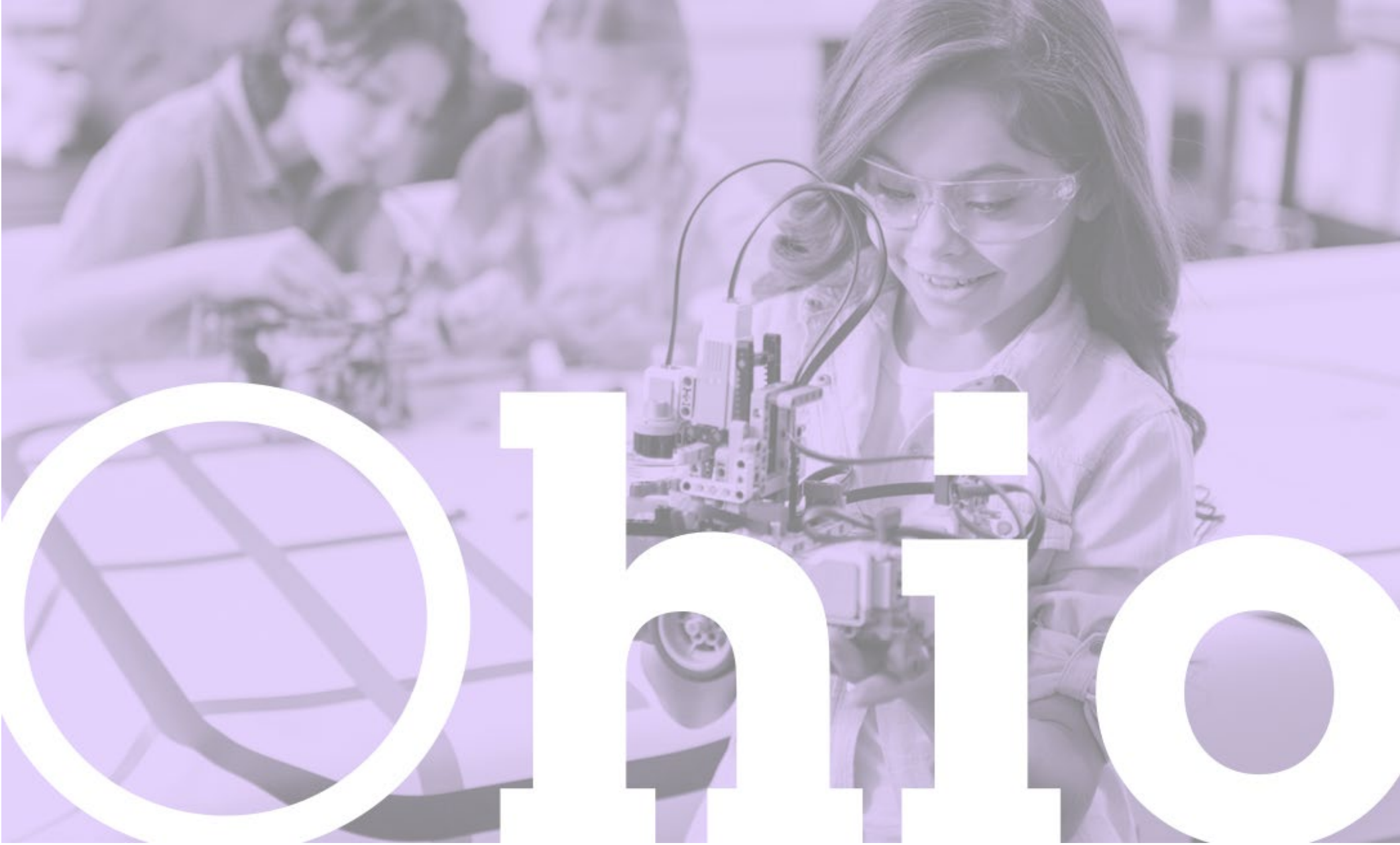

Ohio's Model Curriculum

Technology Grades 9-12

ADOPTED JULY 2022

Ohio | Department of Education

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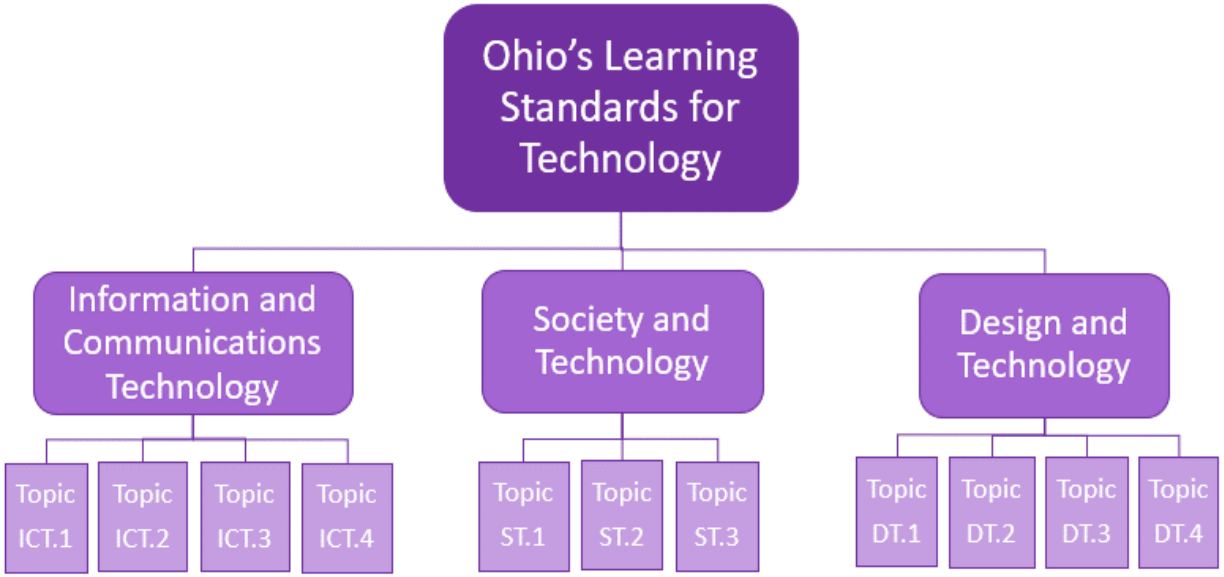
Organization of Ohio's Model Curriculum for Technology

The organization of Ohio's Model Curriculum for Technology follows the same format as Ohio's Learning Standards for Technology. The Technology Learning Standards and Model Curriculum consist of strands, topics and content statements. Both are organized by grade bands so students at the end of each grade band have acquired the knowledge and skills outlined.

Strands are overarching categories and provide three lenses through which kindergarten through grade 12 students consider and engage with technology.

Topics organize and focus the instruction. Each strand is broken into several topics. *Topic statements remain consistent from kindergarten through grade 12*.

Content Statements further refine the topic statements to define what students should know and be able to do at each grade band. Content statements are organized *by K-2, 3-5, 6-8 and 9-12 grade bands*.



STRAND AND TOPIC DESCRIPTIONS

Below, are the strand and topic statements for kindergarten through grade 12:

Information and Communications Technology

The understanding and application of digital learning tools for accessing, creating, evaluating, applying and communicating ideas and information.

Topic 1: Identify and use appropriate digital learning tools and resources to accomplish a defined task.

Topic 2: Use digital learning tools and resources to locate, evaluate and use information.

Topic 3: Use digital learning tools and resources to construct knowledge.

Topic 4: Use digital learning tools and resources to communicate and disseminate information to multiple audiences.

Society and Technology

The interconnectedness of technology, self, society and the natural world, specifically addressing the ethical, legal, political and global impact of technology.

Topic 1: Demonstrate an understanding of technology's impact on the advancement of humanity – economically, environmentally and ethically.

Topic 2: Analyze the impact of communication and collaboration in both digital and physical environments.

Topic 3: Explain how technology, society and the individual impact one another.

Design and Technology

Addresses the nature of technology to develop and improve products and systems over time to meet human/societal needs and wants through design processes.

Topic 1: Define and describe technology, including its core concepts of systems, resources, requirements, processes, controls, optimization and trade-offs.

Topic 2: Identify a problem and use an engineering design process to solve the problem.

Topic 3: Demonstrate that solutions to complex problems require collaboration, interdisciplinary understanding and systems thinking.

Topic 4: Evaluate designs using functional, aesthetic and creative elements.

CONTENT STATEMENTS

Below, is an example of a content statement for grade band 6-8 with its corresponding content statement code. This content statement addresses Topic 2 within the Society and Technology (ST) Strand.

SOCIETY AND TECHNOLOGY

Topic 2: Analyze the impact of communication and collaboration in both digital and physical environments.

6-8.ST.2.a. Critique specific instances of how technology has impacted access to information, communications and collaboration.

The example below breaks down the content statement code into its components.

NOTE: The topic statement numbers and content statement letters do not dictate curriculum or teaching methods. For example, while Topic 1 appears before Topic 2 in the standards for a given grade band, teachers do not need to teach Topic 1 before Topic 2. A teacher might prefer to teach Topic 2 before Topic 1 or to highlight connections by teaching Topic 1 and Topic 2 at the same time.

The lowercase letters for content statements do not indicate a preferred order. They do not identify relationships between content statements across grade bands. They are included to facilitate discussions, planning and implementation of the standards.

Ohio's Model Curriculum & Instructional Supports for Technology

OVERVIEW OF THE MODEL CURRICULUM COMPONENTS

The model curriculum contains two sections: **Expectations for Learning** and **Content Elaborations.**

Expectations for Learning

LEARNING PROGRESSION

Explains the position of the content statement within its respective learning progression, including previous and future learning

IMPORTANT CONCEPTS

Identifies important concepts students should develop

KEY SKILLS/PROCEDURES

Identifies key skills and procedures students should know and demonstrate

The information above clarifies the expectations for student learning and guides teachers in developing lessons and assessments, both formative and summative.

Content Elaborations

CLARIFICATIONS

Provides clarification of the content

CONTENT FOCUS

Identifies the aspects of the content that teachers should stress with their students

OVERVIEW OF THE INSTRUCTIONAL SUPPORTS

Instructional supports will offer instructional strategies and resources that target specific content statements. The Department will add instructional supports as they are identified and developed, after careful vetting and review.

These supports will include descriptive examples of instructional strategies. Supports will also identify connections to other content statements in technology, across content areas and to careers to help teachers plan instruction and incorporate technology content into their curricula. Other supports woven throughout will include descriptions of common misconceptions and ways to structure technology experiences that are equitable and accessible to all students.

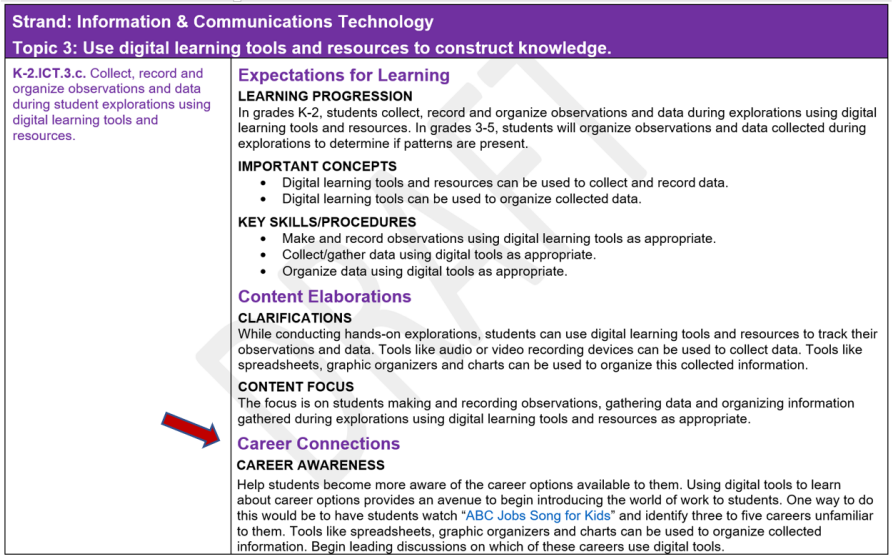
Ohio's Model Curriculum for Technology: Career Connections

It is important for students to understand how the knowledge and skills they acquire in school apply to their ultimate career and life goals. Ohio's Model Curriculum for Technology provides examples of Career Connections. These Career Connections are a starting point for teachers to begin drawing connections to careers for students. The Instructional Supports mentioned earlier will continue this work and address Career Connections more fully.

When developing Career Connections, schools and districts may consider using the Career Connections Framework. The framework is a planning tool districts and schools can use to provide students with opportunities to develop a vision and realistic plans for their future. It aligns the many efforts around college and career readiness to support students in becoming productive and engaged citizens. While many of the career connections throughout this model curriculum are designed to help students become aware, explore and plan for specific careers, it is understood that students often will change career pathways of interest over time.

Throughout Ohio's Learning Standards and Model Curriculum for Technology, many of the skills students are beginning to learn and refine can be associated with work environments. *Career Connections in this model curriculum are organized by the Technology Standards Strands, providing one example per grade band for each strand.* In this way, teachers can see how these connections relate to key technological knowledge and skills in each strand and progress by grade band. The Career Connections lend themselves to interdisciplinary connections and students explore careers that go well beyond those involving information technology. Again, these are a suggested starting point for educators and can be modified or expanded.

Career Connections are located in a separate section within those model curriculum entries that contain them.



Strand: Information & Communications Technology
Topic 3: Use digital learning tools and resources to construct knowledge.

K-2.ICT.3.c. Collect, record and organize observations and data during student explorations using digital learning tools and resources.

Expectations for Learning

LEARNING PROGRESSION
In grades K-2, students collect, record and organize observations and data during explorations using digital learning tools and resources. In grades 3-5, students will organize observations and data collected during explorations to determine if patterns are present.

IMPORTANT CONCEPTS
- Digital learning tools and resources can be used to collect and record data.
- Digital learning tools can be used to organize collected data.

KEY SKILLS/PROCEDURES
- Make and record observations using digital learning tools as appropriate.
- Collect/gather data using digital tools as appropriate.
- Organize data using digital tools as appropriate.

Content Elaborations

CLARIFICATIONS
While conducting hands-on explorations, students can use digital learning tools and resources to track their observations and data. Tools like audio or video recording devices can be used to collect data. Tools like spreadsheets, graphic organizers and charts can be used to organize this collected information.

CONTENT FOCUS
The focus is on students making and recording observations, gathering data and organizing information gathered during explorations using digital learning tools and resources as appropriate.

Career Connections

CAREER AWARENESS
Help students become more aware of the career options available to them. Using digital tools to learn about career options provides an avenue to begin introducing the world of work to students. One way to do this would be to have students watch "ABC Jobs Song for Kids" and identify three to five careers unfamiliar to them. Tools like spreadsheets, graphic organizers and charts can be used to organize collected information. Begin leading discussions on which of these careers use digital tools.

CAREER CONNECTIONS ACROSS K-12

Career Awareness - Elementary Grades (K-5)

Students become familiar with careers through learning that connects classroom instruction to future work. Career awareness strategies show students various types of careers and stimulate interest in future work.

Technology Model Curriculum Example: Giving elementary students opportunities to learn about work environments and discover unique career opportunities associated with the technology skills they are learning will aid in stimulating student interest in future work. Discussing careers that use digital tools can be an effective way to tie technology to career awareness.

> (3-5.ICT.3.c.) Engage students in organizing observations and data collected during student explorations to determine if patterns are present by using a video library such as *Kids Work* and having students record whether the career video they have watched is something they would enjoy doing. Ask students to record this information for multiple careers. Have the class record their thoughts and then use the class data to determine if

there is a pattern across the classroom of the careers that students would and would not enjoy.

Career Exploration - Middle Grades (6-8)

Students explore their career interests through embedded activities. Career exploration strategies are opportunities for students to discover work environments and understand the various aspects of the workplace. Strategies include tools and instruments that help students understand and appreciate their strengths and interests. Students start plans for their future with career information and postsecondary education data. Plans include course selection and planning as well as career aspirations and goals.

Technology Model Curriculum Example: Middle school is an important time for students to begin refining their interests and furthering their understanding of the workplace. These are prime grades to begin having students use their technology knowledge and skills to explore career options in the technology fields.

(6-8.ICT.3.a.) Using OhioMeansJobs K12, ask students to take the Career Cluster Inventory. Students use the Dynamic Career Pathways tool to explore occupations in information technology and the Employment Projections tool to research further and determine whether a career in this industry may be in their future. In the process, they analyze and integrate textual, visual and quantitative information (such as images, diagrams, graphs, infographics, videos and interactives) from multiple digital learning tools and resources. (Students must first create an account on the OhioMeansJobs K-12 website, to take the Career Cluster Inventory.)

Career Planning - High School (9-12)

Students continue career exploration while focusing on career planning. Activities provide advanced experiences that offer hands-on opportunities in the workplace. Career planning strategies focus on making clear links between career options and educational decisions. Students develop the skills to revisit previous exploration and planning strategies as they face career changes throughout life.

Technology Model Curriculum Example: High school students need to begin finalizing their post-high school plans. To gain further insight on what options exist for students, it is important to give students opportunities to interact with and work in the community.

(9-12.DT.4.c.) While critically evaluating a design solution at multiple points of a design process, have students work with their community to identify real-world problems to solve. Consider connecting students to the district's Business Advisory Council to hear about the real issues businesses face. Have students implement the design process to potentially solve those problems with evaluations of the process along the way. Consider how this type of opportunity may lead to an internship or other work-based learning opportunity for students.

BUILDING SKILLS ALIGNED TO THE OHIOMEANSJOBS-READINESS SEAL

Career Connections learning strategies are an effective way for students to establish an understanding of and demonstrate the professional skills that will be essential for success in their career and life goals. The professional skills outlined in the OhioMeansJobs-Readiness Seal can be found across the career connection learning strategies within the model curriculum. These associations will help students make connections to the expected skills and behaviors within the world of work and can be used to support high school students in meeting the seal requirements.

There are clear associations between Ohio's Learning Standards and Model Curriculum for Technology and the professional skills outlined in the OhioMeansJobs-Readiness Seal. For example, a distinct connection exists between the knowledge and skills in the standards and model curriculum and professional skills involving digital technology where the student has "an in-depth understanding of emerging technology and leverages technology to solve problems, complete tasks and accomplish goals." Additional associations (such as those involving creativity and innovation, teamwork and collaboration and critical thinking and problem-solving) exist through the use of the outlined Career Connections found throughout this model curriculum.

Grades 9-12 Model Curriculum

STRAND: INFORMATION AND COMMUNICATIONS TECHNOLOGY

The understanding and application of digital learning tools for accessing, creating, evaluating, applying and communicating ideas and information.

Topic 1: Identify and use appropriate digital learning tools and resources to accomplish a defined task.

9-12.ICT.1.a. Develop strategies for using digital learning tools and resources to plan, implement and reflect upon a complex task.

Expectations for Learning

LEARNING PROGRESSION

In grades 6-8, students selected and used digital learning tools or resources to support planning, implementing and reflecting upon a defined task. In grades 9-12, students learn how to develop strategies for using digital learning tools and resources to plan, implement and reflect on complex tasks.

IMPORTANT CONCEPTS

- Depending on the task, digital tools and resources have varying benefits and limitations.
- Effectively selecting digital learning tools and resources for a task takes strategic planning and evaluation.
- Developing strategies for using digital tools and resources helps make planning, implementing and reflecting on tasks more effective.

KEY SKILLS/PROCEDURES

- Analyze a task to select appropriate digital learning tools and resources to support the task.
- Establish a plan to strategically use digital tools and resources to effectively plan, implement and reflect on a complex task.

Content Elaborations

CLARIFICATIONS

By developing strategies for using digital learning tools and resources, students can more effectively plan, implement and reflect upon complex tasks both individually and in groups. This could include strategically using digital tools for time and project management, collaboration, peer feedback and revision. Before selecting digital tools, students should carefully consider the task to determine which features of digital tools they will need.

For example, in English language arts, students may create digital storybooks to teach grammar to younger students. For this project, students must consider which digital tools and resources will help them plan the sequence of their stories, create their graphics, share their work with peers or other learners to gain feedback and revise their work. Beyond the strategic selection of digital tools and resources, students develop strategies for using these tools and resources. For example, in the project above, students may

Topic 1: Identify and use appropriate digital learning tools and resources to accomplish a defined task.	
	use strategies that involve saving and keeping track of different versions of their work. When sharing their work with others, students may develop strategies for collecting this feedback and for monitoring what feedback has been received, responded to and resolved. **CONTENT FOCUS** This content statement focuses on students strategically selecting and using digital learning tools and resources to support the processes of planning, implementing and reflecting on complex tasks.
9-12.ICT.1.b. Based on project-specific requirements, develop criteria to select digital learning tools and resources to support the concurrent management of multiple projects.	**Expectations for Learning** **LEARNING PROGRESSION** In grades 6-8, students developed criteria for selecting digital learning tools and resources to accomplish a defined task. In grades 9-12, students develop criteria based on project-specific requirements to select digital learning tools and resources to support the concurrent management of multiple projects. **IMPORTANT CONCEPTS** • Project requirements and constraints impact the criteria used for selecting digital learning tools and resources that will effectively support the concurrent management of multiple projects or project components. • Collaboration often is required while working on projects. • The ability to manage multiple projects or multiple aspects of a project is a requirement for most professional environments. **KEY SKILLS/PROCEDURES** • Analyze project requirements and constraints across multiple projects or components of a project that affect the selection of digital learning tools and resources. • Develop criteria for selecting project management and productivity tools. **Content Elaborations** **CLARIFICATIONS** Constraints and project requirements, such as timelines, access, workload, group requirements or project goals, can affect the criteria used for the selection of digital learning tools and resources. As students identify the tasks in each project, or in each component of a single project, they need to review project management and productivity tools to identify the features needed to support successful project completion. Students may find that concurrent management of multiple projects or components within a project requires coordinating the use of more than one tool. For example, students may be asked to complete a project in social studies to identify, share and solve a social issue in their local community. They would need the

Topic 1: Identify and use appropriate digital learning tools and resources to accomplish a defined task.	
	ability to select the proper digital tools to collaborate with one another to assign tasks, schedule multiple timelines, manage workloads across components of the project and organize information. **CONTENT FOCUS** The focus is on students developing criteria and purposefully selecting digital learning tools and resources that aid them in aspects of managing multiple projects or multiple aspects of one project concurrently (such as time, people, tasks and documents).
9-12.ICT.1.c. Analyze and evaluate the ease of use and effectiveness of available features of selected digital learning tools and resources.	**Expectations for Learning** **LEARNING PROGRESSION** In grades 6-8, students evaluated digital learning tools and resources to support learning and productivity. In grades 9-12, students analyze and evaluate the ease of use and effectiveness of available features of selected digital learning tools and resources. **IMPORTANT CONCEPTS** • It is important to understand the benefits and limitations of a particular digital learning tool or resource for completing a task. • Two tools or resources may have the same or similar features, but one may be easier to use than another. • Not every user uses a tool or resource in the same way or finds the same tools and resources beneficial. **KEY SKILLS/PROCEDURES** • Identify the function and features of digital learning tools and resources. • Compare the features of various digital tools and resources used to perform specified functions to make determinations concerning their ease of use and effectiveness. **Content Elaborations** **CLARIFICATIONS** Digital learning tools and resources can be evaluated for their effectiveness and ease of use. Exploring the various features of tools and resources, how they meet pre-established criteria and how well they support the task at hand will allow students to independently select digital tools and resources suited for future tasks and individual needs. How well a digital tool works in combination with other digital tools needed for a project is another factor that may impact tool selection. Evaluating digital tools and resources in terms of their ease of use and effectiveness can become a common practice that enhances how effectively students are able to complete projects. For example, in an assignment in which students are asked to document and reflect on a science experiment, students could

Topic 1: Identify and use appropriate digital learning tools and resources to accomplish a defined task.	
	evaluate the effectiveness of the digital tools used for documentation and the features available in and missing from these tools to improve the documentation of future experiments. **CONTENT FOCUS** The focus is on students evaluating the ease of use and effectiveness of features available in digital learning tools and resources.

Topic 2: Use digital learning tools and resources to locate, evaluate and use information.	
9-12.ICT.2.a. Use advanced search and filtering techniques to locate needed information using digital learning tools and resources.	**Expectations for Learning** **LEARNING PROGRESSION** In grades 6-8, students used advanced search techniques to locate information using digital learning tools and resources. In grades 9-12, students use advanced search and filtering techniques to locate information using digital learning tools and resources. **IMPORTANT CONCEPTS** • Advanced search and filtering techniques produce results more relevant to the information need. • Utilizing a variety of search and filtering techniques when searching a scholarly database provides access to credible sources of information. • Some search techniques are more useful than others for specific search purposes. **KEY SKILLS/PROCEDURES** • Identify and use advanced search and filtering techniques. • Evaluate search and filtering techniques and digital learning tools and resources that will be most useful for gathering specific information. **Content Elaborations** **CLARIFICATIONS** By using advanced search and filtering techniques (such as Boolean, proximity and nested searches), targeted information can be located online in a more efficient method. For example, students in a science class can use filtering techniques to help them find information about the emergence and growth of an invasive fish species in their local area. By narrowing the time period they search, students may see a greater impact of the growth of this species. Students may use advanced search techniques to track the presence of this fish species in nearby areas, excluding particular areas that do not have an impact on the growth of the species within their local area. By using more effective search and filtering techniques to locate information, students will be able to efficiently evaluate information and integrate this information into their projects and assignments. **CONTENT FOCUS** This content statement focuses on selecting and using advanced search and filtering techniques that will assist in locating information and resources that are beneficial to completing a given task in an efficient manner.

Topic 2: Use digital learning tools and resources to locate, evaluate and use information.	
9-12.ICT.2.b. Independently construct an evaluative process for information sources chosen for a learning task.	**Expectations for Learning** **LEARNING PROGRESSION** In grades 6-8, students used multiple criteria to evaluate the validity of the information found with digital learning tools and resources. In grades 9-12, students independently construct an evaluative process for information sources. **IMPORTANT CONCEPTS** • A variety of criteria and strategies are used to evaluate the credibility of a source, including those that are predetermined and self-determined. **KEY SKILLS/PROCEDURES** • Independently create a process for evaluating information from a chosen source using criteria and strategies that are self-determined in addition to those that are predetermined. • Reflect upon the process developed to evaluate source credibility to determine if changes are needed to improve this process. • Select credible information as a result of the evaluation process constructed. **Content Elaborations** **CLARIFICATIONS** Information literacy criteria, such as timeliness, relevancy, bias, authority, accuracy and purpose can be a part of a process that students construct to evaluate information sources. Students can further strengthen the evaluative process by considering areas where their evaluation of sources may fall short and then incorporating additional questions to target these areas. Students may identify additional evaluation criteria or strategies that are specific to the topics they are investigating. As part of constructing an evaluative process, students can determine how they will document the process they use and organize their findings. **CONTENT FOCUS** The focus is on students independently constructing an evaluative process for information sources.

Topic 2: Use digital learning tools and resources to locate, evaluate and use information.	
9-12.ICT.2.c. Analyze the complexities and discrepancies found in digital information to make informed decisions.	**Expectations for Learning** **LEARNING PROGRESSION** In grades 6-8, students used multiple criteria to evaluate the validity of the information found with digital learning tools and resources. In grades 9-12, students analyze the complexities and discrepancies found in digital information to make informed decisions. **IMPORTANT CONCEPTS** • Digital information may have discrepancies and complexities that need to be identified and understood. • Complexities and discrepancies found in digital information can be identified and analyzed by comparing information across multiple sources. **KEY SKILLS/PROCEDURES** • Compare and contrast digital information from multiple sources to identify similarities and differences in information, determine credibility and relevance and construct an informed understanding of a topic. • Distinguish between discrepancies in information due to inconsistencies or inaccuracies and differences in information due to the complexity of a topic. **Content Elaborations** **CLARIFICATIONS** By analyzing the various information found through digital learning tools, students can make informed decisions about what information is credible, relevant and useful to their work. Through this analysis, students can identify discrepancies between information sources by comparing and contrasting similar information across, for example, different sponsors, authors and media. Students can examine complexities in digital information that can be created by the range and breadth of information available and variety of perspectives represented across information sources (such as organizational websites that may have a particular mission or research interest). In the case of these complexities, differences in information may be found across sources that are each credible. Students can analyze such complexities as they identify gaps in information and synthesize information to develop a more informed understanding upon which to base decisions. This content statement is a natural progression from content statement 9-12.ICT.2.b. that involves students in independently constructing a process for evaluating the credibility of information sources.

Topic 2: Use digital learning tools and resources to locate, evaluate and use information.	
	CONTENT FOCUS The focus is to develop students' abilities to make informed decisions when working with information that contains complexities and discrepancies and determining what information is credible, relevant and useful to completing the task at hand.
9-12.ICT.2.d. Apply principles of copyright, use digital citation tools and use strategies to avoid plagiarism when using the work of others as well as creating personal work.	**Expectations for Learning** **LEARNING PROGRESSION** In grades 6-8, students applied principles of copyright, used digital citation tools and used strategies to avoid plagiarism. In grades 9-12, students apply principles of copyright, use digital citation tools and use strategies to avoid plagiarism when using the work of others as well as creating personal work. **IMPORTANT CONCEPTS** • Online sources have different usage rights. The specific usage rights for each source must be examined and followed. • Copyright laws, including those for digital materials, need to be understood and followed. • It is important to understand what constitutes plagiarism and how to avoid plagiarism. **KEY SKILLS/PROCEDURES** • Identify the usage rights of a given digital source. • Apply principles of copyright. • Avoid plagiarism by utilizing strategies and digital citation tools to credit sources for information used. **Content Elaborations** **CLARIFICATIONS** Multiple strategies are necessary to avoid copyright infringement and plagiarism. When using the work of others, students should use copyright best practices, such as determining and adhering to permitted uses of content and seeking permission from copyright holders when needed. They may need to conduct an analysis of the four fair use factors (purpose, amount, nature and effect). Students can avoid plagiarism by systematically keeping track of information sources and taking advantage of digital citation tools to properly cite sources. **CONTENT FOCUS** The focus is on the importance of following copyright law and providing documentation of all content, including digital resources and tools. When students use the work of others and create content of their own, they will have the necessary knowledge to apply copyright principles and use strategies and digital citation tools to properly cite sources and avoid plagiarism.

Topic 3: Use digital learning tools and resources to construct knowledge.	
9-12.ICT.3.a. Synthesize textual, visual and quantitative research and data (e.g., images, diagrams, maps, graphs, infographics, videos, animations, interactives) from a variety of digital learning tools and resources.	**Expectations for Learning** **LEARNING PROGRESSION** In grades 6-8, students analyzed and integrated textual, visual and quantitative information from multiple digital learning tools and resources. In grades 9-12, students synthesize textual, visual and quantitative research and data from a variety of digital learning tools and resources. **IMPORTANT CONCEPTS** • It may be required to integrate different types of information (textual, visual and quantitative) from multiple resources to achieve a specific purpose or task. **KEY SKILLS/PROCEDURES** • Synthesize textual, visual and quantitative information from a variety of digital learning tools and resources to achieve a specific task or purpose. **Content Elaborations** **CLARIFICATIONS** Textual, visual and quantitative information each bring a different layer of information to a topic or concept. As students synthesize these different forms of information, they build a more complete understanding. Students can use digital learning tools to synthesize evidence and construct knowledge from different types of information they locate using digital tools and resources, including research and data pulled from images, maps, graphs, infographics and videos. For example, students in a health class researching trends in teen use of tobacco products and possible influences will likely draw upon a variety of textual, visual and quantitative information resources that they will need to synthesize to determine how these pieces of information connect to form a coherent understanding. They may use a database tool to analyze online datasets that provide percentages of current teen smokers. Students can use visualization tools to see their data displayed in different formats (such as an interactive map that displays percentages by region or a line graph that shows how these percentages change across years). In addition, advertisements for tobacco products and for anti-smoking campaigns may serve as resources for examining possible factors in teen smoking. **CONTENT FOCUS** This content statement focuses on students constructing knowledge through synthesizing different types of information found from a variety of digital learning tools and resources.

Topic 3: Use digital learning tools and resources to construct knowledge.	
9-12.ICT.3.b. Analyze relationships and forecast outcomes using data collected by students or retrieved from a variety of digital learning tools and resources.	**Expectations for Learning** **LEARNING PROGRESSION** In grades 6-8, students analyzed data collected or retrieved from a variety of digital learning tools and resources to determine if patterns or trends were present. In grades 9-12, students analyze relationships and forecast outcomes using data collected by students or retrieved from a variety of digital learning tools and resources. **IMPORTANT CONCEPTS** • Digital learning tools can support data collection and analysis by helping to organize observations and look for trends or patterns to determine relationships. • Data can be collected or retrieved from digital sources and analyzed to determine if relationships are present. • Relationships found when analyzing data can be used to make predictions. **KEY SKILLS/PROCEDURES** • Use digital learning tools and resources to assist in data collection, organization and analysis. • Analyze data, collected on one's own or retrieved from a variety of digital sources, to determine if relationships are present. • Make predictions based on relationships found in analyzed data. **Content Elaborations** **CLARIFICATIONS** Data analysis can be more impactful for students when they have the opportunity to examine data they gathered through explorations. Digital learning tools can support data collection by helping students organize their observations or data entries. These digital tools can support data analysis by helping students look for trends or patterns to determine relationships. Students also can construct knowledge using data gathered from a variety of credible online sources of information. Students can interpret the data gathered and make forecasts or predictions of outcomes based on their analysis. For example, students in a social studies class can make predictions about the outcome of a local election based on data gathered from online voting trends over past elections. Students in math or science class can gather data on the distance a model car can travel over a set time, analyze relationships between variables of speed, distance and time and then predict outcomes when factors like ramp height or ramp surface are changed. After testing the new factors, the predicted results and actual results can be compared for further analysis.

Topic 3: Use digital learning tools and resources to construct knowledge.	
	CONTENT FOCUS The focus is on students analyzing data they collected or retrieved from various digital learning tools and resources to determine if relationships are present to make predictions. **Career Connections** **CAREER PLANNING** Through Career Connections provided in earlier grades, students were exposed to various digital tools to facilitate career awareness and exploration while performing data analysis to identify career interests. Data analytics exist across many career fields. Using student-identified career interests, students now use digital tools to explore how different careers use formal and informal data to determine relationships and forecast outcomes. Students then select an occupation and develop one or more career plans using OhioMeansJobs K-12. (Students must first create an account on the OhioMeansJobs K-12 website to develop a career plan using this link.) Teachers can consider aiding students in academic course selection based on career interests. For example, if a student is interested in data visualization tools, the student can consider a data analytics math course like *Data Science Foundations*.
9-12.ICT.3.c. Create artifacts using digital learning tools and resources to demonstrate knowledge.	**Expectations for Learning** **LEARNING PROGRESSION** In grades K-12, students create artifacts using digital learning tools and resources to demonstrate knowledge. Since this content statement is present in multiple grade bands, student artifacts will vary based on grade-level content. Artifacts should progress in complexity, variety and sophistication as students reach each grade band. **IMPORTANT CONCEPTS** • Digital learning tools and resources can be used to create and develop original content that demonstrates knowledge of a concept or topic. **KEY SKILLS/PROCEDURES** • Determine what type of artifact can be used to effectively demonstrate the knowledge that has been constructed of a topic or concept. • Use digital learning tools and resources to create an artifact consisting of original content that demonstrates knowledge constructed of a topic or concept.

Topic 3: Use digital learning tools and resources to construct knowledge.	
	Content Elaborations **CLARIFICATIONS** Students can provide evidence of their learning through creating artifacts (such as videos, annotated images, graphs, charts, video games and diagrams) using digital learning tools and resources. Creating their own content through such artifacts demonstrates the knowledge they have constructed about a concept or topic. For example, students could create a visual brochure using the research they conducted on a chosen country in a world language class. Or students could create a children's e-book to demonstrate knowledge of a science concept using appropriate English language arts conventions while using other ABC-style books as anchor texts. Students could take pictures using digital cameras or create their own artwork (or in collaboration with the fine arts teacher) to add original artwork to the ABC-style e-book. To demonstrate knowledge gained from the health research project described in 9-12.ICT.3.a., students could construct an infographic that displays the key relationships found in the analyzed data. This content statement is a natural progression from content statements 9-12.ICT.3.a. and 9-12.ICT.3.b. that involve students in analyzing and synthesizing information and data. **CONTENT FOCUS** The focus is on students creating digital artifacts that demonstrate their knowledge through the effective use of digital learning tools and resources.

Topic 4: Use digital learning tools and resources to communicate and disseminate information to multiple audiences.	
9-12.ICT.4.a. Use digital learning tools and resources to identify communication needs considering goals, audience, content, access to tools or devices, timing of communication (e.g., time zones), etc.	**Expectations for Learning** **LEARNING PROGRESSION** In grades 6-8, students used digital learning tools and resources to identify communication needs considering goals, audience and content. In grades 9-12, students use digital learning tools and resources to identify communication needs considering goals, audience, content, access to tools or devices and additional factors. **IMPORTANT CONCEPTS** • Communication needs vary based on a number of factors (for example, goals, audience, content, access to tools or devices). • To effectively communicate and disseminate information to multiple audiences it is necessary to first identify communication needs. • Digital learning tools and resources can be used to gather information about communication needs. **KEY SKILLS/PROCEDURES** • Identify communication needs using digital learning tools and resources. **Content Elaborations** **CLARIFICATIONS** The first step in developing a plan to share digital information is to identify communication needs. By considering multiple factors (such as plan goals, audience characteristics, access to tools and timing), students are able to begin building the foundation of a plan to communicate and disseminate information to multiple audiences. After identifying communication needs, students continue to develop their communication plans in content statement 9-12.ICT.4.b. Students may use digital tools like survey or poll tools to identify communication needs (such as audience members' spoken language(s), content familiarity, accessibility needs and availability) and to assist in planning. **CONTENT FOCUS** This content statement focuses on students using digital learning tools and resources to identify communication needs for various tasks based on a variety of criteria, such as plan goals, the intended audience, content to be shared and tools and devices accessible at that time.

Topic 4: Use digital learning tools and resources to communicate and disseminate information to multiple audiences.	
9-12.ICT.4.b. Based on communication needs, develop, implement and evaluate a communication plan to disseminate information to multiple audiences.	**Expectations for Learning** **LEARNING PROGRESSION** In grades 6-8, students selected and used a variety of media formats to communicate to a target audience and evaluated the effectiveness of a digital tool to communicate information to multiple audiences. In grades 9-12, students develop, implement and evaluate a communication plan to disseminate information to multiple audiences that is based on communication needs. **IMPORTANT CONCEPTS** • When developing a communication plan for sharing digital information with a variety of audiences, the content, audience and specific task goals and characteristics guide the construction of the plan. • Some digital tools are more effective than others for addressing a variety of audiences. • It is important to evaluate the effectiveness of a communication plan to identify components that can be improved for future implementations. **KEY SKILLS/PROCEDURES** • Create a communication plan for sharing information digitally based on identified communication needs that consider audience, content, goals, access, timing and other task specifics. • Select online communication tools that are appropriate for specific audiences, content and tasks. • Develop a strategy for how to best use online communication tools to communicate and disseminate information to multiple audiences. • Evaluate a communication plan to identify areas for improvement. **Content Elaborations** **CLARIFICATIONS** By first analyzing communication needs, students can create and implement plans for sharing digital information with a variety of audiences. Taking communication needs into consideration, students can develop plans that incorporate appropriate online communication tools that will allow them to best convey information to targeted audiences. They can lay out other details within their plans, such as when different communications will take place based on timelines and availability. Students can consider the criteria they will use to evaluate their communication plans and to assess and improve their plans for use in the future. For example, students could be asked to develop and implement communication plans in which they identify what segments of their community are affected by a particular community problem, how they will communicate with team members in another school to develop solutions to the problem and how they will share solutions with impacted members in their community.

Topic 4: Use digital learning tools and resources to communicate and disseminate information to multiple audiences.	
	CONTENT FOCUS The focus is on developing, implementing and evaluating a communication plan that meets identified communication needs that must be considered to communicate and disseminate information to multiple audiences.
9-12.ICT.4.c. Integrate accessibility principles to effectively communicate to, and meet the needs of, multiple audiences.	**Expectations for Learning** **LEARNING PROGRESSION** In grades 6-8, students discussed and identified ways to communicate and disseminate information so that users with varied needs could access information. In grades 9-12, students integrate accessibility principles to effectively communicate to, and meet the needs of, multiple audiences. **IMPORTANT CONCEPTS** • It is necessary to integrate accessibility principles when communicating and disseminating information to make all digital communications as accessible as possible. • Making content accessible to different audiences requires first considering the communication needs of these audiences. • The accessibility features available vary for each digital communication tool. **KEY SKILLS/PROCEDURES** • Consider the communication needs of different audiences in terms of accessibility principles. • Use accessibility features that allow for optimal communication of all information to the largest possible audience. **Content Elaborations** **CLARIFICATIONS** Identifying the communication needs of different audiences from the start and taking into consideration their varied needs, abilities and preferences is necessary to make content accessible to a variety of audiences and to reach the broadest possible audience. Students engage in the upfront planning necessary for integrating accessibility principles as they view the information to be communicated from the multiple perspectives of their audiences and ask themselves questions such as, "Is this information understandable?" and "Can audience members perceive or take in this information?" By integrating accessibility principles (such as universal or inclusive design) and features into the way students create and share their content, students will be able to communicate and disseminate information to a variety of audiences. For example, including closed captioning for a video or choosing a digital tool with speech-to-text compatibility would provide access to a wider audience by supporting people who are hard of hearing or

Topic 4: Use digital learning tools and resources to communicate and disseminate information to multiple audiences.	
	non-native language speakers. Students could create accessible documents to share learning with audiences outside of the classroom by providing alternative text to describe images and using text displayed in fonts and colors perceivable by people with visual impairments. **CONTENT FOCUS** The focus is on integrating accessibility principles and features to make digital content accessible to people with varying needs, abilities and preferences.
9-12.ICT.4.d. Use digital learning tools to represent and model complex systems of information to a target audience.	**Expectations for Learning** **LEARNING PROGRESSION** In grades 6-8, students evaluated the effectiveness of a digital tool to communicate information with multiple audiences. In grades 9-12, students use digital learning tools to represent and model complex systems of information to a target audience. **IMPORTANT CONCEPTS** • Digital learning tools enable complex systems of information to be represented and modeled in a format that can be more easily comprehended by a target audience. **KEY SKILLS/PROCEDURES** • Consider the system of information to be shared and the characteristics of a target audience. Evaluate digital learning tools to determine appropriate tools to represent and model this complex system of information to the target audience. • Create a digital representation that models a complex system of information that meets the needs of a target audience. **Content Elaborations** **CLARIFICATIONS** Representing and modeling complex systems of information can engage students in discerning patterns and relationships in data that can involve large datasets and multiple factors or components. Certain digital learning tools (such as data visualization tools and simulations) have the capability to make patterns, relationships and interactions between the multiple elements of a complex system more clearly seen and comprehended. By utilizing these capabilities, students can communicate complex systems of information to a target audience more effectively. For example, students could communicate factors affecting the weather during a hurricane (such as wind speed, wind direction and temperature) using a simulation or interactive real-time map. In math, students could use pivot tables within spreadsheets to look at various aspects of complex data. How students would

Topic 4: Use digital learning tools and resources to communicate and disseminate information to multiple audiences.	
	use digital tools to communicate this information would depend on their target audience. Are students modeling a complex system for middle school students or a visiting scientist? This content statement forms a natural progression from the content statements in Topic 3 of this strand that engage students in using digital learning tools to construct knowledge, analyze information and synthesize information and data. **CONTENT FOCUS** The focus is on using digital learning tools to organize information into a representation that makes a complex system of information and the models of patterns, relationships and interactions within this system more comprehensible to a target audience.

STRAND: SOCIETY AND TECHNOLOGY

The interconnectedness of technology, self, society and the natural world, specifically addressing the ethical, legal, political and global impact of technology.

Topic 1: Demonstrate an understanding of technology's impact on the advancement of humanity – economically, environmentally and ethically.

9-12.ST.1.a. Interpret, and practice, ethical considerations and legal requirements involved in the creation and use of digital technologies.

Expectations for Learning

LEARNING PROGRESSION

In grades 6-8, students advocated and exhibited ethical, legal and responsible practices when utilizing technology. Students also reviewed and demonstrated ethical considerations and legal requirements involved in creating artifacts using digital technologies. In grades 9-12, students interpret and practice ethical considerations and legal requirements involved in creating artifacts using digital technologies.

IMPORTANT CONCEPTS

- It is important to understand the rights associated with the ownership of intellectual property.
- The ethical responsibilities and legal requirements for using digital artifacts involve both determining usage rights and giving appropriate credit to the holder of the rights to that work.
- It is critical to understand the difference between copyright infringement, plagiarism and piracy and how this applies to the creation and use of digital artifacts. (For example, certain uses of digital technology can constitute piracy and plagiarism, even when credit is given.)
- Ethical considerations and laws surrounding the creation and use of digital artifacts may need to be reevaluated due to advancements in technology.

KEY SKILLS/PROCEDURES

- Protect intellectual property rights of self and others.
- Appropriately credit sources of all media types that can be used when creating digital artifacts.
- Interpret and apply the laws associated with the creation and use of digital artifacts, identifying legal and illegal uses.
- Determine ethical and unethical behavior related to the creation and use of digital artifacts, explaining one's reasoning.

Content Elaborations

CLARIFICATIONS

When using digital technologies to create artifacts (such as digital images, online video, source code and apps), it is important to recognize the ethical and legal concerns that should be considered. This includes intellectual property, plagiarism, piracy, copyright infringement and, in general, showing respect for the work and rights of others.

Topic 1: Demonstrate an understanding of technology's impact on the advancement of humanity – economically, environmentally and ethically.	
	When creating any digital artifact, students must determine usage rights and provide appropriate credit for the work they use. Students' creation of their own work can involve applying Creative Commons licenses and participating in open educational resources. Students can contrast the benefits of using, creating and sharing digital artifacts with the potential risks. **CONTENT FOCUS** This content statement focuses on students interpreting and applying laws pertaining to their creation and use of a range of digital artifacts. Students also must weigh ethical considerations that may be involved. Responsible, legal and ethical use of another's work (such as source code, designs or images) and of digital technologies when creating artifacts is emphasized.
9-12.ST.1.b. Debate the advantages and disadvantages of widespread use, accessibility and reliance on technology in one's world, in the workplace and in global society.	**Expectations for Learning** **LEARNING PROGRESSION** In grades 6-8, students explored the advantages and disadvantages of widespread use, accessibility and reliance on technology in one's world. In grades 9-12, students debate the advantages and disadvantages of widespread use, accessibility and reliance on technology in one's world, the workplace and global society. **IMPORTANT CONCEPTS** • The widespread use of a technology can have both advantages and disadvantages on one's world, the workplace and global society. • There are potential positives and negatives both in being immersed in technology and being unplugged. • Inequities in access to technology can have implications for one's world, the workplace and global society. • Ethical decision-making is needed in weighing the positive and negative consequences of a technology.

Topic 1: Demonstrate an understanding of technology's impact on the advancement of humanity – economically, environmentally and ethically.	
	KEY SKILLS/PROCEDURES • Consider different perspectives concerning the positive and negative impacts of widespread use of technology, comparing the advantages and disadvantages of technology use in terms of one's world, the workplace and global society. • Provide examples of how access to technology can affect an individual, the workplace and global society. **Content Elaborations** **CLARIFICATIONS** Students research and debate the advantages and disadvantages of widespread technology use in areas such as environmental resources, agriculture, medicine and transportation. Students consider disadvantages that reliance on technology can bring, such as impacts on interpersonal skills when changing from face-to-face to remote forms of communication, technology addiction, reliance on electricity and connectivity, risks to data privacy and cybersecurity threats. When considering advantages and disadvantages stemming from technology use, inequities that exist between populations who do and do not have access to technology must be considered, as in those reflected by the digital divide. Students could watch a documentary, view a popular film or read a fictional story in which technology plays an important role in the plot or character development. Students then could debate the positive or negative impacts of this technology and consider these impacts in terms of a technology in their own world. **CONTENT FOCUS** The focus is on students weighing the positive and negative impacts of widespread use, accessibility and reliance on technology. Individuals, organizations and cultures balance the tension between an innovation's potential positive and negative consequences. Students debate these advantages and disadvantages. As digital citizens, they discuss balancing the adoption of a technology with mitigating potential negative consequences, while taking into account the diverse population of those impacted.

Topic 1: Demonstrate an understanding of technology's impact on the advancement of humanity – economically, environmentally and ethically.	
9-12.ST.1.c. Select a technology and analyze its global impact across multiple disciplines.	**Expectations for Learning** **LEARNING PROGRESSION** In grades 6-8, students analyzed an environmental concern and investigated technology solutions to that problem. In grades 9-12, students select a technology and analyze its global impact across multiple disciplines. **IMPORTANT CONCEPTS** • Technological impacts can be felt at the individual, local, national or global level in a wide variety of contexts over time. • Technological impacts can extend across multiple disciplines. **KEY SKILLS/PROCEDURES** • Trace the evolution of a technology over time. Analyze and explain its consequences, considering geographic scope. • Analyze and explain how a specific technology has affected more than one discipline or field (such as agriculture, medicine and transportation). **Content Elaborations** **CLARIFICATIONS** Technological impacts can extend over time, across geographic areas and across disciplines. Students identify a technology and analyze the nature of its impact on people and society in a variety of ways, such as economically, environmentally and ethically. Students could look to current events to find technologies to examine. For example, rare earth minerals located in China are needed to manufacture many technological products, including mobile phones, medical equipment, electric cars and solar panels. Students could research the impact of a technology whose production is reliant on the import of critical resources from China, analyzing this impact in terms of the disciplines or fields affected and global reach. Students could create a digital product that would effectively illustrate findings, such as the short- and long-term global impact of the production of that technology. **CONTENT FOCUS** The focus is on students analyzing the impact of a specific technology over time and across geographic areas. Students analyze these impacts in terms of their reach across multiple disciplines.

Topic 2: Analyze the impact of communication and collaboration in both digital and physical environments.	
9-12.ST.2.a. Demonstrate and advocate effective collaboration strategies and techniques using technology.	**Expectations for Learning** **LEARNING PROGRESSION** In grades 6-8, students critiqued specific instances of how technology impacts access to information, communications and collaboration. In grades 9-12, students demonstrate and advocate effective collaboration strategies and techniques using technology. **IMPORTANT CONCEPTS** • Effective collaboration requires meaningful communication and communicating with respect. • Effective collaboration strategies and techniques can vary depending on the technology tools being used, situation, task and users. • Modeling effective collaboration strategies and techniques can encourage others to collaborate more effectively. **KEY SKILLS/PROCEDURES** • Select and use technology tools in combination with collaboration strategies and techniques to support collaboration within a particular task. • Reflect on the effectiveness of the collaboration strategies and techniques used with particular technology tools for a collaborative task. • Model effective collaboration in online discussions, group work and peer feedback. **Content Elaborations** **CLARIFICATIONS** Students can demonstrate effective collaboration strategies and techniques using technology when, for example, they co-create using cloud computing (such as co-authoring documents or co-producing audio, video and music); share perspectives using discussion boards and blogs; conduct virtual meetings using video conferencing, chat tools and interactive whiteboards; and solve problems together using interactive tools that involve immersive environments (such as virtual worlds). Students can learn which technology tools and strategies are useful for a particular collaboration given the situation, task and users. Tools and strategies used to collaborate with a co-author on a shared document may differ from those used to discuss design solutions with a larger group. When collaborating, students can compare the advantages and disadvantages of using different strategies and techniques in combination with various technology tools. This enables them to advocate for those combinations of strategies and tools that would be effective for collaborating within a particular context. For example, students could work on a collaborative project using various online tools to share documents and provide feedback. They could then rate the usefulness of the strategies and tools they used for their collaboration.

Topic 2: Analyze the impact of communication and collaboration in both digital and physical environments.	
	CONTENT FOCUS This content statement focuses on how to appropriately and effectively collaborate in a digital environment. Students practice behaviors that promote productivity and collaboration. Certain technology tools are more effective than others, depending on the situation, task or users; one tool often does not meet all needs. **Career Connections** **CAREER PLANNING** Using the OhioMeansJobs.com K12 "Big Interview" tool, students work in small groups to use technology to conduct mock job interviews. Students electronically collaborate to evaluate and provide feedback to each other on their techniques and ability to effectively communicate both in their mock interview videos and when collecting peer feedback. (Select "Visit Interview Practice Center" to access the "Big Interview" tool.)
9-12.ST.2.b. Describe and demonstrate professionalism and civility in communications and collaborative environments.	**Expectations for Learning** **LEARNING PROGRESSION** In grades 6-8, students explained how the use of technology can have both positive and negative impacts on personal, professional and community relationships. Students also applied appropriate interactions and digital etiquette in varying contexts, reflecting on potential impacts in both digital and physical environments. In grades 9-12, students describe and demonstrate professionalism and civility while communicating and collaborating in all environments. **IMPORTANT CONCEPTS** • Effective and professional communication and collaboration are based on respectful, civil behavior and practices. • Nonverbal communication (for example, tone of voice and facial expressions) can be lost in digital environments. There are ways to express some aspects of nonverbal communication in digital environments (such as strategic use of punctuation marks and capital letters). • Professionalism includes tone, grammar, appropriateness and respectful communication. **KEY SKILLS/PROCEDURES** • In digital and physical environments, use appropriate words, tone and nonverbal signals to engage in professional and civil communication and collaboration. • Determine instances of communication and collaboration that are and are not professional and civil based on behavior. • Explain how personal communication choices can affect professional standing.

Topic 2: Analyze the impact of communication and collaboration in both digital and physical environments.	
	Content Elaborations **CLARIFICATIONS** Students apply appropriate etiquette demonstrating professionalism and civility within a variety of digital environments (such as social media, email, learning management systems and videoconferencing), as well as in physical environments. Students convey thoughts productively and constructively by practicing to think critically about the way they will respond and evaluate their responses before posting or publishing (such as when peer editing, using discussion boards and providing feedback). Students demonstrate professionalism and civility for academic work and career readiness. For example, students could be given or create scenarios in which digital communication would be necessary (such as when taking an online course, facilitating a webinar or participating in a virtual meeting). They could establish rules for communicating within this digital scenario and create sample interactions. **CONTENT FOCUS** The focus is on students describing and demonstrating effective and professional communication and collaboration, based on respectful, civil behavior and practices. Behavior in both physical and digital environments can have social and professional consequences. Students identify how critically thinking about and evaluating their responses contribute to the way they communicate and collaborate.
9-12.ST.2.c. Analyze how social media impacts society, individuals and organizations.	**Expectations for Learning** **LEARNING PROGRESSION** In grades 6-8, students investigated how social media impacts society and the digital identities of individuals and organizations. In grades 9-12, students analyze how social media impacts society, individuals and organizations. **IMPORTANT CONCEPTS** • Social media tools have unique features and processes for sharing (such as hashtags and mentions) as compared to other traditional or web tools. These tools can influence social media's potential impact on society, individuals and organizations. • Social media memberships tie users' accounts to their digital footprints. • Individuals and organizations may have different or conflicting interests for using social media (such as an individual's desire to share personal life events versus a business' goal to mine data and advertise). • Participation in a network includes membership (either named or anonymous) that can have both positive and negative consequences (such as being able to access useful resources, yet unknowingly sharing private information).

Topic 2: Analyze the impact of communication and collaboration in both digital and physical environments.	
	KEY SKILLS/PROCEDURES • Explain ways that social media tools can be used to exert an influence on society, individuals and organizations. • Explain how participation in a social media network can have consequences for privacy. • Compare and contrast the goals of an individual user or organization to the goals of the social media platform. **Content Elaborations** **CLARIFICATIONS** Students analyze the positive and negative impact that social media usage can have on society, individuals and organizations. Positive impacts might include providing an efficient platform for collaboration, networking, public relations, market research and job searches. Potentially negative impacts could be infringement on privacy, intentional or unintentional spreading of false information, cyberbullying and reduced productivity. For example, students could analyze specific current events discussed on social media or sample social media accounts, such as accounts of politicians, news agencies, celebrities and influencers, for impact on culture and public opinion or policy. **CONTENT FOCUS** The focus is on examining how social media tools impact society, individuals and organizations, resulting in both positive and negative consequences. Users participating in social media automatically are joining a network of individuals and organizations in a fast-paced, media-rich environment. Social media posts often have an impact on larger public events, policy and opinion.

Topic 2: Analyze the impact of communication and collaboration in both digital and physical environments.	
9-12.ST.2.d. Manage and adjust appropriate interactions and digital etiquette in varying contexts, in digital, physical and cultural environments.	**Expectations for Learning** **LEARNING PROGRESSION** In grades 6-8, students applied appropriate interactions and digital etiquette in varying contexts and reflected on potential impacts in both digital and physical environments. In grades 9-12, students manage and adjust appropriate interactions and digital etiquette in varying contexts, in digital, physical and cultural environments. **IMPORTANT CONCEPTS** • Social norms that guide interaction can vary across different physical and digital contexts. • Cultures hold their own social norms that guide appropriate interaction; what is considered appropriate etiquette in physical and digital environments can vary from culture to culture and differ from one's own. • Interactions in digital environments may be less formal but still have certain norms for communication that users are expected to follow. • Nonverbal cues (such as emojis) exist in communications that take place in digital environments and can impact interactions. **KEY SKILLS/PROCEDURES** • Identify specific behaviors related to digital etiquette. • Identify specific behaviors involving appropriate interaction and digital etiquette that vary across contexts in physical, digital and cultural environments. • Contrast behaviors that are acceptable in digital environments (such as social media, chats and texts) with those acceptable in more traditional forms of communication (such as business communication). • Adjust ways of interacting and digital etiquette behaviors according to the situation. **Content Elaborations** **CLARIFICATIONS** Students identify how different contexts may require making adjustments to etiquette behavior and the way they interact. They learn to manage and adjust their interactions based on differences they identify in what is considered appropriate interaction in varying contexts (such as digital and physical environments, formal and informal settings or different groups of internet users). In addition, students must recognize differences that exist in social conventions across cultures to engage effectively in the global environment found online, modifying their behaviors accordingly. For example, students could participate in role-play scenarios in various contexts, adjusting their digital communication in each. Or students could analyze a variety of examples of digital interactions to identify

Topic 2: Analyze the impact of communication and collaboration in both digital and physical environments.	
	appropriate and inappropriate interactions given different audiences (such as parents, teachers, the principal, a public official or peers). Students also could examine topics that might include diversity and inclusion principles, cultural competency and racial bias education. **CONTENT FOCUS** The focus is on students being able to adjust their interactions and digital etiquette according to the social conventions appropriate in varying contexts. Digital communication norms may differ from more traditional methods for communication. For example, the conventions of a business letter or legal document differ from those acceptable for email, chat or text messages. Productive interactions require an awareness and sensitivity to individuals' cultural norms.

Topic 3: Explain how technology, society and the individual impact one another.

9-12.ST.3.a. Debate how demand for technology and innovation have reshaped the social, cultural, political and/or economic landscape, citing references and examples.

Expectations for Learning

LEARNING PROGRESSION

In grades 6-8, students discussed and defined how the development and use of technology has influenced societal issues. In grades 9-12, students debate how demand for technology and innovation have reshaped the social, cultural, political and/or economic landscape, citing references and examples.

IMPORTANT CONCEPTS

- Social, cultural, political and economic aspects of society can each create demand for technology and innovation to varying degrees.
- All areas of life can be impacted by the demand for technology and innovation.

KEY SKILLS/PROCEDURES

- Identify a technology or innovation that has impacted people and communities as an example of how demand for technological development can reshape societal landscapes (social, cultural, political and/or economic).
- Analyze the relationship between demand for a technology or an innovation and different aspects of society (social, cultural, political and/or economic), examining the nature of this demand and its impact on these different societal landscapes.
- Using evidence gained through research and analysis, debate an issue involving demand for a technology or innovation and its societal impact (such as weighing the pros and cons of social media considering its ability to respond to the public's demand for content and influence society).

Content Elaborations

CLARIFICATIONS

Societal demand can drive the development of a technology or an innovation. These technological developments can then, in turn, impact society. Students explain how demand for a technology or an innovation has impacted social, cultural, political or economic landscapes over time. Narrowing their focus, students find factual references to support their claims.

For example, demand for better transportation technology impacted people's settlement patterns over time. The shapes of some cities changed because of connection (or lack thereof) to downtown. Rail connections were constructed before road connections. Consequently, cities that had rail connections to their downtowns changed more quickly than those that did not. Having cars and roads allowed other more sparsely populated areas to later fill in. Similarly, technology, such as railroads and other methods of travel, enabled people to settle in areas farther away, establishing suburban areas and settlements in rural areas.

Demand can be created for technology development through businesses' need to offer goods and services that consumers need or want in order to make a profit. Development of an innovation provides a means for

Topic 3: Explain how technology, society and the individual impact one another.	
	businesses to offer goods and services that have a competitive edge (such as certain smartphone features and the integration of smartphones with cars and homes). Government can serve as a means through which society promotes or restricts technologies (such as nuclear power plants and stem cell research). Innovation can stem from intervention and assistance by government, enabling large-scale implementations of technological advances like railroad, air travel and space travel. **CONTENT FOCUS** This content statement focuses on students examining the ways that demand for technological development and aspects of society interrelate, laying the groundwork for a debate of issues involving this demand and its societal impact. Students analyze the demands that are created for a technology or an innovation and how this demand for technological development has changed the social, cultural, political and/or economic landscape. Students build evidence for their findings using references and examples from their research and analysis.
9-12.ST.3.b. Discuss how technological innovation has resulted when ideas, knowledge or skills have been shared across multiple fields.	**Expectations for Learning** **LEARNING PROGRESSION** In grades 6-8, students explained how new technology development is driven by factors such as commercialization, creative/inventive thinking and cultural/historical influence. They also analyzed how technological innovations can have multiple applications, both intended and unintended. In grades 9-12, students discuss how the sharing of ideas, knowledge and skills across multiple fields has resulted in technological innovation. **IMPORTANT CONCEPTS** • When technology is developed, resources, ideas, knowledge and skills often are shared across areas and fields to maximize innovation. • A technological innovation can spread to other fields where it can be adopted and adapted. **KEY SKILLS/PROCEDURES** • Describe examples of innovations that have been developed through the contribution of ideas, knowledge and skills from multiple fields and identify the contributions of each field. • Describe examples where the application of technological innovations has spread across multiple fields.

Topic 3: Explain how technology, society and the individual impact one another.	
	Content Elaborations **CLARIFICATIONS** Technological innovation can span multiple fields, benefiting from input, resources, support and development efforts from multiple sources. For example, developing the GPS (Global Positioning System) satellite network required knowledge and skills from multiple fields. Companies involved in the communication industry were needed to create the technology, including the satellites, that make GPS possible. The aviation industry was needed to build the rockets that put the GPS satellites into orbit. Innovations in technology can spread to multiple fields where they can be adopted and adapted. While GPS technology originally was developed for military use, it now is used in a variety of industries, including in agriculture for the navigation of combines and consumer products like watches, mobile devices or home automation systems. **CONTENT FOCUS** The focus is on students studying specific examples of technological innovations to discuss how these technological developments are a result of shared ideas, knowledge and skills from multiple fields.
9-12.ST.3.c. Forecast the need to review, adapt and innovate laws and policies applied to copyrights, patents, trademarks and speech.	**Expectations for Learning** **LEARNING PROGRESSION** In grades 6-8, students evaluated current and past revisions to laws, rules and policies as society responds to technological advancements. In grades 9-12, students forecast the need to review, adapt and innovate laws and policies applied to copyrights, patents, trademarks and speech. **IMPORTANT CONCEPTS** • Technology advancements may dictate laws and policies to be developed that were not necessary in the past. • Ongoing review of current laws and policies are necessary due to areas of rapid technological advancement in today's world and the need for laws and policies to be able to respond to these advancements.

Topic 3: Explain how technology, society and the individual impact one another.	
	KEY SKILLS/PROCEDURES • Review and discuss how laws and policies involving copyrights, patents, trademarks and speech apply as new technologies are developed; consider previous revisions due to technological advancements and future implications of these advancements. • Identify laws and policies involving copyrights, patents, trademarks and speech that need to be created, adapted or removed because they no longer apply due to the development of new technologies. **Content Elaborations** **CLARIFICATIONS** As innovations occur, laws and policies must be reviewed to ensure they respond to technological advancements. For example, with the advent of new ways to share content, from the printing press to the development of streaming technology (like Spotify™, YouTube™ and Netflix™), changes in law have had to follow, such as those involving copyright law. Students can investigate these changes in law and the kinds of cases courts have heard involving new technologies. Through reviewing laws and policies, they can be evaluated to determine where adaptations as well as new laws and policies will be needed. Forecasting this need would be ongoing and interpretive. Predictions can be informed by previous law and policy revisions that concerned past innovations. Students can access past court cases involving new technologies to see what issues were presented and how these cases were resolved. They also can access a case currently being reviewed by the Supreme Court and predict how this case might be resolved. After the court renders its decision, students can determine how their predictions aligned with the court's rulings and opinions. Students also can consider future implications of a technological development to inform their forecasts. **CONTENT FOCUS** The focus is on students interpreting current copyright, patent, trademark and speech laws and policies as they pertain to technological advancements. Students forecast the need for adaptations to be made to current laws and policies and for creating new laws and policies.
9-12.ST.3.d. Predict changes in society and intentional and unintentional consequences resulting from continued technological progress and defend the rationale within a given context.	**Expectations for Learning** **LEARNING PROGRESSION** In grades 6-8, students analyzed how technological innovations and inventions can have multiple applications, both intended and unintended. In grades 9-12, students predict changes in society and intentional and unintentional consequences resulting from continued technological progress and defend the rationale within a given context.

Topic 3: Explain how technology, society and the individual impact one another.	
	IMPORTANT CONCEPTS • When considering societal changes that may result from continued technological progress, intentional and unintentional consequences of that technology need to be taken into account. • Societal changes resulting from technological progress may differ from one culture to another or from one location to another. • The understanding of a technology's impact on society may change as additional information is gained and perceptions of the impact change over time. **KEY SKILLS/PROCEDURES** • Identify older and newer developments of a technology that has shown continued progress and identify their societal impacts. • Analyze how intentional and unintentional consequences resulting from technological developments occur within society. • Use a rationale to defend a prediction of societal changes resulting from a technology's continued progress. Consider intentional and unintentional consequences of that technology (past, present and future) when developing this rationale. **Content Elaborations** **CLARIFICATIONS** Technological progress results in both intentional and unintentional consequences. Both types of consequences must be considered to predict the impact of continued technological progress on society. The automobile provides an example of how societal impacts changed with continued technological progress. When the automobile was first introduced, people predicted it would never last. It was not reliable. Laws were enacted reducing the amount of road that automobiles could use and speeds were limited to travel no faster than horses to reduce accidents. However, as technology involving transportation progressed and roads were paved, automobiles were permitted to travel at higher speeds because they could do so safely. Automobiles became a more reliable and prevalent mode of transportation. The use of GPS technology to tag photos with precise location information illustrates how intentional and unintentional consequences may exert their impacts as a result of technological progress. GPS photo-tagging has enabled people to find the exact location where a photograph was taken. This has brought larger crowds to previously unknown locations, which has provided broader access to beautiful scenery. However, the presence of large crowds has negatively impacted some delicate ecosystems.

Topic 3: Explain how technology, society and the individual impact one another.	
	CONTENT FOCUS The focus is on students analyzing and then predicting how society changes, both in intentional and unintentional ways, as a result of continued technological progress. Students evaluate the impact of those predicted changes. They defend their predictions, providing a rationale.
9-12.ST.3.e. Analyze and influence one's digital identity and digital footprint while considering past, present and future implications.	**Expectations for Learning** **LEARNING PROGRESSION** In grades 6-8, students managed components of their digital identities and digital footprints. In grades 9-12, students analyze and influence their digital identities and digital footprints while considering past, present and future implications. **IMPORTANT CONCEPTS** • Digital content is almost impossible to permanently delete. • Perceptions are subjective. Criteria for evaluating one's digital identity and footprint (also called digital tattoo) are subject to interpretation. • Strategies and techniques can be used to influence one's digital identity and footprint. **KEY SKILLS/PROCEDURES** • Identify and use criteria to evaluate one's digital identity and digital footprint. • Explain the positive and negative implications one's digital identity and digital footprint can have on one's present and future. • Apply steps to enhance, edit or create digital identities and digital footprints to have a positive impact moving forward; consider the impacts one's identity and footprint have had in the past and implications for the present and future. **Content Elaborations** **CLARIFICATIONS** As students analyze and take steps to influence their digital identities and footprints or tattoos, they need to understand how this digital information can have an impact on someone's life in the present and future. Allow students to acknowledge the impact of their identities and footprints on their past and present lives and potentially on their futures. Then, provide them with techniques to edit, enhance and create digital identities and digital footprints that, moving forward, would be of benefit to them.

Topic 3: Explain how technology, society and the individual impact one another.	
	For example, students could conduct evaluations of their own digital identities and footprints based on predetermined criteria. Students could conduct peer evaluations, discussing their findings and efforts that could be made to improve their identities and footprints. Students also could create identities that could be used in new environments, such as in college, career or business settings, that would have a positive impact on their future. **CONTENT FOCUS** The focus is on students evaluating and improving their digital identities and digital footprints. Students consider impacts their identities and footprints have had in the past and implications for the present and future.

STRAND: DESIGN AND TECHNOLOGY

Addresses the nature of technology to develop and improve products and systems over time to meet human/societal needs and wants through design processes.

Topic 1: Define and describe technology, including its core concepts of systems, resources, requirements, processes, controls, optimization and trade-offs.

9-12.DT.1.a. Explore and document how systems theory includes the concepts of system dynamics, systems thinking and computational thinking.

Expectations for Learning

LEARNING PROGRESSION

In grades 6-8, students documented how technology can impact efficiency and analyzed how tools and processes can alter the natural and human-designed worlds. Students also examined how components of a system interrelate and how changes in one part of a system can impact other parts of that system. In grades 9-12, students explore and document how systems theory includes the concepts of system dynamics, systems thinking and computational thinking.

IMPORTANT CONCEPTS

- Design problems exist in multiple systems.
- Systems thinking provides multiple tools for solving problems that take into consideration the interaction between systems and between the components within a system.
- System dynamics enables modeling solutions, taking into account the interaction between systems and between the components within a system over time.
- Computational thinking provides tools to analyze and quantify a problem (such as the requirements for an effective solution).

KEY SKILLS/PROCEDURES

- Determine the systems that need to be considered to solve a problem.
- Explain the interaction between systems and their possible impacts on a solution when using a design process to create, modify or optimize a technology.
- Considering the systems that impact a problem, explain how computational thinking can be used to solve that problem (such as determining the quantifiable elements of the problem and recognizing patterns).

Content Elaborations

CLARIFICATIONS

Systems theory is the study of how systems interact. Systems thinking, system dynamics and computational thinking, all aspects of systems theory, provide tools and methods for understanding and solving complex problems. Applying systems thinking when designing a solution promotes viewing a problem in its entirety, examining how components interact within a system and systems interact with each

Topic 1: Define and describe technology, including its core concepts of systems, resources, requirements, processes, controls, optimization and trade-offs.	
	other. System dynamics enables examining the way systems interact when designing a solution, modeling the behavior of interrelated systems as they change over time. Computational thinking provides tools to quantify and analyze a problem (such as breaking complex problems into simpler problems). In the example below, systems thinking, system dynamics and computational thinking all come into play in the efficient management of a farm. A systems thinking approach is needed because a farm functions as a system made up of subsystems designed to perform tasks (such as planting, cultivating and harvesting crops). Subsystems respond to input from other subsystems, such as when changes in seasonal temperatures and rainfall affect harvesting schedules. System dynamics help farmers understand the behavior of and interaction between these changing subsystems. Many processes used by these subsystems (like determining an irrigation schedule) are created computationally by breaking down a problem into simpler problems, using mathematics to express relationships, analyzing needs and creating step-by-step solutions. **CONTENT FOCUS** This content statement focuses on understanding how systems thinking, system dynamics and computational thinking can be used to help understand complex problems and design solutions to these problems.
9-12.DT.1.b. Discuss how a design process builds on the core concepts of technology, including the relationship between systems.	**Expectations for Learning** **LEARNING PROGRESSION** In grades 6-8, students continued to build on their understanding of the core concepts of technology. They analyzed how tools, materials and processes are used to alter the natural and human-designed worlds. Students also examined how requirements, trade-offs and optimization interrelate within a design process. In grades 9-12, students discuss how a design process builds on the core concepts of technology, including the relationship between systems. **IMPORTANT CONCEPTS** • Having an innovative and inventive mindset is vital to a design process. • The core concepts of technology are interrelated within a design process. Their relationship needs to be considered to optimize a design process. • Iterative processes used to improve design solutions take into consideration whether the systems and subsystems involved are functioning optimally. • Many technological advances are developed by changing open loop systems into closed loop systems, enabling systems to be controlled autonomously. This results in more responsive and efficient systems.

Topic 1: Define and describe technology, including its core concepts of systems, resources, requirements, processes, controls, optimization and trade-offs.	
	KEY SKILLS/PROCEDURES • Reverse engineer and describe the systems used in a product. • Using the core concepts of technology, defend the design choices made to solve a problem. • Describe how invention, innovation and iteration were incorporated in a design process used. • Describe technological advancements that are examples of converting open loop systems to closed loop systems. **Content Elaborations** **CLARIFICATIONS** Technological design is an iterative process to develop and optimize human-made products or processes. Generally, a design process is a plan to find solutions to problems. The core concepts of technology are interrelated within this process. When developers engage in a design process, they view these core concepts as a whole, not individually. They consider the interactions between requirements, processes and controls to determine trade-offs that can result in optimal design solutions. Tools, machines, processes and materials all involve systems (such as logistics, capital and labor) that influence a design process and the resulting solution. Designing new products often occurs by taking existing designs and making improvements (redesign). One area to consider involves the operation of open loop systems. Open loop systems require operator input to make changes to the system. In contrast, a closed loop system can run more efficiently because it can respond to information from the system and take action based on this feedback. (For example, feedback from a thermostat that is a part of a closed loop system can automatically cause the system to turn on the heat when the temperature is too cold; an open loop system would require a person to intervene to raise the temperature.) **CONTENT FOCUS** The focus is on the interaction between the core concepts of technology within a design process, ranging from the interaction between two materials (such as whether to use wood or metal for a structure) to the interaction between systems (for example, how transportation and regulations impact a design).

Topic 2: Identify a problem and use an engineering design process to solve the problem.	
9-12.DT.2.a. Evaluate a design solution using conceptual, physical, digital and mathematical models at various intervals of a design process in order to check for proper design and note areas where improvements are needed (e.g., check the design solutions against criteria and constraints).	**Expectations for Learning** **LEARNING PROGRESSION** In grades 6-8, students applied a complete design process to solve an identified individual or community problem. They considered multiple factors, including criteria and constraints, to justify design decisions. In grades 9-12, students implement, document and present a design process as applied to a particular product, process or problem. At various intervals of a design process, they use conceptual, physical, digital and mathematical models to evaluate a design solution, checking for proper design and noting areas that need improvement (such as checking the design solutions against criteria and constraints). **IMPORTANT CONCEPTS** • It is important to evaluate the definition of a design problem to ensure the resulting solution will address user needs and wants and meet design constraints and requirements. • Design solutions should be checked at various intervals of a design process to ensure they are following the criteria and constraints. • Conceptual, physical, digital and mathematical models can be used to evaluate the effectiveness of a design solution. **KEY SKILLS/PROCEDURES** • Define a design problem, identifying user needs and wants and design criteria and constraints. • Evaluate a problem's definition to ensure the identified user needs and wants, criteria and constraints will result in a design solution that addresses the problem or scenario. • Use conceptual, physical, digital and mathematical models to gain the feedback needed to evaluate the effectiveness of a design solution. • Assess and refine design solutions at various intervals based on the results gained through the use of conceptual, physical, digital and mathematical models. **Content Elaborations** **CLARIFICATIONS** During a design process, it is important to have multiple checkpoints to ensure consideration of criteria, constraints and design requirements and to verify proper design. Developers use conceptual, physical, digital and mathematical models to evaluate their design solutions, considering past solutions to problems where applicable. They document their results and note areas for improvement.

Topic 2: Identify a problem and use an engineering design process to solve the problem.	
	CONTENT FOCUS This content statement focuses on students evaluating design solutions at different intervals during a design process using conceptual, physical, digital and mathematical models. Students use this information to identify areas for improvement and make needed adjustments to their design solutions.
9-12.DT.2.b. Implement, document and present a design process as applied to a particular product, process or problem.	**Expectations for Learning** **LEARNING PROGRESSION** In grades 6-8, students applied a complete design process to solve an identified individual or community problem. In grades 9-12, students implement, document and present a design process as applied to a particular product, process or problem. They use an evaluation process that includes the use of models to check for proper design and note areas where improvements are needed. **IMPORTANT CONCEPTS** • A design process, including alternative solutions, needs to be documented to provide an ongoing record that tracks the progression of a solution from its initial to final stages. • A design process is fluid. • Documentation of a design process should reflect the iterative thought process involved. **KEY SKILLS/PROCEDURES** • Explain the iterative process involved in a design process, focusing on how one idea can lead to another. • Describe the adjustments made during a design process used to develop a particular solution. • Document a design process to provide an ongoing record of a solution's development (such as initial ideas, sketches, tests conducted, data collected, decisions made and results of these decisions). • Present a design solution to a chosen audience structured by the design process used to develop that solution. Use documentation of this design process as a resource. **Content Elaborations** **CLARIFICATIONS** As designers engage in a design process to develop a solution, they can build important records of their work by documenting the processes they use to create their solutions. By keeping a record of the nonlinear, iterative process implemented, a designer can track the progression from initial ideas to a finished design. This record makes clear the decisions made during the process and the results of those decisions. Documentation includes information such as ideas, observations, sketches, test procedures, data collected and the role this data plays in decisions made during the design process.

Topic 2: Identify a problem and use an engineering design process to solve the problem.	
	When developing a solution to a problem, designers often need to present their findings to other stakeholders. Clear and detailed documentation of the processes they have used to design their solutions provides information needed for these presentations. Useful methods for documenting a design process include using an engineering notebook, journal, blog, website or portfolio to structure the ongoing recording of this process. **CONTENT FOCUS** The focus is on students documenting the design processes they use as they develop solutions for a particular product, process or problem. Students present the design processes they applied to develop their solutions using their ongoing records of these processes as a resource.

Topic 3: Demonstrate that solutions to complex problems require collaboration, interdisciplinary understanding and systems thinking.	
9-12.DT.3.a. Evaluate a technological problem that has benefited from a multidisciplinary approach.	**Expectations for Learning** **LEARNING PROGRESSION** In grades 6-8, students collaborated to solve problems as interdisciplinary teams, modeling different roles and functions. In grades 9-12, students evaluate a technological problem that has benefited from a multidisciplinary approach. **IMPORTANT CONCEPTS** • Design solutions can be evaluated and improved through collaboration between multiple disciplines when considering problems and their solutions. • A multidisciplinary approach to problems and their solutions helps ensure relevant perspectives, knowledge and skills are applied to a design solution. **KEY SKILLS/PROCEDURES** • Determine the disciplines that contribute to the solution of a given problem. • Identify the knowledge and skills from each discipline that contribute to the solution of a given problem. • Explain and evaluate the contribution of each discipline that is applied to the solution of a given problem. **Content Elaborations** **CLARIFICATIONS** Approaching problems through multidisciplinary lenses brings different knowledge, skills and perspectives to developing solutions. For example, to provide internet connectivity to all people, internet service providers must consider factors, including distance from areas with existing connectivity, terrain, governmental regulations, environmental impact and return on investment. This requires people with knowledge and skills from multiple disciplines or fields, such as information technology, civil engineering, business and environmental science. **CONTENT FOCUS** This content statement focuses on students analyzing a problem from the perspectives of multiple disciplines and evaluating how each discipline contributed to the effectiveness of the solution.

Topic 3: Demonstrate that solutions to complex problems require collaboration, interdisciplinary understanding and systems thinking.	
9-12.DT.3.b. Locate and evaluate past predictions about the development of technology.	**Expectations for Learning** **LEARNING PROGRESSION** In grades 6-8, students explained ways that invention and innovation within one field can transfer into other fields of technology. In grades 9-12, students locate and evaluate past predictions about the development of technology. **IMPORTANT CONCEPTS** • People have been making predictions about the development of technology with varying degrees of accuracy throughout history. • The accuracy of predictions can depend on interactions between and within systems (such as the accuracy of a prediction about a product's success depending on how that product's development and marketing take into account consumers' wants and needs). • Studying and evaluating past predictions about the development of a technology can inform future development decisions. **KEY SKILLS/PROCEDURES** • Identify past technological trends and predictions. • Identify interdisciplinary understandings that impacted the development of a past technology. • Identify interactions between and within systems that impacted the development of a past technology. • Compare predicted and actual results concerning a technological development. • Analyze the factors that contributed to the accuracy of predictions made about a technological development. **Content Elaborations** **CLARIFICATIONS** Throughout history, technological implementations have benefited from past predictions about future needs. Evaluations of past predictions about technology development are based on historical records, evidence of implementation, attempts, successes and failures. Research may be required to identify past technological developments, their successes and failures. Examining past predictions about the development of a technology and the reasons why they were or were not accurate can inform future development decisions. For example, Google Glass smart glasses, initially developed as a prototype for early adopters, were marketed to the public following the initial release to early adopters. However, Google's expectation that Google Glass would have wider public appeal was never realized due to consumer concerns about privacy, cost and other issues. The initial promotion for public use

Topic 3: Demonstrate that solutions to complex problems require collaboration, interdisciplinary understanding and systems thinking.	
	of the glasses shifted to the workplace, with later versions of the glasses used in specific work settings, such as factories and the medical field. **CONTENT FOCUS** The focus is on evaluating predictions made about a technology's development and use, using historical research on the implementation of that technology. This includes researching predictions, patterns of adoption and non-adoption and impacts, both past and present. Students also consider future implications for technology development.
9-12.DT.3.c. Describe techniques for making decisions about the future development of technology.	**Expectations for Learning** **LEARNING PROGRESSION** In grades 6-8, students examined factors that drive new technology development, such as commercialization, creative/inventive thinking and cultural/historical influence. In grades 9-12, students describe techniques for making decisions about the future development of technology. **IMPORTANT CONCEPTS** • It is necessary to determine the criteria that will guide decision-making about future technological development and the relative importance of these criteria. • Criteria used to make decisions involving future technological developments include social, environmental, economic, political, safety and cultural considerations. • Knowledge gained from different disciplines often is applied when assessing decision-making criteria. • Developers apply techniques (such as the use of matrices) to make decisions about future technological development. **KEY SKILLS/PROCEDURES** • Identify criteria that can be used to make decisions about the future development of a technology and the relative importance of these criteria. • Deconstruct a decision-making process, including the criteria weighed when making a decision. • Describe how decision-making techniques (such as the use of matrices) can be applied to guide future development of a technology. • Identify current research and development being used to make decisions about future technological developments.

Topic 3: Demonstrate that solutions to complex problems require collaboration, interdisciplinary understanding and systems thinking.	
	Content Elaborations **CLARIFICATIONS** Several criteria affect decision-making processes when considering technology development and adoption. Technology development stems from needs or wants in areas where improvements can be realized. Criteria to take into account when making decisions about the when, how, where and what of technology development include social, environmental, economic, political, safety and cultural considerations. Using decision-making matrices to rank various solutions and consider decision points is one technique that can be used to guide future technological development. For example, students might use this technique to weigh costs and benefits or pros and cons for different solutions to make decisions about the development of a technology. **CONTENT FOCUS** The focus is on students understanding how techniques can be used to guide decisions about the future development of technology. This includes criteria that could be considered as part of the decision-making process and their relative importance.
9-12.DT.3.d. Analyze the interactions within systems and between systems.	**Expectations for Learning** **LEARNING PROGRESSION** In grades 6-8, students gave examples of how changes in one part of a system can impact other parts of that system. Students also deconstructed a system into its component parts and described how they interrelate. In grades 9-12, students analyze the interactions within systems and between systems. **IMPORTANT CONCEPTS** • The components within a system interact with each other to produce a desired outcome. • Systems can have an effect on other systems, interacting to produce a desired outcome. **KEY SKILLS/PROCEDURES** • Deconstruct a system by explaining the functions of its components and how their interaction affects the desired outcome. • Identify and describe a system that interacts with other systems, explaining how the interaction between systems affects the desired outcome.

Topic 3: Demonstrate that solutions to complex problems require collaboration, interdisciplinary understanding and systems thinking.	
	Content Elaborations **CLARIFICATIONS** Systems are made up of multiple components organized to achieve a common goal. Components within a system can interact internally with other components in that system. Systems also can interact with each other to achieve a desired outcome. Data and feedback are used to optimize performance. For example, an automobile features several systems that collect data. A central computer collects data from all the systems to optimize the performance of the vehicle, such as braking performance and crash avoidance. Typically, the braking system is controlled by the driver. However, systems involving the brakes and collision sensors can interact to improve car safety using feedback from these sensors. As sensors monitor for objects in the car's path, brakes are activated when sensor feedback indicates danger of a collision. **CONTENT FOCUS** Students choose systems to analyze, focusing on how the interactions among system components and between systems affect achieving a desired outcome.
9-12.DT.3.e. Apply systems thinking to solve a complex problem.	**Expectations for Learning** **LEARNING PROGRESSION** In grades 6-8, students deconstructed a system into its component parts and described how they interrelate. In grades 9-12, students apply systems thinking to solve a complex problem. **IMPORTANT CONCEPTS** • Interactions between or within systems can be the cause of complex problems. • Systems thinking can be used with a design process to solve a complex problem. • One's understanding of the interactions within and between systems (systems, subsystems and system components) can impact the solution developed for a complex problem. • An efficient method for analyzing a complex problem is to break it down into simpler problems.

Topic 3: Demonstrate that solutions to complex problems require collaboration, interdisciplinary understanding and systems thinking.	
	KEY SKILLS/PROCEDURES • Identify the systems, subsystems and system components that impact a complex problem. • Analyze how interactions between systems, subsystems and system components impact a complex problem and its solutions. • Design multiple solutions to a complex problem taking into consideration the interactions identified between systems, subsystems and system components. • Evaluate solutions to a complex problem in terms of how they will affect and be affected by other systems. **Content Elaborations** **CLARIFICATIONS** Complex problems do not exist within an isolated environment or system. Solving such problems requires applying a systems-thinking approach and considering influences across interrelated systems. Systems thinking can be used with a design process to solve a complex problem. For example, a decrease in fuel economy from a vehicle could be caused by one of many subsystems that help to control the engine/fuel system. **CONTENT FOCUS** The focus is on solving a complex problem by breaking it down into simpler problems and determining the systems, subsystems and parts that impact the problem.

Topic 4: Evaluate designs using functional, aesthetic and creative elements.	
9-12.DT.4.a. Evaluate project/product solutions and communicate observations of the entire design process results.	**Expectations for Learning** **LEARNING PROGRESSION** In grades 6-8, students examined the progression of a product to identify how the functional, aesthetic and creative elements were applied. In grades 9-12, students evaluate project/product solutions and communicate observations of the entire design process results. Students also determine revisions and modifications to a design's function and aesthetics based on data/information related to product testing. **IMPORTANT CONCEPTS** • Evaluation of a project or product solution should describe what aspects of the solution are effective and what aspects need improvement. • Solutions should be evaluated at key points over the course of a design process, recording results and observations to show progress made toward project or product goals. **KEY SKILLS/PROCEDURES** • Evaluate functional, aesthetic and creative elements for quality during a design process. • Evaluate examples of products in relation to application of the principles and elements of design. • Communicate and display evaluation results and solutions and discuss observations made over the course of a design process. **Content Elaborations** **CLARIFICATIONS** As students develop project or product solutions, they must examine their ideas to make sure they meet design requirements. Their evaluation must include consideration of the functionality of the design. Does the design achieve its given purpose? Students evaluate the aesthetic appeal of the design using the design principles (balance, rhythm, proportion, unity and emphasis) and elements (line, shape, form, color, texture, space and value). Students must evaluate how creative elements are applied through design choices. Using a design portfolio, students can communicate evaluation results and observations they record throughout the process of solution development. Artifacts such as sketches, pictures, video and other visual representations of their projects need to be included in the portfolio to document progress. **CONTENT FOCUS** This content statement focuses on students evaluating a design solution in terms of its functionality, aesthetic appeal and creativity and documenting the progression of the solution over the course of the entire design process. Students then communicate their observations of process results.

Topic 4: Evaluate designs using functional, aesthetic and creative elements.	
9-12.DT.4.b. Interpret data/information related to product testing to determine revisions and modifications to a design's function and aesthetics.	**Expectations for Learning** **LEARNING PROGRESSION** In grades 6-8, students examined the progression of a product to identify how the functional, aesthetic and creative elements were applied. Students also applied the design principle "form follows function" to develop a product. In grades 9-12, students interpret data/information related to product testing to determine revisions and modifications to a design's function and aesthetics. **IMPORTANT CONCEPTS** • A design solution must be usable and based on current methods and materials, with thought given to future technologies to leave open the possibility of finding new solutions. • Determining the balance of functionality and aesthetics is important to creating a successful design and guides revisions and modifications made to a design. • There are processes and procedures for testing the functionality and aesthetics of products. • Product designs may be modified in terms of functionality and aesthetics based on results of product testing. **KEY SKILLS/PROCEDURES** • Interpret product testing data in terms of design criteria concerning functionality and aesthetics. • Analyze multimodal representations of product testing data (such as charts, diagrams and testing for acoustics or noise). • Determine revisions and modifications needed in terms of functionality and aesthetics based on product testing. • Assess revisions and modifications in relation to functionality and aesthetics. **Content Elaborations** **CLARIFICATIONS** Concern with functionality when developing a product is a critical component of testing and evaluation. The aesthetic appeal of a product design can affect user satisfaction with the human-built world and also must be considered. Results from product testing provide crucial information that guides revisions and modifications to a product's functional and aesthetic design. When interpreting test data concerning the functionality of a product design, students consider efficiency, sustainability, affordability (cost benefit analysis), simplicity and usability. Can the product be used, maintained or fixed easily? Students consider design principles (balance, rhythm, proportion, unity and emphasis) and elements (line, shape, form, color, texture, space and value) when evaluating aesthetic appeal.

Topic 4: Evaluate designs using functional, aesthetic and creative elements.	
	Developers weigh the relative importance of the functional and aesthetic elements of a product's design. Some products may be designed primarily for functionality. However, concern with only functionality may leave consumers dissatisfied with the lack of aesthetic appeal. Developers may consider questions such as, "Can a product be made more aesthetically pleasing while not sacrificing functionality?" Students can construct rubrics or checklists using design criteria concerning functionality and aesthetics. They can use these tools to guide their interpretations of testing data and the revisions and modifications they make to product designs. Students can study the changes to models of products over time, discussing revisions and modifications in terms of the functional and aesthetic elements. **CONTENT FOCUS** The focus is on students evaluating selected products in terms of functionality and aesthetics using data gained from testing. Students interpret this data to make revisions and modifications to the product's design.
9-12.DT.4.c. Critically evaluate a design solution at multiple points of a design process. Consider design requirements and adjust processes and outcomes as needed.	**Expectations for Learning** **LEARNING PROGRESSION** In grades 6-8, students examined the progression of a product to identify how the functional, aesthetic and creative elements were applied. Students considered design requirements to justify decisions when developing solutions to problems. In grades 9-12, students critically evaluate a design solution at multiple points of a design process. They consider design requirements and adjust processes and outcomes as needed. **IMPORTANT CONCEPTS** • Design outcomes and processes are adjusted and refined as solutions are developed. • Evaluating a design at multiple points during development can result in a more efficient process, enabling adjustments to be made throughout this process. • When evaluating a design solution, it is important to consider the design from perspectives that were not previously considered. **KEY SKILLS/PROCEDURES** • Determine what information is critical to the success of a design solution and the evaluations that are needed to capture this information. • Determine evaluation points during the design process timeline. • Analyze and interpret evaluation results, including feedback and product testing data. • Determine adjustments to design processes and outcomes based on design requirements, such as criteria and constraints.

Topic 4: Evaluate designs using functional, aesthetic and creative elements.	
	Content Elaborations **CLARIFICATIONS** Evaluating a design solution at multiple points during a design process allows developers to adjust this process to achieve optimal outcomes. By verifying design requirements at these points, adjustments can be made as needed. Evaluation of a design solution can include considering data and feedback from various sources (such as end-user input, research of existing sources of data or running tests and simulations). A critical aspect of conducting these evaluations is determining when would be the most advantageous points for evaluations to take place during the process. It can be useful to revisit past design solutions for ideas that can be applied to a current project, as well as future designs. Doing so can promote viewing the solution from a perspective that has not been considered and uncovering new ways of thinking about or approaching the design. Students evaluate solutions as a part of their own design projects. They also can consider examples of product design specifications and view these designs in various phases of the design process. Students can analyze changes in the product designs in terms of needs and desires concerning design outcomes. **CONTENT FOCUS** The focus is on students evaluating their design solutions and interpreting the results. These results determine what changes are needed in processes and outcomes based on design requirements. Evaluation occurs at critical points during development, with adjustments made before final products or design solutions are implemented. **Career Connections** **CAREER PLANNING** Students work with their community to identify real-world problems to solve. Consider having students work with the district's Business Advisory Council to hear about the real issues businesses face. Students can bring these issues back to the classroom to develop solutions through implementing the design process with evaluations of the process along the way. Students can work closely with representatives of the community to test their designs and, using an iterative design process, refine their solutions based on feedback. Consider how this type of opportunity may lead to an internship or other work-based learning opportunity for students.

Topic 4: Evaluate designs using functional, aesthetic and creative elements.	
9-12.DT.4.d. Explain the interrelationship between technology, creativity and innovation.	**Expectations for Learning** **LEARNING PROGRESSION** In grades 6-8, students examined the progression of a product to identify how the functional, aesthetic and creative elements were applied, including principles of universal design and "form follows function." In grades 9-12, students explain the interrelationship between technology, creativity and innovation. **IMPORTANT CONCEPTS** • Evaluation of a design solution takes into account appearance, user experience, form, function, innovation and creativity. • Common, everyday items (such as whiteboards, pencils, desks, cell phones and computers) have undergone a process of design and redesign that applied innovation and creative invention, making earlier designs less desirable. • Continuous improvement is an iterative process of redesigning and creating more functional and aesthetically pleasing products. This process should be ongoing, occurring throughout the course of development. **KEY SKILLS/PROCEDURES** • Assess the role innovation and creativity play in technological progress. • Identify and discuss improvements to items that have undergone iterations of redesign by examining the functional, aesthetic and creative elements (such as a common item that has undergone many iterations or a completed design that has undergone iterations). **Content Elaborations** **CLARIFICATIONS** The flexible, iterative nature of a design process provides the opportunity for creative and innovative thinking to be applied during the development of a technology. Technological change is a function of this thinking, with creativity and innovation seen in improvements to functionality and aesthetics. Design solutions need to be evaluated in terms of how well they meet design requirements (aspects such as form, function, appearance, user experience, innovation and creativity). Developers weigh the relative importance of functional and aesthetic elements of a product's design. Determining this balance is important to creating a successful design. Companies develop technological advances based on perceived and discovered needs in the market. Those needs are based on people's desires for functional, creative and aesthetic elements. **CONTENT FOCUS** Students evaluate solutions or products in terms of how well they meet the design requirements (aspects such as user experience, form, function, appearance, innovation and creativity).