# FUTU?ELAB+

AG/ENVIRONMENTAL Solution Seeking Microbes

# Design Thinking to Identify Challenges

Developed in partnership with: Discovery Education and Ignited

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#### Cover Image

*Lactobacillus casei* is one of many friendly bacteria in your gut microbiome.

# **Design Thinking to Identify Challenges**

# DRIVING QUESTION

How can we use the principles of design thinking to identify local and global challenges that can be solved with microbes?

# OVERVIEW

Design thinking applies empathy to problem-solving, allowing product designers to match technology with users' needs in a meaningful way. The focus of a design-thinking approach revolves around a deep interest in developing an understanding of the people for whom the product is designed. As a human-centered iterative and interactive process that focuses on customers as people with defined needs, this approach challenges assumptions to provide solution-based approaches to solve problems.

In this lesson, students will be introduced to the concepts of design thinking with an informal practice day where students will interview each other to identify generic challenges and design solutions to each other's challenge. Once students have a general idea of how to interact with the process of design thinking, they will use these concepts to design interview questions, research themed local and global challenges (climate change, disease, pollution, or food production), and conduct interviews of self-sought community participants. Students will showcase their design solutions in the next lesson in an event called "Micro-Con."

## ACTIVITY DURATION

Four to five class sessions (45 minutes each)

# ESSENTIAL QUESTIONS

What is a local or global challenge that involves one of the following: climate change, disease, pollution, or food production?

How can we develop empathy for people in our community?

How can microbes be utilized to solve a local or global challenge?

## OBJECTIVES

Students will be able to:

**Apply** the principles of design thinking to **develop** solutions to a simple challenge for a partner in class.

**Develop** empathy for the people they are interviewing.

**Identify** local and/or global challenges using the principles of design thinking.



# Materials

Poster paper (drawing models)

Таре

Modeling clay

Construction paper

Pipe cleaners

Toothpicks

**Building blocks** 

**Popsicle sticks** 

Scissors

Duct tape

Pens

Pencils

Career Profile: Aditya Kinjapur, PhD

Design Thinking Capture Sheet

Example Prototype/Student Sample

Micro-Con Challenge Topic Research Capture Sheet

Designing and Revising Interview Questions Capture Sheet

Interview Guidelines Resource

Toolkit

# **Pedagogical Framing**

Instructional materials are designed to meet national education and industry standards to focus on in-demand skills needed across the full product development life cycle—from molecule to medicine which will also expose students and educators to the breadth of education and career pathways across biotechnology.

Through this collection, educators are equipped with strategies to engage students from diverse racial, ethnic, and cultural groups, providing them with quality, equitable, and liberating educational experiences that validate and affirm student identity.

Units are designed to be problembased and focus on workforce skill development to empower students with the knowledge and tools to be the change in reducing health disparities in communities.



# SOCIAL-EMOTIONAL LEARNING

Students will practice empathy and understanding the perspectives of others, as they focus on the background, culture, and context of those they interview (their partners and a community member). This lesson will emphasize taking others' perspectives, demonstrating compassion for the user for whom they are developing a solution.

# CULTURALLY AND LINGUISTICALLY RESPONSIVE INSTRUCTION

As students focus on a deep understanding of the person for which they are optimizing a solution, they will focus on the culture and life experiences of their users. They will need to forgo their own biases and/or stereotypes to truly feel what it means to operate in the user's world and to feel the user's struggle in order to design an appropriate solution. Additionally, students may have the option to analyze local or global challenges to which they are not usually exposed, as teachers may wish to assign students specific communities to focus on as they design solutions.

# ADVANCING INCLUSIVE RESEARCH

Communities that have been historically mistreated by medicine are hesitant to engage in clinical research, and in order to engage these communities, trust must be rebuilt. In this lesson, students will explore some tools and strategies that researchers can use to facilitate recruitment in clinical trials, including taking time to build relationships with underrepresented groups, and increasing community knowledge and awareness of the clinical trial process. Students will practice developing cultural humility as they work to engage their community and develop solutions to their struggles.

### COMPUTATIONAL THINKING PRACTICES

Students implement a wide range of computational thinking strategies as they gain experience with the design thinking process. As they conduct and interpret data from interviews, students practice the computational thinking strategies of collecting and analyzing data. Later, students use the computational thinking strategies of finding patterns and developing algorithms in order to create a journey map. Finally, students gain experience with the computational thinking strategy of building models by constructing a 3D prototype.

### CONNECTION TO THE PRODUCT LIFE CYCLE

Through surveying and interviewing users, and developing an understanding of empathy and humandriven design principles, students engage deeply in the **develop** and **discovery** phases of the product life cycle. They begin defining a problem that microbial engineering can solve (**discovery**) and begin to create surveys and feedback mechanisms for their target audience (**develop**).

# Have you ever wondered...

# How do big-named companies design such userfriendly products?

Many of our favorite tools, whether that be phones, computers, skateboards, cooking equipment, or our favorite snack foods, have all been designed with the user in mind. Designers do not just create things "for fun," but also create their products by interviewing users and connecting to their needs.



# MAKE CONNECTIONS!

# How does this connect to the larger unit storyline?

By this lesson, students have learned the structure of microbes, where microbes are found, the diversity of microbes, how to take care of them, microbe superpowers, and how humans have utilized microbes. This lesson connects to the larger storyline by teaching students how to connect with their community, design interview questions, and identify challenges in order to solve a challenge using microbes.

By identifying a challenge, students will then be able to identify a potential microbe that will be their superhero, what superpowers the microbe will need to solve the challenge, or how the weapons or shields of this superhero microbe might be able to be used by humans to solve their challenges.

# *How does this connect to careers?*

**Product designers** use multiple tools (user interface, tech tools, principles of design) to recognize, define, and design a product for a particular client need. Product designers use their skills in working with people to identify customer pain points, brainstorm solutions for these pain points, and ultimately create a "journey map" of the product idea.

*Journalists* collect information from multiple sources, then share a more cohesive story with the public. To research a story, they read background information and interview experts in the field. That information becomes the substance of their visual or written work.

# *How does this connect to our world?*

Students will be identifying current local or global challenges that they will actively be trying to solve using microbes. Students have the option to identify challenges that are smaller scale and local or larger scale and global.



# Day 1

### LEARNING OUTCOMES

Students will be able to:

**Gather** data from an interview with their classmate.

**Identify** struggles, challenges, or problems by focusing on the life experiences of their classmates.

**Brainstorm** solutions to the challenges presented.

#### INDUSTRY & CAREER CONNECTION

Before beginning today's lesson, highlight the Career Profile: Aditya Kunjapur, PhD. Dr. Kunjapur who uses design and engineering to make useful products to help solve world challenges. As his focus is on creatively connecting information to innovate, he emphasizes the importance of listening to the client and asking the right questions.

#### COMPUTATIONAL THINKING IN ACTION

By participating in this design thinking activity, students are utilizing the computational thinking strategies of collecting data, analyzing data, finding patterns, and developing algorithms. Students come to understand that design thinking is a comprehensive way to solve problems.



# Procedure

| Whole | Group | (10 minutes) |
|-------|-------|--------------|
|       | aroup | (±0          |

- 1 Hand out the *Design Thinking Capture Sheet*. Begin class with a quick write. Ask students: *What do you think of when you hear the words design, thinking, and empathy*?
- 2 After three minutes, allow students to share or call on students (if none volunteer), and record responses on the board. Tell students that these terms describe a process called "design thinking" and that they will learn how design thinkers develop empathy when creating products that solve a problem. These skills will be used in the next lesson.
- 3 Tell students that instead of telling them exactly what design thinking is, it will be more fun to experience it for themselves. Invite them to engage with an open mind and an understanding that everyone in the class is new to what you will be doing today and that risks and mistakes are welcome.

## Small Group (35 minutes)

**Teacher Note** > You may wish to demonstrate Step 2 by describing your own day aloud, drawing on the board a graph where the x-axis is neutral and the y-axis is the "mood" you were in. As you tell the story of your day, draw a line on the graph that goes above and below the "zero" line, indicating the activities you were doing when you were at your "highs" and "lows." As an optional extension or "homework," you may wish to give students the chance to record the interview to listen multiple times and analyze comments. Have waivers available for this that students and parents sign, noting that the information will only be used in the classroom as appropriate. An example can be seen below.



# Day 1 Continued

#### COMPUTATIONAL THINKING IN ACTION

"Journey maps" are good demonstrations of the computational thinking strategy of developing algorithms, which involves listing out specific steps on how to accomplish a task.

# Procedure

- 1 Organize students into pairs, preferably with a partner who is not a close friend as it is important that students learn how to gain empathy, and will be more relevant if they do not have a personal connection already.
- Place prototype building materials (paper, sticks, pipe cleaners, tape, etc.) on a table where students have access to them. Tell students they will be creating a prototype or solution using various materials (point to the materials on the table) to solve a challenge with which their partners are faced. Tell students they will be playing the role of a **Product designer**, using their skills in working with people to identify customer pain points, brainstorm solutions for these pain points, and ultimately create a "journey map" of the product idea. Give students the four prepared interview questions, allowing them to read over them and prepare to interview. Encourage students who are being interviewed to try to communicate how they were feeling throughout the day.
  - **a.** Potential question 1: Would you please describe your day yesterday, from when you woke up to when you went to bed?
  - **b.** Potential question 2: From what you just described, what were the high or good points of your day?
  - **c.** Potential question 3: From what you just described, what were the low or bad points of your day?
  - **d.** Potential question 4: What is something that would have made your day better?.
- 3 Give the first student five minutes to ask the interview questions and record the student's responses on the capture sheet. After time is up, switch roles and allow five more minutes for the other student to interview. If students finish early, have them ask their interviewee to elaborate on some of their responses, giving personal stories.
- 4. Dig deeper: Give students a chance to write how they feel about the first interview and develop a few questions of their own for a second, quick follow-up interview (about one to two minutes for each interview this time). Instruct students to ask "why" often during the second interview and make sure the questions reflect what they learned about their partners in the first interviews. Encourage "awkward silence" to draw out more information, and to think about the strategies that are working or not working while interviewing.

# Day 1 Continued



# Procedure

- 5. Capture findings: Tell students to analyze their notes about the interviews. Students should identify what their partners are trying to accomplish or desire, any difficulties they have in trying to accomplish this, and something about each partner's experience that the other partner might not be aware of. Encourage them to include notes to help them remember these things.
- 6. Tell students to write a statement that illustrates the challenge. (e.g., My partner needs a solution to \_\_\_\_\_ because \_\_\_\_\_.)
- 7. Give students the remainder of class to brainstorm and sketch potential solutions for their partners. Tell students the more possibilities, the better. Their solutions should be varied and numerous. Encourage students to come up with solutions that might not solve the entire problem. Show students the materials available and tell them to bring in any additional (school appropriate) supplies that may help them design a prototype of their hero the next day.

# Day 2

LEARNING OUTCOMES

Students will be able to:

**Practice** empathy in designing a solution to a problem.

**Use** feedback to **optimize** a solution to a problem.

# Procedure

1

# Whole Group (3 minutes)

Give students three minutes to finalize their solution sketches. Tell students to circle their top three to five solutions for each partner's struggle or problem.

# Small Group (40 minutes)

- 1 Tell students to share their solutions with their partners. Set a timer for four minutes and tell the first student to explain potential solutions and allow the partner to give feedback on what he or she likes or dislikes. Encourage the use of "I like, I wish, I wonder..." feedback to get the conversation started. Remind students that feedback is most helpful when it is kind, specific, and helpful. The student should take notes. After the first partner is finished, students should switch roles and repeat. Tell students the goal is to learn about their partners and how they feel, so they should allow their partners to give feedback without trying to defend their solutions (not everyone thinks the same way).
- 2. After sharing with their partners, allow students time to reflect by writing in the Reflection section of the capture sheet on what they learned about their partners and what they liked or did not like about the prototype. Have students either select one of their prototypes to move forward with, modify a prototype, or create an entirely new solution that best accommodates their partners.
- 3. Tell students they will now build their physical prototypes. Allow students to use materials they brought in or supplies provided to build a prototype of their solution. Tell students to make something with which their partners can use or interact. For example, if a student has a hard time getting up in the morning because that student does not like the sound of an alarm clock, the teacher can show a prototype of an alarm clock that connects to a playlist of favorite songs using the materials on the table. They will not have much time to do this, and the constraint of time is meant to drive their creativity and to encourage unpolished ideas to materialize regardless of if students think they are "good" or not. Set the timer for ten minutes for this and encourage students to use the materials on the table.

Continues next page >

#### INDUSTRY & CAREER CONNECTION

Journalists collect information from multiple sources, then share a more cohesive story with the public. To research a story, they read background information and interview experts in the field. That information becomes the substance of their visual or written work.

#### COMPUTATIONAL THINKING IN ACTION

By building physical prototypes, students are developing the computational thinking strategy of building models.

# Day 2 Continued



# Procedure

- 4. Tell students they will now test their solutions and show them to their partners. Have students take turns (about five minutes each) giving their prototype to their partners. Tell students to allow their partners to use or misuse the prototype. Tell students the prototype is not important, but what is important is how it solves or does not solve their partner's challenges. Students will record their observations and partner's feedback. Students should record the following:
  - a. What worked?
  - **b.** What could be improved?
  - c. What questions did your partner have about the prototype?
  - d. What ideas did your partner have about the prototype?
- 5. You may wish to share the *Example Prototype/Student Sample* with students.

# Day 3

## LEARNING OUTCOMES

Students will be able to:

**Identify** the key components to the design-thinking process.

**Apply** the principles of design thinking to ideate solutions to a real-world challenge or problem.

# Procedure

# Whole Group (10 minutes)

- 1 Have each student place his or her prototype in the center or front of the room, wherever each student can easily see all prototypes. Lead the class in a reflection discussion of the activity, asking the whole group the following questions:
  - **a.** Who had a partner who made something that you really liked? (Ask them to share what they liked about it.)
  - **b.** Who sees a prototype that they want to learn more about? (Ask which one and have the student who made the prototype explain what it is for.)
  - c. How did talking to your partner help you in your design?
  - d. How did testing and getting feedback change your design?
  - e. What was the most difficult part of this process for you? (For example, interviewing, framing the challenge, generating ideas, sharing ideas, building prototypes, or testing prototypes.)

# Whole Group (15 minutes)

**Teacher Note** > You may want to display the design thinking process somewhere prominent in the room starting on Day 3 for the remainder of the unit. You may also wish to choose partners for your students for the remainder of the unit before beginning today's lesson.



# Day 3 Continued

# Procedure

- 1 Ask students to look at the components of design thinking on the poster (empathize, define, ideate, prototype, test). Ask for volunteers to give examples of each component from the previous days.
- 2 Invite students to answer the Lesson 9 questions in the **Toolkit**. Give students an opportunity to read the scientist profile on *Aditya Kunjapur* if they have not already, focusing on what he does in his field and what might be most relatable or what resonates most with the students. They should log their thoughts in the **Toolkit**: *Based on the career profile in this lesson, what does this tell you about the types of people that do science? What did you find most relatable?* If time permits, you may ask students to share their thoughts.

# Small Group (30 minutes)

1

Pass out the *Micro-Con Challenge Topic Research Capture Sheet*. Tell students they will choose a partner and work together to select a topic from one of the following categories (environmental, health, food production). Tell them they will be working with this partner for the remainder of the unit. In the next lesson, they will be designing microbebased solutions to the challenges they identify in this lesson. These solutions will be showcased in a three-day event called "Micro-Con" in which they will switch between being an attendee and a presenter, engaging in various activities, evaluating prototypes, dressing up as Superhero scientists or Superhero microbes, and observing the food that "Microgrub" provided for the event. This lesson will focus on identifying the challenges our community faces:

- a. Environmental
- **b.** Health
- c. Food production
- 2 Allow students the remainder of the period to research their topic in more detail, filling out the *Micro-Con Challenge Topic Research Capture Sheet.* You may wish to provide students with the articles, or ask them to research independently. Students should focus on the following:
  - **a.** Define your topic in detail. If there are multiple types, define each that you can find.
  - **b.** What is a specific challenge in this topic? (global and locally)



# Day 3 Continued

# **Procedure**

- c. What is causing this challenge?
- d. What, if anything, is currently being done to solve this challenge?
- e. How might microbes be utilized to solve this challenge?

# Homework:

Students may need more time to research. If so, finishing independently from their partners as homework to then share with them in the next class period would be appropriate. Also, since this lesson prepares students for future interviews with community members, you may wish to ask students to begin contacting potential interviewees for their project and start setting up dates for an interview.



# Day 4

### LEARNING OUTCOMES

Students will be able to:

**Create** interview questions that might help define a community or global struggle or problem.

**Evaluate** their peers' interview questions and give meaningful feedback

# Procedure

**Teacher Note** > Teachers or parents can be interviewed if other community members are not available. Make sure students have a plan as to the format of the interview: email/text/ video/sound clip. Recruit, if possible, a willing back-up client that students may use in the event that they really struggle to find their own.

# Whole Group/Small Group (5-15 minutes)

1

Group students into the three major categories (environmental, health, food supply) and ask students to share their research from the previous day with their group, identifying responses to the five focus questions.

# Small Group (30-35 minutes)

| 1 |  | Have students work through the <i>Designing and Revising Interview</i><br><i>Questions Capture Sheet</i> to design specific interview questions related<br>to their topics. Students should come up with at least ten questions, but<br>are encouraged to identify as many as possible (the more they can find<br>out about their interviewee the better). Give students example sentence<br>frames when needed. |
|---|--|--|
|   | a.   | What are some difficulties you have in your daily life or occupation?  |
|   | b.   | How do you think (their topic) has affected you or your community?   |
|   | c.   | How do you think (their topic) has affected the world?   |
| 2 |  | When students are finished designing their questions, pair groups<br>together and have them practice interviewing each other. During this<br>time, groups should take notes on which questions worked well and<br>which ones need to be refined. Encourage students to use the phrasing<br>"I like, I wish, I wonder"  |
| 3 | Allow students the remainder of the class period to refine questions<br>and draft five more based on their feedback and add to the final par |  |

# Day 5

# Procedure

#### Homework

Have students interview their subjects! If students were unable to set up an interview outside of class, you may wish to give small groups of students time to perform their interview in class. Students should prepare for their interview by scanning the tips in the *Interview Guidelines Resource*. Once students have transcribed their interviews, have them highlight the following:

- Where is the difficulty of the interviewee mentioned? (highlight in green)
- Where is your topic mentioned? (highlight in blue)
- Where are the connections to your topic? (highlight in pink)
- What is a potential challenge that could be solved? (highlight in purple)

In Lesson 10, these interview annotations will be used to then design a solution, using microbes, to the challenge identified.



# National Standards

| Next<br>Generation<br>Science<br>Standards    | <ul> <li>LS2.A: Interdependent Relationships in Ecosystems         Ecosystems have carrying capacities resulting from biotic and abiotic factors. The fundamental tension between resource availability and organism populations affects the abundance of species in any given ecosystem.     </li> <li>LS2.C: Ecosystem Dynamics, Functioning, and Resilience         If a biological or physical disturbance to an ecosystem occurs, including one induced by human activity, the ecosystem may return to its more or less original state or become a very different ecosystem, depending on the complex set of interactions within the ecosystem.     </li> </ul> |  |
|---|--|--|
|   |  |  |
|   | 7. Engaging in argument from evidence<br>Respectfully provide and/or receive critiques on scientific<br>arguments by probing reasoning and evidence, challenging<br>ideas and conclusions, responding thoughtfully to diverse<br>perspectives, and determining additional information required<br>to resolve contradictions.   |  |
| Career and<br>Technical<br>Education<br>(CTE) | <b>A1.3</b><br>Recognize the role of innovation in creation of emerging<br>biotechnology careers, including those in nanotechnology,<br>biofuels, and forensics.   |  |
|   | <b>A1.5</b><br>Evaluate the impact of biotechnological applications on<br>both developing and industrial societies, including legal and<br>judicial practices.   |  |
|   | <b>2.1</b><br>Recognize the elements of communication using a sender-<br>receiver model.   |  |
|   | <b>2.2</b> Identify barriers to accurate and appropriate communication   |  |
|   | <b>4.1</b> Use electronic reference materials to gather information and produce products and services.   |  |
|   |  |  |

# National Standards

| Career and | 4.3  |
|------------|--|
| Technical  | Use information and communication technologies to        |
| Education  | synthesize, summarize, compare, and contrast information |
| (CTE)      | from multiple sources.                                   |
|            |  |
|            | 5.4  |

## 5.1

Identify and ask significant questions that clarify various points of view to solve problems.

# 5.6

Read, interpret, and extract information from documents.

# 7.2

Explain the importance of accountability and responsibility in fulfilling personal, community, and workplace roles.

# 7.4

Practice time management and efficiency to fulfill responsibilities.

# 7.8

Explore issues of global significance and document the impact on the Health Science and Medical Technology sector.

# **Design Thinking Capture Sheet**

# ANSWER KEY

# Goal:

To gain a deeper understanding of a user's experience of the issue you are working on.

### Quickwrite:

What do you think of when you hear the words *design*, *thinking*, and *empathy*?

When I think of the word *design*, art, innovation, technology, and solution come to mind. When I think of the word *thinking*, brain, power, solution, and energy come to mind. When I think of the word *empathy*, feelings, connections, and understanding come to mind.

## Norms for Empathetic Interviews:

- Seek to understand, not confirm.
- Ask once, clearly.
- Ask questions that elicit stories and feelings.
- PROBE: "Tell me more..." "What was that like for you?"

## **Interview Questions:**

| Qu | estions   | Notes  |  |
|----|---|--|--|
| 1. | Would you please describe your day yesterday, from when<br>you woke up to when you went to bed? | <ul> <li>First, Meg wakes up and gets out of bed.</li> <li>She gets coffee and prepares to go to work.</li> <li>She commutes to work.</li> <li>She teaches, and then commutes back home.</li> <li>When she gets home, she relaxes and walks her dog with her significant other.</li> <li>Then she has dinner and washes the dishes.</li> <li>After that, she hangs out with her family before going to bed.</li> </ul> |  |
| 2. | From what you just described, what were the high or good points of your day?                    | <ul> <li>Interacting with her students</li> <li>Walking the dog</li> <li>Spending time with family</li> <li>Drinking coffee</li> </ul>   |  |
| 3. | From what you just described, what were the low or bad points of your day?                      | <ul> <li>Commuting to and from work</li> </ul>   |  |
| 4. | What is something that would have made your day better?   | <ul> <li>Anything to make the commute more enjoyable</li> <li>Coffee</li> </ul>  |  |

## **Design Thinking Capture Sheet**

# ANSWER KEY

#### Continued

# Digging Deeper:

Follow up on your earlier interview. Think about what interested you from the first interview. Make at least two follow-up questions and ask "why" often during the second interview.

| Design your own questions                    | Notes  |
|--|--|
| 1. Why is commuting a low point of your day? | <ul> <li>People are mean on the road</li> <li>Always traffic delays</li> <li>Feels like wasted time</li> </ul>     |
| 2. Why do you keep mentioning coffee?        | <ul> <li>Warm and nice</li> <li>Helps calm and distract from mean people and frustrating things on road</li> </ul> |

## Capture Findings and Take a Stand:

| What is something your partner desires?  | Meg needs a superhero's help to make her commute to and<br>from work more enjoyable because she does not appreciate<br>all the rude people on the road and traffic delays are very<br>frustrating for her. |
|--|--|
| What have you found out about your partner's feelings?   |  |
| She values spending time with the people she cares about,<br>and she does not appreciate rude or mean people that she<br>encounters on the road. |  |

# **Design Thinking Capture Sheet**

# ANSWER KEY

### Continued

## Brainstorm:

at random.

What are potential superhero powers or prototype solutions that could meet your partner's needs?

- You are now creating a solution to the problem you identified.
- Come up with as many different ideas as you can, but try not to repeat.
- Use words and pictures and/or sketches.

This is a little coffee figurine speaker that suctions to the top of the dashboard. You can record little messages or words of affirmations from family or friends, and store it in the figure. To play them, press the button on the front and they will play



This is a big straw that can extend from a cup all the way in the cup holder to the driver. It comes with clips so the driver can secure it to places on the surrounding interior of the car so it is sturdy throughout the duration of the drive. This is a joke bracelet. It senses sharp or rapid movements of the arm or hand, and plays a joke whenever it senses it. It also has an option to record and store jokes or other messages from friends, family, or yourself.





# **Design Thinking Capture Sheet**

# ANSWER KEY

#### Continued

This is a device that attaches to the roof of your car and has different color lights that you can set to your mood. Also, there are speakers that allow the option to play music that you can assign to each color. For example, you can program meditation music to the color blue if you want a calming option, or upbeat pop to a bright pink if you are in a fun mood. The control pad can be attached to the steering wheel so it will not be a distraction while driving. Music can be turned on or off.



#### **Reflection:**

What are potential superhero powers or prototype solutions that could meet your partner's needs?

- What did you learn about your partner?
- What did your partner like about your ideas?
- What did your partner not like about your ideas?

### Coffee figure idea:

- Meg likes it, and thinks it is cute and small and convenient to use.
- One complication would be constantly pressing the button, which could make for a distraction while driving.
- It is unlikely that Meg will remember to press the button every time something frustrating happens on the road, so she is unsure how much use she will get out of it.

### Coffee-scented car freshener:

- It is not a bad idea, but it is basic, and has probably been done before.
- There are other scents more favorable for a calm atmosphere than coffee.

# lights on the sides of it. These lights are a warmer toned gold color to provide a calming essence to the car at later times of the day.

This is another coffee-scented car freshener, but it also has



### Big straw:

- Way too complicated.
- Would likely get in the way while driving, even with clips, since it is a long piece of plastic in front of your face.
- Physics???? Seems like it would be very hard to drink coffee efficiently from a huge straw.
- Would just be another annoyance and Meg would rather just reach for her coffee to drink it than use this.

### Joke bracelet:

- Seems like an okay idea.
- Jokes could get annoying and an extra annoyance during frustrating situations.
- Meg is a fairly calm driver and does not make obscene gestures or move her hands angrily when there are rude people on the road, so she is unsure she would get much use out of this.

# **Design Thinking Capture Sheet**

## ANSWER KEY

#### Continued

Ceiling lights with music:

- Very customizable to user, good.
- Meg appreciates that it is simple to use and to change the color; does not provide huge distraction from driving.
- One concern would be that it could be hard to see the light in the daytime.
  - There would probably still be some light, car interior is darker than outside.
  - Could work more for early mornings and late nights or darker evenings.

### Car freshener with lights:

- Again, basic, has probably been done before.
- The little amount of light that comes from it would likely not be visible due to external light.

### Choose your solution:

Choose from one of the following options:

- 1. If you have chosen one of your ideas, which one have you selected? Why have you selected this option? How will it best meet the needs of your partner?
- 2. If you have to modify one of your ideas, how will you change it? What have you learned about your partner that makes you want to modify an idea?
- 3. If you choose to create an entirely new idea, what new idea will you develop?

I have selected the ceiling lights with music. I have selected this option because it is the one that is the most effective and the one with the fewest complications. It is the most customizable to the user and does not provide any extra annoyances to the already frustrating experience. I will likely modify it to fit Meg's favorite colors, or the colors she thinks will be the most effective in making her calm or bringing her joy. For example, if Meg absolutely hates the color red, but likes greens and blues, maybe I will make the product have cooler-toned lights, or vice versa.

Continues next page >

Do not share with students

# **Design Thinking Capture Sheet**

# ANSWER KEY

Do not share with students

Continued



## **Design Thinking Capture Sheet**

# ANSWER KEY

Continued

# Testing your prototype:

After you have built your prototype, allow your partner to interact with it and give you feedback. Record notes below.

| Questions  | Notes  |
|--|--|
| What worked?   | <ul> <li>The lights have a control that works, which is great.</li> <li>Colors are calming, no unnecessary colors.</li> </ul>  |
| What could be improved?                                    | <ul> <li>There are speakers involved, but it seems like this prototype is more of a bluetooth speaker situation rather than setting up music for each color, so that will need to be figured out.</li> <li>Maybe it could be smaller so it will not get in the driver's field of vision (Less clunky, smaller speakers)</li> <li>Needs a better way to attach to the car.</li> </ul> |
| What questions does your partner have about the prototype? | <ul> <li>How will you end up making the music portion customizable?</li> <li>How will the speakers be able to change volume? It would be hard to reach a volume button all the way up on the device. Would it be on the controls?</li> <li>How will I attach the control to the steering wheel?</li> </ul>   |
| What ideas does your partner have about the prototype?     | <ul> <li>Shrink the size, make it flatter so it covers less of the windshield.</li> <li>Maybe make it have straps that can attach to the outside of the windows, sturdier hold.</li> <li>Sleeker design, maybe make it all white or a neutral color to match the inside of the car.</li> </ul>   |

### Class Debrief/Discussion:

- a. Who had a partner that made something that you really liked? (ask to share what they liked about it).
- b. Who sees a prototype that they want to learn more about? (ask which one and have the student who made the prototype explain what it is for).
- c. How did talking to your partner help you in your design?

- d. How did testing and getting feedback change your design?
- e. What was the most difficult part of this process for you? (interviewing, framing the problem, generating ideas, sharing ideas, building prototypes, testing prototypes).

## **Design Thinking Capture Sheet**

## ANSWER KEY

#### Continued

- a. Answers will vary.
- b. Answers will vary.
- с.
- Talking to my partner helped me get to know my partner's needs and wants.
- Helped me empathize with the struggles my partner goes through.
- Gave me adequate feedback on how the product may or may not work.
- Let me be aware of the problem from my partner's perspective, rather than me just assuming how it would be.
- d.
- Testing helped weed out any errors the prototype may have had.
- Made it possible to experience the product hands-on, leading to a more accurate critique of its function/accessibility/design/aesthetics instead of just waiting for the final product, which may have had lots of errors.
- Testing along the way made me aware of what was more realistic to make and what could be achieved in the time allotted.
- e.
- The most difficult part of the process was brainstorming ideas, because I honestly did not have any idea of where to go...
  - It was very hard to think of ideas initially, but once I started getting some general ideas, the rest came kind of smoothly to me.
  - Once I had an idea, design and prototyping was easier and more smooth-sailing because I just had to work around the initial plan and add adjustments to make it better and more user-friendly.

Do not share with students

# Micro-Con Challenge Topic Research Capture Sheet

# ANSWER KEY

Do not share with students

# Design Thinking Reflection:

Use what you have learned to give examples of the following terms:

| Empathize | One example of empathizing would be if a Product designer listens to their consumers and<br>asks a lot of questions to identify and fully understand the problem they face. It would not be<br>empathetic if the designer simply asked what the problem was and then went on to assume<br>the details and the best solution to it. |
|-----------|--|
| Define    | Defining a problem is taking into account all the details and perspectives on a certain issue<br>and coming to a clear understanding of what the issue is, why the issue is bad, and what<br>could be done to fix it.  |
| Ideate    | To ideate is to form potential solutions to the defined problem. For example, you can ideate<br>a wide range of solutions to a specific problem. In this assignment, for example, I made<br>solutions involving scent, sounds, and light to Meg's problem.   |
| Prototype | Prototyping is taking those ideas and making them a reality. For example, I took my idea of ceiling lights with music and built a simple machine that could do those tasks.  |
| Test      | Testing a prototype helps assure it actually works, or could help locate errors in the design.<br>For example, when we tested my initial prototype, we found it was very big and clunky and<br>inconvenient to use.  |

# Micro-Con Challenge Topic Research Capture Sheet

# ANSWER KEY

# Topic:

Identify the topic you will focus your research on:

# Microbes in food production.

# Research:

Either use the provided articles or perform your own research to describe the following:

|  | •                  |
|--|--------------------|
| Define your topic in detail. If<br>there are multiple types, define<br>each that you can find. | Answers will vary. |
| What is a specific problem in<br>this topic? (global and locally)                              | Answers will vary. |
| What is causing this problem?  | Answers will vary. |
| What, if anything, is currently<br>being done to solve this<br>problem?                        | Answers will vary. |
| How might microbes be utilized to solve this problem?  | Answers will vary. |

### Lesson 9 Career Profile

# Aditya Kunjapur, PhD

University of Delaware, Assistant Professor of Chemical and Biomolecular Engineering



### What is your current role, and how did you get there?

I'm a professor of chemical and biomolecular engineering at the University of Delaware. I actually didn't like biology as a kid because it seemed like memorization and I didn't want to be a medical doctor. But I loved math, chemistry, and physics in the classroom, and I really liked making things, so I chose to major in chemical engineering.

I also did that because I wanted to help decrease our reliance on fossil fuels for energy. I grew up in Houston, Texas—the capital of the oil and gas energy industry. I picked chemical engineering because I knew it could help me make an impact in the energy industry. Eventually I realized that microbes can be used to make biofuels, and that they can be engineered. Suddenly everything that felt like memorization before now felt like information I could use to design an engineered process to make something useful. (If you're more interested in my journey, here's a *YouTube video* where I talk about this.)

# What's most fulfilling about your job/ career? What's most challenging?

It's really fulfilling to be an educator and scientist. I get to help advance the scientific frontier to tackle some of society's most pressing needs, all while working with incredibly talented and motivated students who I train to be the next generation of leaders. Our work takes a lot of resources, and securing those resources requires a lot of effort, skill, and luck.

## What skills do you use on a daily basis?

One of the most useful technical skills that I use on a daily basis that is hard to describe is the ability to creatively connect the dots between two different things that people are talking about or doing. In my job, there's a high priority on doing something "innovative" or new, so I find that some of the best ideas come from drawing relationships between two different concepts, sometimes from very different areas. My favorite example of this is how Steve Jobs took a calligraphy class at Reed College before he dropped out to start Apple. Because of Steve's experience many years earlier at Reed College, Apple pioneered the concept of having different text fonts. This skill isn't strictly technical but can lead to lots of new approaches in science.

The soft skill that I use the most is listening to, and not just hearing, what people have to say. For the graduate students who do research in my lab, carefully listening to what they tell me and asking the right questions has been really instrumental in keeping everyone happy and productive.

# Lesson 9 Career Profile

Continued

If you could give a piece of advice to your younger self, what would it be?

I would encourage my younger self to recognize that my local community/school might not have everything that I might be interested in, especially from a knowledge perspective (in other words, most high schools wouldn't even mention that microbes can be engineered to do various things). And so my advice would be to not be afraid to search on my own for other programs/opportunities to complement my school curriculum, especially during the summers. In modern times, I think the internet helps a lot with this, so it may not be as helpful advice now, but when I was growing up I definitely remember getting bored a lot at school and a little complacent because for a while I thought I knew everything.

### If you could have any superpower, what would it be?

My superpower would be to read other people's minds. There's two big reasons I can think of.

- 1. I'm around a lot of smart people and would love to know what they're thinking and learn how they think.
- 2. I think I'd be a much more effective manager, colleague, mentor, husband, father, etc. if I could understand what other people were thinking.

# If you could instantly learn any language, which would you choose and why?

I'd choose the programming language Python, because it's a versatile coding language and coding is such an important part of society now and for the future. That includes thinking about microbes because a lot of interesting genetic sequence data is available online and easier to find/manipulate if you are skilled at coding.

# **Design Thinking Capture Sheet**

### Goal:

To gain a deeper understanding of a user's experience of the issue you are working on.

# Quickwrite:

What do you think of when you hear the words *design*, *thinking*, and *empathy*?

## Norms for Empathetic Interviews:

- Seek to understand, not confirm.
- Ask once, clearly.
- Ask questions that elicit stories and feelings.
- PROBE: "Tell me more..." "What was that like for you?"

## Interview Questions:

| Qu | estions   | Notes |
|----|---|-------|
| 1. | Would you please describe your day yesterday, from when<br>you woke up to when you went to bed? |       |
| 2. | From what you just described, what were the high or good points of your day?                    |       |
| 3. | From what you just described, what were the low or bad points of your day?                      |       |
| 4. | What is something that would have made your day better?   |       |

# Design Thinking Capture Sheet

Continued

# **Digging Deeper:**

Follow up on your earlier interview. Think about what interested you from the first interview. Make at least two follow-up questions and ask "why" often during the second interview.

| Notes |
|-------|
|       |
|       |
|       |
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|       |

# Capture Findings and Take a Stand:

| What is something your partner desires?                |                                |
|--|--------------------------------|
|  | needs a superhero's help<br>to |
| What have you found out about your partner's feelings? | because                        |
|  |                                |

# Design Thinking Capture Sheet

Continued

# Brainstorm:

What are potential superhero powers or prototype solutions that could meet your partner's needs?

- You are now creating a solution to the problem you identified.
- Come up with as many different ideas as you can, but try not to repeat.
- Use words and pictures and/or sketches.



## **Design Thinking Capture Sheet**

Continued



### **Reflection:**

What are potential superhero powers or prototype solutions that could meet your partner's needs?

- What did you learn about your partner?
- What did your partner like about your ideas?
- What did your partner not like about your ideas?

# **Design Thinking Capture Sheet**

Continued

# Choose your solution:

Choose from one of the following options:

- 1. If you have chosen one of your ideas, which one have you selected? Why have you selected this option? How will it best meet the needs of your partner?
- 2. If you have to modify one of your ideas, how will you change it? What have you learned about your partner that makes you want to modify an idea?
- 3. If you choose to create an entirely new idea, what new idea will you develop?

# Design Thinking Capture Sheet

Continued

# Testing your prototype:

After you have built your prototype, allow your partner to interact with it and give you feedback. Record notes below.

| Questions  | Notes |
|--|-------|
| What worked?   |       |
|  |       |
|  |       |
|  |       |
| What could be improved?                                    |       |
|  |       |
|  |       |
|  |       |
| What questions does your partner have about the prototype? |       |
|  |       |
|  |       |
|  |       |
| What ideas does your partner have about the prototype?     |       |
|  |       |
|  |       |
|  |       |

### Class Debrief/Discussion:

- a. Who had a partner that made something that you really liked? (Ask to share what they liked about it.)
- b. Who sees a prototype that they want to learn more about? (Ask which one and have the student who made the prototype explain what it is for.)
- c. How did talking to your partner help you in your design?

- d. How did testing and getting feedback change your design?
- e. What was the most difficult part of this process for you? (For example, interviewing, building a prototype, etc.).

# Design Thinking Capture Sheet

Continued

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|----------------|----------------|---------------------------|
|----------------|----------------|---------------------------|

# **Example Prototype/Student Sample**

# Challenge:

After interviewing, Matt discovered that Meg does remember to drink enough water throughout the day.

# Solution:

Matt designs a water bottle that has an alarm that ties into her smartwatch. If the water level does not reach a lowenough level by predetermined times, a notification will be sent to her watch to remind her to catch up.

# Prototype:

Matt prototypes this by grabbing a plastic cup, sharpie, slap band, and calculator from the "materials table." He marks on the cup where Meg's water level should be during the day if she is drinking the amount of water she has indicated as necessary. Then he fits the slap band to her wrist as a "smartwatch," and uses the calculator as her smartphone.

- a. What worked?
- b. What could be improved?
- c. What questions does your partner have about the prototype?
- d. What ideas does your partner have about the prototype?

# **Reflection:**

Meg reflects on the design prototype of the SmartBottle Matt created. She really likes the idea of it tying in to her smartwatch to get reminders to drink more water. She asks if she has the power to change the amount of water consumed based on activity for the day. So, if it is a HIIT day, she can add more water. She has an idea of making it a competition, so that she can include her friends who also have a hard time remembering to stay hydrated.

# **Reflection of reflection:**

Matt redesigned the prototype to include Meg's feedback, and then asks for feedback on the new prototype.

# Micro-Con Challenge Topic Research Capture Sheet

# Design Thinking Reflection:

Use what you have learned to give examples of the following terms:

|           | · · · · · · · · · · · · · · · · · · · |
|-----------|---------------------------------------|
| Empathize |                                       |
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# Micro-Con Challenge Topic Research Capture Sheet

# Topic:

Identify the topic you will focus your research on:

# Research:

Either use the provided articles or perform your own research to describe the following:

| Define your topic in detail. If<br>there are multiple types, define<br>each that you can find. |  |
|--|--|
| What is a specific problem in<br>this topic? (global and locally)                              |  |
| What is causing this problem?  |  |
| How might microbes be utilized<br>to solve this problem?                                       |  |

# **Designing and Revising Interview Questions Capture Sheet**

# **Designing Interview Questions:**

Use the following as inspirations and create your own interview questions. Remember what you learned previously about design thinking and how to connect with the person you are interviewing.

# Prepare for the Interviews (15 minutes):

What questions could you ask students/practitioners/ stakeholders to understand their experiences with your group's problem or issue, and the factors contributing to it?

# a. Question Selection/Brainstorm (three minutes):

Individually, review the questions below. Adapt these or generate a few questions of your own.

- What are some difficulties you have in your life?
- How do you think

(their topic) has affected you or your community?How do you think

(their topic) has affected the world?

# b. Share and Organize (five to ten minutes):

As a group, identify and organize your top 5–6 questions. Will they help you understand what makes X challenging, or when community members experience success (i.e., the possible root causes you need to address)?

# c. Predict and Plan (three minutes):

Each person shares one idea they think they will hear. If you are conducting the interview with a partner, decide who will interview and who will take notes.

Continues next page >

# Consider these other possible Empathy Interview questions:

- Tell me about a time when you felt successful in X...What happened? What made this a success? (What did you do? What did others do?)
- Tell me about a time when X was hard... What happened? How did that feel? Why was that hard? How did you react? What do you wish would have happened? What would have helped?
- What advice would you give another student/person about X?
- What advice would you give to me about X?
- What do you wish others knew about X?
- If you could describe how you feel about X in one word, what is it?
- Draw me a picture of what you think about when you hear X... (then "Tell me about what you drew.")

# **Designing and Revising Interview Questions Capture Sheet**

Continued

Write your initial questions first, and then practice with peers and take notes in the middle column. Revise questions if needed in the final column. Come up with additional questions as needed after revisions.

| Initial Question  | Peer Review Notes<br>(What did and did not work?) | Revised Question<br>(if needed)                      |
|---|---|--|
| Ex. How do you think this topic impacts your community? | Ex. The topic was not specific enough.            | Ex. How do you think traffic impacts your community? |
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### **Interview Guidelines Resource**

This may apply to you if you are not familiar with the person you are interviewing. **This is an informational call.** The purpose is to find out who is interested in speaking to you about your subject matter. For interested persons, you can send a follow-up email with your interview questions prior to meeting and talking with them.

Remember, you may need to call *many* organizations before you get a "yes" from someone. Do not get discouraged if it takes a few calls before someone agrees to speak with you.

## Student:

Hi, my name is

| l am a(n)  |        |
|--|--------|
| grade student at   |        |
| in   | class. |
| I'm really interested in speaking with someone regarding |        |

# I have a series of

questions that may take about 10 minutes to answer. If you have time to speak now, I'm happy to go through them with you. If not, I could email them to you if you'd like time to prepare and we could speak at a later date. Would you be willing/able to speak to me about

and the challenges you or your company faces in this area?

If "yes" to the previous question: CLOSING: (get email NAME, email address, and then) *Thank you for your time today. I really appreciate it. I will send you more information immediately through email. Also, is it okay that I record our conversation for the purposes of transcribing our conversation at a later date? Have a wonderful day.* (If not "yes to being recorded," then you will have to take notes in your journal). If "no" to the previous question about being willing to be interviewed: CLOSING: *Thank you for your time today. Have a wonderful day.* 

# Before the Interview:

- a. Understand a little bit about who you are interviewing. The more details you know about your interviewee (university, first jobs, expertise), the more you can ask to help you be successful in solving a problem for your interviewee's local or global problem.
- b. Make sure you confirm the details of the interview with the person your are interviewing: date, time, and approximate length (based on how many questions you have).
- c. Make a plan to record your interview (video or audio) so that you can transcribe it afterwards if agreed upon.

## Day of the Interview:

- a. Test your recording equipment!
- b. Make sure you have your prepared list of questions.
- c. Write down the names of the interviewer and the interviewee(s) as well as the time, date, and location of the interview.
- d. Listen! Be engaged in the interview—not just a person who reads the questions aloud.
  - It is easy to "drift off" while the other person is talking. You might "tune out" while you wait for him or her to finish so you can move on to your next question. Listen and be engaged.

# After the Interview

- a. Summarize the setting of your interview. Use two to three paragraphs to describe the setting, date, location, and time of your interview.
- b. Transcribe it. It is important to dictate word for word, not a summary. Include both the interviewer's questions as well as the interviewee's answers. (You do not have to include filler words, such as "I mean", "you know", "um", etc. These can be a distraction when trying to convey a message through the transcript.)