Introduction

The Ohio Department of Education’s Office of Learning and Instructional Strategies is in the process of revising Ohio’s Model Curriculum for Computer Science.

The State Board of Education adopted Ohio’s Learning Standards and Model Curriculum for Computer Science in December 2018. Implemented in the 2019-2020 (FY2020) school year, the purpose of Ohio’s Learning Standards and Model Curriculum for Computer Science is to provide guidance to schools and districts. Ohio educators, many of whom engage daily with Ohio students, led the process to create Ohio’s Learning Standards and Model Curriculum for Computer Science.

The review and revision process presents an opportunity for families, computer science professionals, community members and other educators, to provide suggestions for improving the model curriculum through a public comment survey, open March 2 through March 18.

In the Fall of 2021, the public was invited to provide comments on the current standards and model curriculum. Advisory group members, who have an educational background or professional experience in computer science, met several times to discuss the public comment and make suggestions for revisions. The advisory group then provided direction and guidance to the working groups of Ohio educators, who worked to write the revisions.

The following is a draft of the revised model curriculum available for viewing and public comment. This document contains the revisions to the model curriculum for the Network and the Internet strand. This model curriculum addresses new proposed standards and therefore new content.

In your review, please focus on the content of the statements. All materials will be going through additional technical edits, but because of the timeline outlined in HB110, the Department wanted to make these drafts available for public comment at this time.

To see the model curriculum adopted by the Ohio State Board of Education in 2018 please visit the Model Curriculum for Computer Science.
Overview of the Computer Science Standards Framework

Ohio’s Computer Science Standards are organized by strands, topics and content statements.

Kindergarten through Grade 8—Content statements are organized by grade level. Below is an example of a content statement for kindergarten and its corresponding content statement code. This content statement addresses the topic of Devices within the Computing Systems strand.
## Kindergarten

<table>
<thead>
<tr>
<th>Strand</th>
<th>Artificial Intelligence</th>
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</thead>
<tbody>
<tr>
<td>Topic</td>
<td>Internet of Things</td>
</tr>
<tr>
<td><strong>NI.IOT.K.a</strong></td>
<td>With guidance and support, identify what smart devices are to recognize what devices are used to connect to the internet.</td>
</tr>
<tr>
<td><strong>NI.IOT.K.b</strong></td>
<td>With guidance and support, recognize how devices connect and exchange data over the internet to demonstrate how information is shared.</td>
</tr>
</tbody>
</table>

### Expectations for Learning

#### LEARNING PROGRESSION
In Kindergarten, with guidance, students are introduced to the idea of what smart devices are, and identify them. In grade 1, students will begin to develop an understanding of smart devices.

#### IMPORTANT CONCEPTS
- A smart device (such as a virtual assistant) is a device that has connectivity, captures useful data and presents it
- A basic technological device (such as a remote control) is missing at least one of these abilities

#### KEY SKILLS/PROCEDURES
- Identify smart devices
- Differentiate between basic technological devices and smart devices

### Content Elaborations

#### CLARIFICATIONS
A student could sort devices into groups of smart devices and basic technological devices.

#### CONTENT FOCUS
Introduce students to the concept of smart devices.

#### COMPUTER SCIENCE PRACTICES

*Practice 7. Communicating About Computing*

  2. Describe, justify, and document computational processes and solutions using appropriate terminology consistent with the intended audience and purpose.*
## Grade 1

<table>
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<tr>
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</table>

### NI.IOT.1.a Identify what smart devices are to recognize what devices are used to connect to the internet.

### NI.IOT.1.b Recognize how devices connect and exchange data over the internet which demonstrates how information is shared.

### Expectations for Learning

**LEARNING PROGRESSION**

In Kindergarten, with guidance, students were introduced to the idea of what smart devices are and identified them. In grade 1, students will begin to develop an understanding of smart devices. In grade 2, they will explain how devices connect and exchange data. Additionally, they will explore different network connectivities.

### IMPORTANT CONCEPTS

- Smart devices connect to the internet using wifi or mobile networks
- Information over a network is broken down into small chunks

### KEY SKILLS/PROCEDURES

- Recognize if a smart device is connected to the internet for the purpose of accessing shared information

### Content Elaborations

**Clarifications**

Networks can be demonstrated unplugged using ideas like the telephone game or a string to simulate information getting shared.

**Content Focus**

Smart devices get their information from the internet and other devices.

**Computer Science Practices**

*Practice 7. Communicating About Computing*

1. Describe, justify, and document computational processes and solutions using appropriate terminology consistent with the intended audience and purpose.
## Grade 2

<table>
<thead>
<tr>
<th>Strand</th>
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<tbody>
<tr>
<td><strong>Topic</strong></td>
<td>Internet of Things</td>
</tr>
<tr>
<td><strong>NI.IOT.2.a</strong></td>
<td>With guidance, students will explain how devices connect and exchange data over different environments to explore how information is shared.</td>
</tr>
</tbody>
</table>

### Expectations for Learning

#### LEARNING PROGRESSION

In grade 1, students began developing an understanding of smart devices. In grade 2 they will explain how devices connect and exchange data. Additionally, they will explore different network connectivities. In grade 3, students will describe information transmission and explore and explain the difference between smart and intelligent devices.

#### IMPORTANT CONCEPTS

- Some networks are shared, or public and some are private
- Public networks are less secure than private networks

#### KEY SKILLS/PROCEDURES

- Explain the difference between common types of network connections (such as the school wifi vs. home wifi) and which is more secure

### Content Elaborations

#### CLARIFICATIONS

Information can be shared via public or private internet connections, such as home, school, or library.

#### CONTENT FOCUS

Public internet connections are less secure than private internet connections.

#### COMPUTER SCIENCE PRACTICES

*Practice 7. Communicating About Computing*

2. Describe, justify, and document computational processes and solutions using appropriate terminology consistent with the intended audience and purpose.
## Grade 3

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<thead>
<tr>
<th>Strand</th>
<th>Artificial Intelligence</th>
<th>Topic</th>
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<tbody>
<tr>
<td>NI.IOT.3.a</td>
<td>Describe how devices</td>
<td>Describe how devices send and</td>
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<td></td>
<td>send and receive</td>
<td>receive information over</td>
</tr>
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<td></td>
<td>information</td>
<td>physical or wireless paths in</td>
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<td></td>
<td></td>
<td>order to identify how</td>
</tr>
<tr>
<td></td>
<td></td>
<td>information is transmitted.</td>
</tr>
<tr>
<td>NI.IOT.3.b</td>
<td>Define intelligent</td>
<td>Define intelligent devices and</td>
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<td></td>
<td>devices and describe</td>
<td>describe the difference between</td>
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<td>the difference between</td>
<td>smart devices and intelligent</td>
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<td></td>
<td>smart devices and</td>
<td>devices in order to identify</td>
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<td></td>
<td>intelligent devices</td>
<td>the difference in their</td>
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<td></td>
<td>in order to identify</td>
<td>capabilities.</td>
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</tbody>
</table>

### Expectations for Learning

#### LEARNING PROGRESSION

In grade 2 students explained how devices connect and exchange data. Additionally, they explored different network connectivities. In grade 3, students will describe information transmission, explore, and explain the difference between smart and intelligent devices. In grade 4, students will recognize how smart and intelligent devices communicate over the internet, and see how network communication can be traced.

#### IMPORTANT CONCEPTS

- Devices send and receive information both wirelessly (wifi, Bluetooth, etc.) and through wired connections
- A smart device (such as a Virtual Assistant) is a device that has connectivity, captures useful data and presents it
- An intelligent device is a smart device that adapts or learns

#### KEY SKILLS/PROCEDURES

- Describe the basic difference between wireless and wired connections
- Define and recognize the difference between smart and intelligent devices, as well as how we interact with them differently

### Content Elaborations

#### CLARIFICATIONS

Explain and distinguish between smart devices such as Bluetooth, wifi and Virtual Assistants. Provide examples of Smart vs. Intelligent devices.

#### CONTENT FOCUS

Explore the difference between smart and intelligent devices and understand how they communicate using networks.

#### COMPUTER SCIENCE PRACTICES

*Practice 7. Communicating About Computing*

2. Describe, justify and document computational processes and solutions using appropriate terminology consistent with the intended audience and purpose.
# Computer Science Model Curriculum: Internet of Things DRAFT

## Grade 4

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<thead>
<tr>
<th>Strand</th>
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<tbody>
<tr>
<td>NI.IOT.4.a</td>
<td></td>
<td>Explore how information is transferred to the internet from smart and intelligent devices in order for students to recognize how the internet and networks operate.</td>
</tr>
<tr>
<td>NI.IOT.4.b</td>
<td></td>
<td>Describe how transferred information is tagged using identifiers in order to transmit information about the user so that students begin to learn no information on the internet is anonymous.</td>
</tr>
</tbody>
</table>

### Expectations for Learning

#### LEARNING PROGRESSION

In grade 3, students described information transmission, explored, and explained the difference between smart and intelligent devices. In grade 4, students recognize how smart and intelligent devices communicate over the internet, and see how network communication can be traced. In grade 5, students will explore how information is transmitted over the internet and identify the risks and benefits of using the internet.

#### IMPORTANT CONCEPTS

- The information collected by smart and intelligent devices to be transferred over the internet can be identified to the user
- No information that is transmitted over the internet is anonymous

#### KEY SKILLS/PROCEDURES

- Describe how information can be identified when transmitted over a network
- Explain how information is sent over a network from a smart or intelligent device

### Content Elaborations

#### CLARIFICATIONS

Smart devices know how to create packets of information that have a "sender" and "recipient." Devices on the internet, know how to route those packets to the correct recipient.

Explain how data is transmitted across the internet and that anyone is allowed to look at it. Discuss that the act of sending information implied that the sender is giving permission for anyone who can see the datastream to examine its contents.

An example is the letter metaphor: Anyone can see the address on an envelope. If you open it and read it, you will know the contents. You can use coded (encrypted) messages to prevent people from knowing what the letter says.

#### CONTENT FOCUS

Describe how information is split into packets for communication and how those packets can be traced back to the sender.
## Grade 5

### NI.IOT.5.a
Learn and model how information is broken down to be transmitted by smart devices to help students visualize how information transfers over the internet.

### NI.IOT.5.b
Explore the benefits of the IoT with regards to convenience, safety, and health to gain an appreciation of the risks involved in using devices, including data theft, identity theft, tracking, and other forms of criminality.

### Expectations for Learning

#### LEARNING PROGRESSION

In grade 4, students recognize how smart and intelligent devices communicate over the internet, and see how network communication can be traced. In grade 5, students will explore how information is transmitted over the internet and identify the risks and benefits of using the internet. In grade 6, students will define the term blockchain in order to recognize how every bit of information shared over networks is personally identifiable. They will similarly explore the weaknesses in networks that allow programmers, both legitimate and illegitimate, to access that personal information.

#### IMPORTANT CONCEPTS

- There are benefits and risks to using devices connected to the internet

#### KEY SKILLSPROCEDURES

- Model and engage in safety practices while using the internet to reduce and avoid risks
- Explain how information is transmitted over the internet in packets
## Artificial Intelligence

### Internet of Things

<table>
<thead>
<tr>
<th>Content Elaborations</th>
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<tbody>
<tr>
<td><strong>CLARIFICATIONS</strong></td>
</tr>
<tr>
<td>Explain how data is transmitted across the Internet, and that anyone is allowed to look at it. Discuss that the act of sending information implied that the sender is giving permission for anyone who can see the datastream to examine its contents.</td>
</tr>
<tr>
<td>Explore methods that students can implement in order to reduce the risk of data theft.</td>
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<tr>
<th><strong>CONTENT FOCUS</strong></th>
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<tbody>
<tr>
<td>Apply the knowledge of networks to assess the risk factors, benefits, and convenience when using smart devices.</td>
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<tr>
<th><strong>COMPUTER SCIENCE PRACTICES</strong></th>
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<tbody>
<tr>
<td><strong>Practice 4. Developing and Using Abstractions</strong></td>
</tr>
<tr>
<td>4. Model phenomena and processes and simulate systems to understand and evaluate potential outcomes.</td>
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<tr>
<td><strong>Practice 7. Communicating About Computing</strong></td>
</tr>
<tr>
<td>3. Articulate ideas responsibly by observing intellectual property rights and giving appropriate attribution.</td>
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</tbody>
</table>
## Grade 6

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**NI.IOT.6.a** Define and explore what the term IoT entails to identify the different aspects of embedded devices, smart devices and intelligent devices, and the way they record, observe and mimic human habits.

**NI.IOT.6.b** Identify and define blockchains to recognize how every device made has unique identifiers and the weaknesses that allow programmers and hackers to see personal identifiable information.

### Expectations for Learning

#### LEARNING PROGRESSION

In grade 5, students gained an understanding of how information is broken into pieces to be transferred over the internet and to use risk/benefit analysis in device utilization. In Grade 6 students will research and define how different smart/intelligent devices track human activities in order to record and mimic their habits. In grade 6, students will define the term blockchain in order to recognize how every bit of information shared over networks is personally identifiable. They will also explore the weaknesses in networks that allow programmers, both legitimate and illegitimate, to access that personal information. In Grade 7, students will be able to explain the positive and negative uses of IoT as it applies to daily life.

#### IMPORTANT CONCEPTS

- Our devices use data collected from our daily habits to personalize our experience (i.e ads, mapping, daily routines)
- Personally identifiable information is gathered and transmitted across networks

#### KEY SKILLS/PROCEDURES

- Review the phrase Internet of Things and how it connects to the blockchain
- Recognize that connections to the internet are key to IoT and these connections are able to mimic human behavior and respond to input
- Recognize that devices have unique identifiers that allow programmers to access identifiable information

### Content Elaborations

#### CLARIFICATIONS

Humans interact with the world through our senses: touch, smell, sight, taste and hearing. Sense receptors in your body are constantly receiving information about the world, from the heat of your coffee cup to the smell of the petunias in your yard, and transmitting it to your brain, where you decide what to do about it. The Internet of Things (IoT) derives its power from technologies that mimic these functions: sensors embedded in devices and internet connections that allow networked devices to gather massive amounts of information and analyze it all for meaning.

All information that is sent and received over the internet is identifiable.
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</table>

Blockchain is a system of recording information in a way that makes it difficult or impossible to change, hack, or cheat the system. A blockchain is essentially a digital ledger of transactions that is duplicated and distributed across the entire network of computer systems on the blockchain.

**CONTENT FOCUS**

Devices track our habits both online and in the real world to adapt content to cater to our habits in order to provide a custom personal experience. All information on the network is identifiable and able to be tracked to the originator.

**COMPUTER SCIENCE PRACTICES**

*Practice 3. Recognizing and Defining Computational Problems*

1. Identify complex, interdisciplinary, real-world problems that can be solved computationally.
2. Decompose complex real-world problems into manageable subproblems that could integrate existing solutions or procedures.

*Practice 4. Developing and Using Abstractions*

4. Model phenomena and processes and simulate systems to understand and evaluate potential outcomes.
## Grade 7

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<tr>
<td>Topic</td>
<td>Internet of Things</td>
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</table>

**NI.IOT.7.a** Explain positive and negative uses of IoT as it applies to daily life; to explore the impact technology has on everyday life; and create ways to mitigate the negative impacts on society, as well as in their personal lives.

### Expectations for Learning

**LEARNING PROGRESSION**

In Grade 6, students researched and defined how smart and intelligent devices were able to track their activities in order to be able to personalize the experience of utilizing the device. In grade 7, students will recognize the positive and negative impacts that technology has on their daily lives as well as the impact of technology on society as a whole.

**IMPORTANT CONCEPTS**

- Devices track our daily movements as well as our online activities in order to quickly deliver information that is pertinent to us
- Data collected and stored has positive and negative effects

**KEY SKILLS/PROCEDURES**

- List the positive and negative uses of IoT and discuss how it applies to our daily lives
- Explain the benefits of the IoT, such as convenience, safety and health; and the risks, including data theft and other forms of criminality

### Content Elaborations

**CLARIFICATIONS**

On a personal level, IoT can also promote greater personal productivity through mobile payments (saving time and effort) and time-management apps. IoT devices can also greatly increase personal and home safety. Remote home monitoring makes it much easier to ensure home security.

From a medical perspective, there are huge benefits to using IoT devices to track an individual’s health trends. For instance, a smart bed can monitor your sleep, track the amount of high-quality sleep you get at night and potentially alert you to previously undiagnosed medical issues like sleep apnea. From an environmental perspective, IoT devices can facilitate immense cost and energy savings. Smart thermostat systems can identify which rooms require the most cooling or heating, and they can track the times of day when you tend to use certain areas of your house. By adjusting temperatures according to needs in real-time, a smart thermostat can reduce electricity use and save money.
On the other hand, data can show when we are asleep, when we are awake, where we are going, and how fast we are getting there. When this data enables services we want, we may be happy to provide it, but there are instances in which our connected devices and the data they collect might be used against us.

**CONTENT FOCUS**

The same devices and information that can help us can also make us vulnerable.

**COMPUTER SCIENCE PRACTICES**

*Practice 1. Fostering an Inclusive Computing Culture*

2. Address the needs of diverse end-users during the design process to produce artifacts with broad accessibility and usability.

*Practice 7. Communicating About Computing*

1. Select, organize and interpret large data sets from multiple sources to support a claim.
# Grade 8

<table>
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<tr>
<td><strong>Topic</strong></td>
<td>Internet of Things</td>
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</table>

**NI.IOT.8.a** Explore career pathways related to IoT to identify careers associated with the Computer Science field.

**NI.IOT.8.b** Model the lifecycle of information in the IoT: data gathering, transmission, reception, and analysis to recreate a real-world scenario.

## Expectations for Learning

### LEARNING PROGRESSION

In grade 7, students will recognize the positive and negative impacts that technology has on their daily lives as well as the impact of technology on society as a whole. In grade 8, students will explore their career interests through embedded activities. Career exploration strategies are opportunities for students to discover and understand the various aspects of IoT importance. In grades 9-12, students are able to gather information to be able to design simple smart applications and an accompanying life-cycle.

### IMPORTANT CONCEPTS

- Various careers are associated with IoT
- IoT information has a lifecycle

### KEY SKILLS/PROCEDURES

- List the various career pathways associated with the IoT field
- Explain the lifecycle of the information in the IoT

## Content Elaborations

### CLARIFICATIONS

Students will explore IoT careers and investigate the necessary pathways to engage in future academic and industry professions.

The lifecycle of information in the IoT is data gathering, transmission, reception, and analysis. To understand IoT, analysis involves recreating a real-world scenario. For example, Mary Claire Wright, a computer science teacher at Davidson High School in Mobile, Alabama, shared about her positive experiences using Igor’s IoT platform in her classroom and throughout the school. Wright discussed how she uses IoT-enabled lighting settings in order to make lights in her classroom bright or dim, warm or cool. These subtle changes help redirect students’ attention.

"I subtly change the lighting depending on what we have going on. High school students can listen to a lecture for about seven minutes before their attention starts to wander, and you have to do something to reset their clock. I use the lights. It has worked like a charm."
**Strand**  | **Artificial Intelligence**  
---|---  
**Topic**  | **Internet of Things**  

**CONTENT FOCUS**
The Internet of Things (IoT) is revolutionizing every industry, from home appliances to agriculture to space exploration.

The IoT is the worldwide network of internet-connected, automated devices that sense and collect interconnected data in order to allow users to monitor and control that environment.

**COMPUTER SCIENCE PRACTICES**

*Practice 4. Developing and Using Abstractions*

1. Evaluate existing technological functionalities and incorporate them into new designs

*Practice 3. Recognizing and Defining Computational Problems*

1. Identify complex, interdisciplinary, real-world problems that can be solved computationally.
Grades 9-12 Foundational Level

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<td>Internet of Things</td>
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**NI.IOT.9-12.F.a** Students will design an IoT life cycle scenario that encompasses data gathering, transmission, reception, and data analysis to demonstrate how the IoT operates and apply these skills to design products that model the process.

**NI.IOT.9-12.F.b** Students will explore and plan career pathways related to IoT to identify careers associated with the Computer Science field.

**Expectations for Learning**

**LEARNING PROGRESSION**

In Grade 8:
Students modeled the lifecycle of information in the IoT: data gathering, transmission, reception, and analysis to recreate a real-world scenario.

By the end of the 9-12 Foundational Level:
Students can gather information to be able to design simple smart applications and an accompanying life cycle.

In the 9-12 Advanced Level:
Students will be able to design and implement a working smart device and its life cycle or application for a smart device life cycle.

**IMPORTANT CONCEPTS**

- The IoT life cycle consists of smart devices, students will identify and analyze the data they gather, what they transmit across the internet, what entity receives the data, and what is done with the data after it is received.
- A smart device may receive as well as send information.

**KEY SKILLS/PROCEDURES**

- Demonstrate understanding of smart devices
- Demonstrate the life cycle of smart device implementations
- Design a smart device life cycle
- Implement a smart device life cycle (advanced)

**Content Elaborations**

**CLARIFICATIONS**

Smart devices, while an essential part of an IoT life-cycle, must be paired with other devices to transmit and receive data. That data must then be analyzed to provide meaning from that data.

**CONTENT FOCUS**

Smart device life-cycles.
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<tr>
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<td>Internet of Things</td>
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<tr>
<td><strong>COMPUTER SCIENCE PRACTICES</strong></td>
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<tr>
<td><em>Practice 3. Recognizing and Defining Computational Problems</em></td>
<td>1. Identify complex, interdisciplinary, real-world problems that can be solved computationally.</td>
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<tr>
<td></td>
<td>2. Decompose complex real-world problems into manageable subproblems that could integrate existing solutions or procedures.</td>
<td></td>
</tr>
<tr>
<td><em>Practice 4. Developing and Using Abstractions</em></td>
<td>2. Evaluate existing technological functionalities and incorporate them into new designs.</td>
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<tr>
<td><em>Practice 5. Creating Computational Artifacts</em></td>
<td>1. Plan the development of a computational artifact using an iterative process that includes reflection on and modification of the plan, taking into account key features, time and resource constraints and user expectations.</td>
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<tr>
<td>Strand</td>
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<tr>
<td>Grade 8</td>
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<tr>
<td>NI.IOT.9-12.A.a Students will design and implement an IoT life cycle scenario that encompasses data gathering, transmission, reception, and data analysis to demonstrate how the IoT operates and apply these skills to design products that model the process.</td>
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<tr>
<td>Grade 9-12 Foundational Level</td>
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<tr>
<td>Students are able to gather information to be able to design simple smart applications and an accompanying life cycle.</td>
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<tr>
<td>Grade 9-12 Advanced Level</td>
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<td>Students will be able to design and implement a working smart device and its life-cycle or application for a smart device life-cycle. Beyond High School: Students should be able to fully understand how smart devices communicating with each other create an &quot;Internet of Things,&quot; or IoT.</td>
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**Expectations for Learning**

**LEARNING PROGRESSION**

In Grade 8:
Students modeled the lifecycle of information in the IoT: data gathering, transmission, reception, and analysis to recreate a real-world scenario.

By the end of the 9-12 Foundational Level:
Students are able to gather information to be able to design simple smart applications and an accompanying life cycle.

In the 9-12 Advanced Level:
Students will be able to design and implement a working smart device and its life-cycle or application for a smart device life-cycle. Beyond High School: Students should be able to fully understand how smart devices communicating with each other create an "Internet of Things," or IoT.

**IMPORTANT CONCEPTS**

- The IoT life cycle consists of smart devices
- A smart device may receive as well as send information
- Students will identify and analyze the data they gather, what they transmit across the Internet, what entity receives the data, and what is done with the data after it is received

**KEY SKILLS/PROCEDURES**

- Demonstrate understanding of smart devices
- Demonstrate life cycle of smart device implementations
- Design a smart device life cycle
- Implement a smart device life cycle (advanced)

**Content Elaborations**

**CLARIFICATIONS**

Smart devices, while an essential part of an IoT life-cycle, must be paired with other devices to transmit and receive data. That data must then be analyzed to provide meaning from that data.
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**CONTENT FOCUS**
Smart device life-cycles.

**COMPUTER SCIENCE PRACTICES**

*Practice 3. Recognizing and Defining Computational Problems*
1. Identify complex, interdisciplinary, real-world problems that can be solved computationally.
2. Decompose complex real-world problems into manageable subproblems that could integrate existing solutions or procedures.

*Practice 4. Developing and Using Abstractions*
2. Evaluate existing technological functionalities and incorporate them into new designs.

*Practice 5. Creating Computational Artifacts*
1. Plan the development of a computational artifact using an iterative process that includes reflection on and modification of the plan, taking into account key features, time and resource constraints, and user expectations.
2. Create a computational artifact for practical intent, personal expression or to address a societal issue.

*Practice 6. Testing and Refining Computational Artifacts*
1. Systematically test computational artifacts by considering all scenarios and using test cases.
2. Identify and fix errors using a systematic process.
3. Evaluate and refine a computational artifact multiple times to enhance its performance, reliability, usability and accessibility.