



Lesson 4: Design Indoor Lighting for Microgreens



Instructor:

Grade level: 9-12

Created/last edited/submitted:

Lesson Summary:

In this lesson plan, students will design and test an indoor lighting system for a local restaurant to generate the best production of microgreens that can be sold in the restaurant. Please note that we recommend the instructor break this lesson into three to four parts. Each part should be at least 45 minutes. In the first part, the instructor shares the design challenge, and ask students to conduct research and evaluate different light conduction that will have influence on the growth of microgreens. In the second part, the instructor asks students to draw prototype and list materials that they need to build their indoor lighting system. Students need to explain details in each part of their design and how they make their design decisions. In the third part, the instructor asks students to build the indoor lighting system and structure a research plan to collect data for their lighting system. After collecting data for 2~3 weeks later (after the microgreens fully grow), the instructor can have a presentation day (maybe serve microgreen salad) that students can present their lighting system design and research findings. In addition, students can discuss how they will redesign their lighting system by using the evidence from their research.

Objectives:

1. Students will use engineering design process to solve a design challenge.
2. Students will apply their knowledge about photosynthesis and lights to design a lighting system by visually and verbally presenting and explaining how they solve the problem and how they make their design decisions.

Skills of the day:

1. Science and engineering practices (Standards):

- a. Defining problems
- b. Developing and using models
- c. Planning and carrying out investigations
- d. Analyzing and interpreting data
- e. Designing solutions

2. Life skills:

- a. Critical thinking
- b. Using evidence to make decisions
- c. Communicating information

Words of the day:

- a. **Engineering design process:** As for the engineering design process, it involves thinking and strategizing approaches, such as defining problems, asking questions, searching for information, imagining solutions, planning things out, creating and improving that are all used to help engineers solve a problem. No single engineering design process (approach) exists; rather it is an iterative process to help engineers solve problems.

Background:

Farm-to-table has become the ultimate food trend for many upscale restaurants across the U.S. Restaurants use simple indoor hydroponic system to grow fresh and truly local and seasonal vegetables, and turn them to cuisine. Among the easiest and fastest growing crops, microgreens, miniature plants of greens, herbs or other vegetables, are one of the salad ingredients that have rich nutrition and flavor, and can be grown cost-effectively in a tiny space and with simple supplies. Microgreens are great crops for urban restaurants where they have limited space for outdoor gardening, but still want to serve fresh vegetables to their costumers.

Like other plants, growing microgreens require soil, water, and sunlight (or grow light). An effective artificial lighting system is especially important for restaurant chefs who want to grow microgreens in an indoor environment. Each type of herb requires different lighting conditions for successful growth, and grow lights come in different features, shapes, sizes, and price ranges. For example, different artificial lights, such as incandescent lights, fluorescent lights, LED lights, metal halide lights, high-pressure sodium lights and so on, have pro's and con's for indoor plant lighting. In addition, different light wattages also have influence on plants' growth. In order to select and design the best grow light system for indoor growing to generate the best production of microgreens for a local restaurant, students need to apply what they have learned from the pervious three lessons in this unit to solve the design challenge.

Activity 1 Design Challenge and Background Research: (~ 45 minutes)

1. Materials:

- a. Computers or device that has access to Internet.
- b. Wi-Fi or Internet
- c. (Optional) Engineering design process poster

2. Activity steps:

- a. 3 to 4 students in a group.
- b. Give the design challenge to students. Tell students that a local restaurant wants to use Farm-to-table concept to grow fresh salad to serve costumers. The restaurant chef wants to start with growing microgreens, which are

miniature plants of greens, herbs or other vegetables, in the restaurant where costumers can see how fresh their salad indigents are. Because the chef wants to grow microgreens indoor, it is important to have a lighting system that can help generate the best production of microgreens. Your design challenge is to design a lighting system that can generate the best production of microgrees for the restaurant.

- c. Discuss/review the engineering design process with students. Tell students that they are going to use engineering design process to design their lighting system for microgreens.
- d. Ask students to think about what they have learned from the pervious 3 lessons. Remind students that each type of herb requires different lighting conditions for successful growth. Therefore, they will need to conduct background research and evaluate different artificial lights, bulb wattages, light spectrum color, the best grow temperature for microgreens, and other important factors that will have influence on the lighting conditions for successful growth of microgreens.
- e. Ask students to write a short report of their research and share the report with the class.

Activity 2: Prototype and Material List (~ 45 minutes)

1. Materials:

- a. Shallow trays, such as aluminum foil baking tray.
- b. Organic soil/or regular soil
- c. Microgreens seeds
- d. Water
- e. Various artificial lights
- f. Thermometers
- g. Dark environment (e.g. put the microgreens trays in a big cardboard box, where it can block the natural sunlight).
- h. Computers or device that has access to Internet.
- i. Wi-Fi or Internet

2. Activity steps:

- a. 3 to 4 students in a group.
- b. Give each group 4 trays, soil, microgreens seeds and a thermometer.
- c. Ask students to exam different artificial lights that the instructor provided. If students cannot find what they need from the materials that the instructor provided, students are encouraged to search online to find what they need for their lighting system.
- d. After students exam different artificial lights, ask students to make a material list that they need to build their indoor lighting system.

- e. The instructor can set up a limited budget (such as \$50) for students to design their lighting system. Students can search online to get estimate prices for their design. In addition, in order to reduce the cost, students are encouraged to bring things from their home to use for their design.
- f. Ask students to draw prototype of their lighting system design.
- g. In the prototype, students need to explain details in each part of their design and how they make their design decisions.
- h. Ask students to present and share their prototype design with the class.
- i. Please note that either the instructor or students need to purchase the materials that students need to build their lighting system before the next part of the lesson plan.

Activity 3: Build the Lighting System and Construct a Research Plan (~ 45 minutes)

1. Materials:

- a. All the materials that students need to build their design
- b. Tools, such as rulers, tapes, glues, scissors, nails, hammers, saws, screwdrivers, and so on, that help students put the lighting system together.

2. Activity steps:

- a. 3 to 4 students in a group.
- b. Give students all the materials that they need from their material list to build their prototype lighting system.
- c. The instructor will set up a control group experiment, which the lighting system is the independent variable and the growth of microgreens is the dependent variable. In that way, students can use the control group as the guideline to set up their experimental group experiment.
- d. Ask students to construct a research/data collection plan. The research plan should use the lighting system as the independent variable. For example, what type of lights are used? How long students will keep their lighting system on? The growth of microgreens is the dependent variable. For example, what and how students will measure and record the growth of the microgreens? Besides the lights, students should control the rest of variables to be the same as the control group experiment.
- e. In addition to the research/data collection plan, students also need to come up a research management plan to keep the experiment going. For example, who is responsible of what?
- f. Ask students to share their research plan with the class, and the instructor will check students' research management plans.

- g. After students build their lighting system and have a research/data collection, and research management plan, ask students to put the soil and plant microgreens seeds in the trays. Wet the soil with water and put the trays in a dark environment. Ask students follow their research plan to turn on their lighting system, and record the data that they need for 2~3 weeks.

Discussion/Reflection (~45 minutes):

- a. Set up a date for students to present their result and showcase their lighting system design.
- b. Ask students to share their research result and if they will change their design. If students think about change their design, ask students to explain why they want to change their design.
- c. Ask students to talk about challenges when they design their lighting system and collect data.
- d. The instructor can structure this presentation day as a harvest day that students can enjoy the microgreens that they grow and present their findings.