ML on the environment and the natural world. • Systematically collecting data about features of an existing training data, specifically representation of people across gender, age, ethnicity, and other demographic categories. • Developing a data visualization of the representation of people across gender, age, ethnicity, and other demographic categories within a training data set. • Analyzing the data visualization to identify patterns in representation or lack of representation based on gender, age, ethnicity, and other demographic categories.	**C3 Framework for Social Studies State Standards** • D2.Geo.4.6-8. Explain how cultural patterns and economic decisions influence environments and the daily lives of people in both nearby and distant places. • D3.2.6-8. Evaluate the credibility of a source by determining its relevance and intended use. • D4.2.6-8. Construct explanations using reasoning, correct sequence, examples, and details with relevant information and data, while acknowledging the strengths and weaknesses of the explanations. • D4.3.6-8. Present adaptations of arguments and explanations on topics of interest to others to reach audiences and venues outside the classroom using print and oral technologies (e.g., posters, essays, letters, debates, speeches, reports, and maps) and digital technologies (e.g., Internet, social media, and digital documentary). **Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP3 Construct viable arguments and critique the reasoning of others. • CCSS.MATH.PRACTICE.MP5 Use appropriate tools strategically. • CCSS.MATH.PRACTICE.MP6 Attend to precision. • CCSS.MATH.PRACTICE.MP7 Look for and make use of structure. • CCSS.MATH.PRACTICE.MP8 Look for and express regularity in repeated reasoning. **Common Core English Language Arts Anchor Standards** • CCSS.ELA-LITERACY.CCRA.SL.1 Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively. • CCSS.ELA-LITERACY.CCRA.SL.2 Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. • CCSS.ELA-LITERACY.CCRA.SL.4 Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience. • CCSS.ELA-LITERACY.CCRA.SL.5 Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations. **Computer Science Teachers Association** • 2-CS-01 Recommend improvements to the design of computing devices, based on an analysis of how users interact with the devices. (P3.3) • 2-DA-08 Collect data using computational tools and transform the data to make it more useful and reliable. (P6.3) • 2-IC-21 Discuss issues of bias and accessibility in the design of existing technologies. (P1.2) **Next Generation Science Standards** Planning and Carrying Out Investigations: • Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions. Analyzing and Interpreting Data: • Construct, analyze, and/or interpret graphical displays of data and/or large data sets to identify linear and nonlinear relationships. • Analyze and interpret data to provide evidence for phenomena. • Analyze data to define an optimal operational range for a proposed object, tool, process or system that best meets criteria for success. Engaging in Argument From Evidence: • Make an oral or written argument that supports or refutes the advertised performance of a device, process, or system based on empirical evidence concerning whether or not the technology meets relevant criteria and constraints.

6–8 Artificial Intelligence and Machine Learning Aligned Starter Pack Lessons
Coding Macbeth **(Language Arts: Language)** Create a chatbot which is able to respond in the way Lady Macbeth does. Eyes on Wildlife **(STEM: BIology)** Learners will create a motion detection algorithm using their webcam and learn how it can be applied to wildlife conservation. Robot Conversations **(Language Arts: Language)** Create a chatbot capable of identifying simple, complex, and compound sentences. Robotic Simulation **(STEM: Physics)** Explore how robotic simulations can be designed in virtual environments to reduce the cost of prototyping. Time to Log Out **(Humanities: Social Studies)** Combat cyberaddiction by developing a program that can measure how long someone spends in front of a computer.

Competency	Look Fors	Aligned Standards
Simulation and Modeling		
Exploring Phenomena Using Models Manipulate a computational model to set up multiple and different scenarios to answer a driving question. Identify mathematical relationships between parts of a computational model.	• Identifying a question to explore using a computational model. • Setting up multiple different scenarios to collect data from a computational model. • Using data collected from a computational model to support a claim about a real-world system. • Identifying mathematical relationships between parts of a computational model and making predictions about how the model will behave with different inputs.	**C3 Framework for Social Studies State Standards** • D4.2.9-12. Construct explanations using sound reasoning, correct sequence (linear or non-linear), examples, and details with significant and pertinent information and data, while acknowledging the strengths and weaknesses of the explanation given its purpose (e.g., cause and effect, chronological, procedural, technical). **Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP3 Construct viable arguments and critique the reasoning of others. • CCSS.MATH.PRACTICE.MP4 Model with mathematics. • CCSS.MATH.PRACTICE.MP7 Look for and make use of structure. • CCSS.MATH.PRACTICE.MP8 Look for and express regularity in repeated reasoning. **Common Core English Language Arts Anchor Standards** • CCSS.ELA-LITERACY.CCRA.R.7 Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words. • CCSS.ELA-LITERACY.CCRA.W.1 Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence. • CCSS.ELA-LITERACY.CCRA.SL.2 Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. **Computer Science Teachers Association** • 3A-AP-17 Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects. (P3.2) **Next Generation Science Standards** **Asking Questions and Defining Problems:** • Ask questions that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information. • Ask questions to determine relationships, including quantitative relationships, between independent and dependent variables. **Developing and Using Models:** • Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. • Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations. • Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems. **Using Mathematics and Computational Thinking:** • Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations. **Constructing Explanations and Designing Solutions:** • Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables. • Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. *Continued on next page*

Competency	Look Fors	Aligned Standards
		Engaging in Argument From Evidence: • Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence. • Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations. • Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems. **Using Mathematics and Computational Thinking:** • Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations. **Constructing Explanations and Designing Solutions:** • Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables. • Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. **Engaging in Argument From Evidence:** • Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence.
Creating Computational Models Develop or modify a computational model based on mathematical relationships between key components of a real-world system.	• Representing relationships between smaller parts of a real-world system in a computational model. • Identifying different parts of a real-world system that a computational model is representing. • Defining relationships between different parts of a real-world system. • Automating relationships between parts of a real-world system with a flowchart or programming/modeling software.	**Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP3 Construct viable arguments and critique the reasoning of others. • CCSS.MATH.PRACTICE.MP4 Model with mathematics. • CCSS.MATH.PRACTICE.MP5 Use appropriate tools strategically. • CCSS.MATH.PRACTICE.MP6 Attend to precision. **Common Core English Language Arts Anchor Standards** • CCSS.ELA-LITERACY.CCRA.SL.5 Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations. **Computer Science Teachers Association** • 3A-DA-12 Create computational models that represent the relationships among different elements of data collected from a phenomenon or process. (P4.4) • 3A-AP-13 Create prototypes that use algorithms to solve computational problems by leveraging prior student knowledge and personal interests. (P5.2) • 3A-AP-16 Design and iteratively develop computational artifacts for practical intent, personal expression, or to address a societal issue by using events to initiate instructions. (P5.2) • 3A-AP-17 Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects. (P3.2) **Next Generation Science Standards** **Developing and Using Models:** • Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. • Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations. • Develop a complex model that allows for manipulation and testing of a proposed process or system. **Using Mathematics and Computational Thinking:** • Create and/or revise a computational model or simulation of a phenomenon, designed device, process, or system.

Competency	Look Fors	Aligned Standards
Creating 3D Models Develop or modify a 3D model based on spatial relationships between key components of a real-world system, object, or location.	• Defining different parts of a real-world system, object, or location. • Representing relationships between smaller parts of a real-world system, object, or location in a digital 3D model. • Identifying different parts of a real-world system, object, or location that a 3D model is representing. • Creating an accurate representation of a real-world system, object, or location using appropriate scaling and dimensions.	**Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP3 Construct viable arguments and critique the reasoning of others. • CCSS.MATH.PRACTICE.MP4 Model with mathematics. • CCSS.MATH.PRACTICE.MP5 Use appropriate tools strategically. • CCSS.MATH.PRACTICE.MP6 Attend to precision. **Common Core English Language Arts Anchor Standards** • CCSS.ELA-LITERACY.CCRA.SL.5 Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations. **Computer Science Teachers Association** • 3A-AP-17 Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects. (P3.2) **Next Generation Science Standards** **Developing and Using Models:** • Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations. • Develop a complex model that allows for manipulation and testing of a proposed process or system.

Competency	Look Fors	Aligned Standards
Assessing Models Compare a computational model that is used or developed to the real-world system it represents to notice: similarities and differences, explicit decisions made about what is included and excluded in the model and other choices made by the creator, and areas where creator bias could affect the model.	• Testing and debugging a computational model. • Considering how a computational model represents a real-world system. • Identifying similarities and differences between a computational model and the real-world system it represents. • Identifying creator decisions made when developing a computational model (e.g., what is included and excluded). • Considering bias in the outputs of a computational model.	**C3 Framework for Social Studies State Standards** • D4.4.9-12. Critique the use of claims and evidence in arguments for credibility. **Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP3 Construct viable arguments and critique the reasoning of others. • CCSS.MATH.PRACTICE.MP6 Attend to precision. **Common Core English Language Arts Anchor Standards** • CCSS.ELA-LITERACY.CCRA.R.7 Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words. • CCSS.ELA-LITERACY.CCRA.SL.2 Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. **Computer Science Teachers Association** • 3A-AP-21 Evaluate and refine computational artifacts to make them more usable and accessible. (P6.3) • 3A-IC-25 Test and refine computational artifacts to reduce bias and equity deficits. (P1.2) **Next Generation Science Standards** **Asking Questions and Defining Problems:** • Ask questions to clarify and/or refine a model, an explanation, or an engineering problem. **Developing and Using Models:** • Design a test of a model to ascertain its reliability. **Planning and Carrying Out Investigations:** • Plan an investigation or test a design individually and collaboratively to produce data to serve as the basis for evidence as part of building and revising models, supporting explanations for phenomena, or testing solutions to problems. Consider possible confounding variables or effects and evaluate the investigation's design to ensure variables are controlled. **Using Mathematics and Computational Thinking:** • Use simple limit cases to test mathematical expressions, computer programs, algorithms, or simulations of a process or system to see if a model "makes sense" by comparing the outcomes with what is known about the real world.

9–12 Simulation and Modeling Aligned Starter Pack Lessons
Architecture of Wind **(STEM: Physics)** Learn how architects test to see if the tall buildings they are designing will be able to withstand strong winds. Da Vinci Bridge **(STEM: Physics)** Reconstruct the historical Da Vinci bridge without nails or ropes using laser cutting. Fire Simulator **(STEM: Chemistry)** Generate fire particle simulations using 3D modeling software. Anatomy of Safety **(Humanities: Social Studies)** Learn how to use 3D game engines to discover potential danger zones or fall areas for senior citizens. Saucy Viscosity **(STEM: Chemistry)** Experience the process of generating water simulations through the use of 3D modeling software. Gears in Motion **(STEM: Physics)** Learn about how gears, as a form of rotary machine mechanics, provide mechanical advantages. Static Stress Testing **(STEM: Physics)** Learn how to stress test models in simulations and identify the weak points of various models.

Competency	Look Fors	Aligned Standards
Programming and Coding		
Defining Procedures as Algorithms Develop an algorithm that decomposes a complex problem, process, or task into smaller parts and uses precise statements. Develop an algorithm that uses conditional logic to produce different outputs. Develop multiple algorithms that process in parallel. Identify the most efficient procedure to solve a problem/complete a task.	• Decomposing a complex problem or task. • Identifying essential steps to solve a complex problem or complete a complex task. • Refining language within steps to be precise. • Using conditional logic to produce different outputs of an algorithm. • Writing multiple algorithms that produce intended outcomes when run in parallel. • Considering efficiency when writing an algorithm.	**Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP6 Attend to precision. **Computer Science Teachers Association** • 3A-AP-17 Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects. (P3.2)
Programming Use a block-based programming language to automate a procedure that solves a problem/completes a task. Use a text-based programming language to automate a procedure that solves a problem/completes a task.	• Planning code with physical or written tools (e.g., graphic organizers, sequenced cards/manipulatives, flowcharts). • Writing an algorithm in a block-based or text language understandable by a computer. • Creating a procedure for a computer to carry out.	**Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP5 Use appropriate tools strategically. • CCSS.MATH.PRACTICE.MP6 Attend to precision. **Computer Science Teachers Association** • 3A-AP-13 Create prototypes that use algorithms to solve computational problems by leveraging prior student knowledge and personal interests. (P5.2) • 3A-AP-16 Design and iteratively develop computational artifacts for practical intent, personal expression, or to address a societal issue by using events to initiate instructions. (P5.2) • 3A-AP-17 Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects. (P3.2) • 3A-AP-18 Create artifacts by using procedures within a program, combinations of data and procedures, or independent but interrelated programs. (P5.2) **Next Generation Science Standards** **Asking Questions and Defining Problems:** • Define a design problem that involves the development of a process or system with interacting components and criteria and constraints that may include social, technical, and/or environmental considerations. **Using Mathematics and Computational Thinking:** • Use simple limit cases to test mathematical expressions, computer programs, algorithms, or simulations of a process or system to see if a model "makes sense" by comparing the outcomes with what is known about the real world. **Constructing Explanations and Designing Solutions:** • Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

Competency	Look Fors	Aligned Standards
Testing and Debugging Strategically choose methods (e.g., using intermediate results, reproduce errors) to find and fix errors in a purposeful order (e.g., the order they are reported by a compiler) to get expected results.	• Discussing how an outcome is similar or different than intended. • Purposefully and strategically selecting the most effective methods to fix errors. • Fixing errors in a logical and purposeful order.	**Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP6 Attend to precision. **Computer Science Teachers Association** • 3A-AP-21 Evaluate and refine computational artifacts to make them more usable and accessible. (P6.3)

9–12 Programming and Coding Aligned Starter Pack Lessons

Benford's Law **(STEM: Mathematics)**
Create a computational experiment using the Monte Carlo Method and Markov Chain to solve complex problems.

Big O Notation **(STEM: Mathematics)**
Learn about Big O Notation and how it is used in coding to explain the complexity of an algorithm.

Diversity of Flowers **(STEM: Biology)**
Investigate how diversity enables flowers to adapt to their environment and create a machine learning model to classify irises.

Microcontroller Robot **(STEM: Physics)**
Learn the basics of robotics and create a functional self-initiated floor cleaner robot.

Competency	Look Fors	Aligned Standards
Data Science		
Collecting Data Collect data that can be automated and recorded through computational tools (e.g. probes, sensor).	• Using computational tools to collect data that can be quantified. • Automating data collection and recording using computational tools.	**Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP5 Use appropriate tools strategically. • CCSS.MATH.PRACTICE.MP6 Attend to precision. **Computer Science Teachers Association** • 3A-AP-16 Design and iteratively develop computational artifacts for practical intent, personal expression, or to address a societal issue by using events to initiate instructions. (P5.2) **Next Generation Science Standards** **Planning and Carrying Out Investigations:** • Select appropriate tools to collect, record, analyze, and evaluate data.
Analyzing Data Use computational tools to manipulate, organize, and reveal patterns and relationships within complex or large data sets. Develop a rule or formula to describe how one variable is related to another or make predictions.	• Using computational tools to manipulate complex or large data sets with data moves (Erickson et al., 2019). • Describing relationships between variables in a complex or large data set. • Drawing conclusions about the relationship between variables in a complex or large numerical data set. • Developing a rule or formula describing how one variable is related to another. • Using data to make predictions.	**Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP4 Model with mathematics. • CCSS.MATH.PRACTICE.MP5 Use appropriate tools strategically. • CCSS.MATH.PRACTICE.MP6 Attend to precision. • CCSS.MATH.PRACTICE.MP7 Look for and make use of structure. • CCSS.MATH.PRACTICE.MP8 Look for and express regularity in repeated reasoning. **Next Generation Science Standards** **Planning and Carrying Out Investigations:** • Select appropriate tools to collect, record, analyze, and evaluate data. **Analyzing and Interpreting Data:** • Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. • Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. **Using Mathematics and Computational Thinking:** • Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.

Competency	Look Fors	Aligned Standards
Evaluating Data Identify data points that don't follow a predicted or identified pattern. Consider questions that arise based on the data set. Evaluate data for trustworthiness and potential biases.	• Identifying data points that are unexpected based on identified patterns. • Asking questions about data that is being analyzed. • Considering if/how data sources are comparable. • Identifying bias in data collection and reporting. • Questioning the origins, history, and intents of a data set and/or the people who collected it.	**Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP6 Attend to precision. **Common Core English Language Arts Anchor Standards** • CCSS.ELA-LITERACY.CCRA.SL.2 Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. **Next Generation Science Standards** **Asking Questions and Defining Problems:** • Ask and/or evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design. **Planning and Carrying Out Investigations:** • Select appropriate tools to collect, record, analyze, and evaluate data. **Analyzing and Interpreting Data:** • Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data.

9–12 Data Science Aligned Starter Pack Lessons

Benford's Law **(STEM: Mathematics)**
Create a computational experiment using the Monte Carlo Method and Markov Chain to solve complex problems.

Causes of Genocides **(Humanities: History)**
Investigate the causes of genocides through data wrangling to prepare data for trend and correlation analysis.

Clean Water **(Humanities: Geography)**
Investigate the relationship between a lack of access to good sanitation and child mortality using Gapminder.

Happy Countries **(Humanities: Economics)**
Investigate the factors behind a country's happiness rating through statistical analysis.

Healthy Diet for All **(STEM: Biology)**
Explore the impact of malnutrition and perform statistical analysis to understand and address the problem of malnutrition in a community.

Internet of Weather **(Geography)**
Create a weather detector using a microcontroller to perform advanced weather analysis.

Language of Populism **(Language Arts: Language)**
Learn about features of language used by populist politicians and analyze word length in political speeches.

Mathematics of Pandemics **(STEM: Mathematics)**
Experience how data modeling helps researchers better understand virus behavior and the spread of a pandemic.

Pollution: Costs & Causes **(Humanities: Economics)**
Examine the effects of pollution on a community using pattern recognition through GIS.

Safe Transit **(Humanities: Geography)**
Investigate and analyze road safety in cities using scatter plots and correlation coefficients.

Storyboarding with Data **(Language Arts: Language)**
Build a storyboard using data to convey a point of view in an argumentative essay.

Urbanization **(Humanities: Social Studies)**
Investigate the impact of urbanization and present findings in an interactive 3D space.

Competency	Look Fors	Aligned Standards
Communicating Data Create a data visualization with 2+ variables illustrating patterns and relationships from a data set. Describe the data to a target audience. Consider creative visualizations of data and design features for a particular audience.	• Designing a visual representation of data. • Discussing affordances and disaffordances of visualization methods. • Describing patterns in data represented by the data visualization orally or in writing. • Connecting data to real-world phenomena and concepts. • Making a data-supported claim or argument. • Selecting design features to communicate to a particular audience.	**C3 Framework for Social Studies State Standards** • D4.2.9-12. Construct explanations using sound reasoning, correct sequence (linear or non-linear), examples, and details with significant and pertinent information and data, while acknowledging the strengths and weaknesses of the explanation given its purpose (e.g., cause and effect, chronological, procedural, technical). • D4.3.9-12. Present adaptations of arguments and explanations that feature evocative ideas and perspectives on issues and topics to reach a range of audiences and venues outside the classroom using print and oral technologies (e.g., posters, essays, letters, debates, speeches, reports, and maps) and digital technologies (e.g., Internet, social media, and digital documentary). **Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP3 Construct viable arguments and critique the reasoning of others. • CCSS.MATH.PRACTICE.MP5 Use appropriate tools strategically. • CCSS.MATH.PRACTICE.MP6 Attend to precision. • CCSS.MATH.PRACTICE.MP7 Look for and make use of structure. • CCSS.MATH.PRACTICE.MP8 Look for and express regularity in repeated reasoning. **Common Core English Language Arts Anchor Standards** • CCSS.ELA-LITERACY.CCRA.W.1 Write arguments to support claims in an analysis of substantive topics or texts using valid reasoning and relevant and sufficient evidence. • CCSS.ELA-LITERACY.CCRA.W.2 Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content. • CCSS.ELA-LITERACY.CCRA.W.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. • CCSS.ELA-LITERACY.CCRA.SL.2 Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. • CCSS.ELA-LITERACY.CCRA.SL.4 Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience. • CCSS.ELA-LITERACY.CCRA.SL.5 Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations. **Computer Science Teachers Association** • 3A-DA-11 Create interactive data visualizations using software tools to help others better understand real-world phenomena. (P4.4) **Next Generation Science Standards** **Obtaining, Evaluating, and Communicating Information:** • Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).

Competency	Look Fors	Aligned Standards
Artificial Intelligence and Machine Learning		
Investigating Artificial Intelligence and Machine Learning Systems Experiment with AI/ML systems such as generative AI, Generative Adversarial Networks, speech to text, natural language processing programs, etc. Discuss instances where the systems perform well and where systems struggle to interact naturally. Explain how perception is integrated into algorithms and used in everyday life, and discuss equity issues that arise with the use of sensors that work differently on different people. Investigate deep learning models such as unsupervised neural networks.	• Systematically exploring and experimenting with a variety of AI/ML systems, including deep learning models, and producing artifacts. • Asking questions about how AI/ML systems work based on experiences with them and exploring the AI/ML systems to answer those questions. • Identifying instances when systems struggle to interact naturally with humans and/or use human language incorrectly, and offering suggested improvements to support natural interaction. • Identifying instances where perception is integrated into algorithms used in everyday life. • Discussing equity issues that arise when sensors that work differently on different people are used within algorithms used in everyday life.	**C3 Framework for Social Studies State Standards** • D4.2.9-12. Construct explanations using sound reasoning, correct sequence (linear or non-linear), examples, and details with significant and pertinent information and data, while acknowledging the strengths and weaknesses of the explanation given its purpose (e.g., cause and effect, chronological, procedural, technical). **Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP3 Construct viable arguments and critique the reasoning of others. • CCSS.MATH.PRACTICE.MP6 Attend to precision. • CCSS.MATH.PRACTICE.MP7 Look for and make use of structure. • CCSS.MATH.PRACTICE.MP8 Look for and express regularity in repeated reasoning. **Common Core English Language Arts Anchor Standards** • CCSS.ELA-LITERACY.CCRA.SL.1 Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively. • CCSS.ELA-LITERACY.CCRA.SL.2 Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. • CCSS.ELA-LITERACY.CCRA.SL.4 Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience. **Computer Science Teachers Association** • 3A-AP-21 Evaluate and refine computational artifacts to make them more usable and accessible. (P6.3) • 3A-IC-24 Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices. (P1.2) **Next Generation Science Standards** **Asking Questions and Defining Problems:** • Ask questions that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information. • Ask questions to clarify and/or refine a model, an explanation, or an engineering problem. **Planning and Carrying Out Investigations:** • Plan an investigation or test a design individually and collaboratively to produce data to serve as the basis for evidence as part of building and revising models, supporting explanations for phenomena, or testing solutions to problems. Consider possible confounding variables or effects and evaluate the investigation's design to ensure variables are controlled. **Engaging in Argument From Evidence:** • Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence. • Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge and student-generated evidence.

Competency	Look Fors	Aligned Standards
Training Artificial Intelligence and Machine Learning Algorithms Program sensors within a computing tool to respond to an environment or activity. Develop a real-world data set that is ready to be used to train a supervised learning model. Develop a chatbot. Train an existing machine learning model using a database of images or sounds. Test the model and discuss its accuracy.	• Writing an algorithm that uses sensors to respond to an environment or activity. • Compiling and labeling a data set appropriate for training a supervised learning model. • Planning, coding, testing, and debugging a chatbot algorithm. • Inputting training data into an existing machine learning classification model. • Testing a student-trained model and discussing the accuracy of the model.	**Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP5 Use appropriate tools strategically. • CCSS.MATH.PRACTICE.MP6 Attend to precision. • CCSS.MATH.PRACTICE.MP7 Look for and make use of structure. • CCSS.MATH.PRACTICE.MP8 Look for and express regularity in repeated reasoning. **Computer Science Teachers Association** • 3A-AP-13 Create prototypes that use algorithms to solve computational problems by leveraging prior student knowledge and personal interests. (P5.2) • 3A-AP-16 Design and iteratively develop computational artifacts for practical intent, personal expression, or to address a societal issue by using events to initiate instructions. (P5.2) • 3A-AP-17 Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects. (P3.2) • 3A-AP-18 Create artifacts by using procedures within a program, combinations of data and procedures, or independent but interrelated programs. (P5.2) **Next Generation Science Standards** **Asking Questions and Defining Problems:** • Define a design problem that involves the development of a process or system with interacting components and criteria and constraints that may include social, technical, and/or environmental considerations. **Constructing Explanations and Designing Solutions:** • Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

Competency	Look Fors	Aligned Standards
Assessing and Auditing Artificial Intelligence and Machine Learning Systems Evaluate and audit an existing AI/ML system to determine what biases exist within the system and offer potential strategies to create a more equitable AI/ML system. Evaluate impacts of AI/ML on the environment and natural world. Create a data visualization of bias in terms of gender, age, ethnicity, or other demographic categories within an existing training data set. Identify when different types of AI and Machine Learning (e.g., supervised, unsupervised, reinforced learning) are the most appropriate option to perform a task or solve a problem.	• Systematically experimenting with an existing AI/ML system to collect data about how well the system works when presented with a testing data set diverse across gender, age, ethnicity, and other demographic categories. • Analyzing data from an existing AI/ML system to determine whether the system works equitably across genders, ages, ethnicities, and other demographic categories. • Brainstorming strategies to update and improve an existing, inequitable AI/ML system to work equitably across gender, age, ethnicity, and other demographic categories. • Investigating and discussing the impact of AI/ML on the environment and the natural world. • Systematically collecting data about features of an existing training data set, specifically representation of people across gender, age, ethnicity, and other demographic categories. • Developing a data visualization of the representation of people across gender, age, ethnicity, and other demographic categories within a training data set.	**C3 Framework for Social Studies State Standards** • D2.Geo.5.9-12. Evaluate how political and economicdecisions throughout time have influenced cultural and environmental characteristics of various places and regions. • D2.Geo.6.9-12. Evaluate the impact of human settlement activities on the environmental and cultural characteristics of specific places and regions. • D4.2.9-12. Construct explanations using sound reasoning, correct sequence (linear or non-linear), examples, and details with significant and pertinent information and data, while acknowledging the strengths and weaknesses of the explanation given its purpose (e.g., cause and effect, chronological, procedural, technical). • D4.3.9-12. Present adaptations of arguments and expla-nations that feature evocative ideas and perspectives on issues and topics to reach a range of audiences and venues outside the classroom using print and oral technologies (e.g., posters, essays, letters, debates, speeches, reports, and maps) and digital technologies (e.g., Internet, social media, and digital documentary). **Common Core Standards for Mathematical Practice** • CCSS.MATH.PRACTICE.MP1 Make sense of problems and persevere in solving them. • CCSS.MATH.PRACTICE.MP2 Reason abstractly and quantitatively. • CCSS.MATH.PRACTICE.MP3 Construct viable arguments and critique the reasoning of others. • CCSS.MATH.PRACTICE.MP5 Use appropriate tools strategically. • CCSS.MATH.PRACTICE.MP6 Attend to precision. • CCSS.MATH.PRACTICE.MP7 Look for and make use of structure. • CCSS.MATH.PRACTICE.MP8 Look for and express regularity in repeated reasoning. **Common Core English Language Arts Anchor Standards** • CCSS.ELA-LITERACY.CCRA.SL.1 Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively. • CCSS.ELA-LITERACY.CCRA.SL.2 Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. • CCSS.ELA-LITERACY.CCRA.SL.4 Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience. • CCSS.ELA-LITERACY.CCRA.SL.5 Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations. **Computer Science Teachers Association** • 3A-DA-11 Create interactive data visualizations using software tools to help others better understand real-world phenomena. (P4.4) • 3A-AP-21 Evaluate and refine computational artifacts to make them more usable and accessible. (P6.3) • 3A-IC-24 Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices. (P1.2) • 3A-IC-25 Test and refine computational artifacts to reduce bias and equity deficits. (P1.2) **Next Generation Science Standards** **Asking Questions and Defining Problems:** • Ask questions that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information. • Ask questions to clarify and/or refine a model, an explanation, or an engineering problem. *Continued on next page*

Competency	Look Fors	Aligned Standards
	• Analyzing the data visualization to identify patterns in representation or lack of representation based on gender, age, ethnicity, and other demographic categories. • Discussing examples of when different types of AI/ML (e.g., supervised, unsupervised, reinforced learning) are the most appropriate option to perform a task or solve a problem.	**Engaging in Argument From Evidence:** • Construct, use, and/or present an oral and written argument or counter-arguments based on data and evidence. • Make and defend a claim based on evidence about the natural world or the effectiveness of a design solution that reflects scientific knowledge and student-generated evidence. **Obtaining, Evaluating, and Communicating Information:** • Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).

9–12 Artificial Intelligence and Machine Learning Aligned Starter Pack Lessons

AI Role Playing (Language Arts: Language)
Experience game-based learning in creative writing using an AI Dungeon to simulate text adventures.

As a Matter of Fake (Humanities: History)
Learn how to differentiate fake news or deliberate online falsehoods by analyzing texts using natural language processing.

Diversity of Flowers (STEM: Biology)
Investigate how diversity enables flowers to adapt to their environment and create a machine learning model to classify irises.

Envisioning Safer Cities (Humanities: Geography)
Discover how planners and policymakers can make cities safer through the use of computer vision.

Figuratively Speaking (Language Arts: Language)
Identify and analyze figurative language in prose and apply story writing skills using AI Dungeon.

Microcontroller Robot (STEM: Physics)
Learn the basics of robotics and create a functional self-initiated floor cleaner robot.

Plastic, Plastic, Everywhere (Humanities, Geography)
Delve deeper into the problem of microplastics and how computer vision can help in creating solutions.

Pathos, Logos, and Ethos (Language Arts: Language)
Analyze persuasion techniques used in advertising and create a chatbot that is able to identify instances of pathos, logos, and ethos.

Sensing Motion (STEM: Mathematics)
Learn how computer vision can be used to emulate how a human being perceives motion of an everyday object.

Uncovering Cyberbullying (Language Arts: Language)
Analyze words using natural language processing to gain insights into cyberbullying.

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