TABLE 1: Structure of the Curriculum [Xu, 2020]

**Goal:** Design a smart greenhouse with a microcontroller and sensors to collect data and answer a relevant research question

Table 1 is very useful for teachers in planning their lessons and implementation. It is a very useful guide that contains learning goals, activities and suggested topics for reading. We suggest that, teachers use this table as a lesson plan.

<table>
<thead>
<tr>
<th>Day</th>
<th>Topic</th>
<th>Goals</th>
<th>Learning Activities</th>
<th>CS/Tech</th>
<th>Reading Materials</th>
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| 1   | Course Overview | • Learn the science of smart, automated greenhouses.  
• Understand microcontrollers, Python, and import statements. | • Introduce students to real-world greenhouses.  
• Conduct interactive coding in Python | • Use Python to perform basic arithmetic operations on the microcontroller. | How do greenhouses work? |
| 2   | Light and Plant Growth | • Understand how colors of light affects plant growth.  
• Program the LED strip to mimic professional grow lights. | • Watch a video on photosynthesis.  
• Understand the light spectrum.  
• Program the LED strip. | • Create instances of objects.  
• Use functions (methods) to modify states of objects and passing function arguments (Parameterization)  
• Use lists (data structures) to control colors of light. | Can plants "see" light? |
| 3   | Light and Plant Growth | • Understand how intensity of light affects plant growth and the relationship between light intensity and distance to light source/color.  
• Program the digital light sensor to measure light intensity in lux. | • Use the light sensor to measure light intensity from the LED strip.  
• Hypothesize the nature of the relationship between distance to the light source and light intensity.  
• Graph the light sensor readings at different distances to test the hypothesis and understand the relationship. | • Continue using functions (methods) with return values to read light intensity values in lux.  
• Use loops to measure data at specific intervals. | Light intensity and duration impact on plant growth |
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| 4   | Temperature/Humidity and Plant Growth      | • Understand how change of temperature affects (relative) humidity (think as a system).  
• Program temperature and humidity sensors to measure these two values. | • Watch a video on how temperature/humidity affect the photosynthesis/respiration.  
• Learn to collect data and automatically transmit data to other devices. | • Understand how data is communicated between networked devices.                | Temperature/humidity and plant growth                     |
| 5   | Treasure Hunt With Live Data Visualizations | • Make scientific hypotheses and use scientific reasoning with empirical data. | • Game: Treasure hunt. Select groups of students to hide temperature/humidity sensors somewhere in the classroom for others to locate using live data visualizations. | • Read real-time data visualization and make scientific arguments.      | N/A                                                    |
| 6   | Manipulation of Temperature/Humidity in Greenhouses | • Design an experiment to test hypotheses.  
• Use actuators (servos, relays, and fans) and “if” statements to achieve automation. | • Come up with a scientific hypothesis on how variables (temperature, humidity, light intensity, etc.) affect plant growth. Design a smart greenhouse that can manipulate these variables and collect data that helps support the hypothesis. | • Use if conditionals to achieve automation using sensor data and actuators. | N/A                                                    |
| 7   | Design and Build the Greenhouse            | Students continue to design and build a smart greenhouse that could help them support their hypotheses or answer research questions that they came up with in Lesson 6. |                                                                                                                                 |                                                                                                                     |