WORLD SMARTS

IREX

# World Smarts: Human Centered Design Curriculum

## Educator Anchor

Investing in Youth Workforce Skills and Global Sustainability

***The World Smarts STEM Challenge is funded by the National Science Foundation (NSF) as part of the Innovative Technology for Students and Teachers (ITEST) initiative.***



IREX is an independent nonprofit organization dedicated to building a more just, prosperous, and inclusive world by empowering youth, cultivating leaders, strengthening institutions, and extending access to quality education and information.

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# How to Use This **Curriculum**

Each module has its own student-facing slide presentation, with additional educator resources and clarification in the notes. These facilitator notes can be found in this anchor document and below each slide. It is recommended that the modules be completed in order; however, you are the expert in your classroom and know best the instructional needs of your students.

## Contents

- Educator Anchor Document
- Educator Unit Plan
- Student Facing PowerPoints for each module
- Student Handouts for each module

**Note:** If your students are familiar with the United Nations Sustainable Development Goals (UN SDGs), or human centered design, you may want to skip some of the introductory activities and launch directly into the design process.

## Curriculum Audience

The World Smarts: Human Centered Design Curriculum is intended for educators to complete in the manner that works best for you and your students. This can be as a virtual exchange with a school partner or independently with one class , and can take place as an afterschool club, activity, or during class. **As each classroom's needs are different, feel free to add, edit or delete any standards or activities to make this resource more relevant for your students.**

## Timing and Logistics

Estimated time for completion of this module's activities and, materials needed, and NGSS and ISTE standards are located at the beginning of each slide deck. There are eight total modules that follow a human centered design process. Please note that the initial modules (Introduction, Empathize, and Define) are longer than the others; this is intentional and meant to reflect that significant time should be invested in authentic problem identification.

## Standards of Learning

Activities throughout the curriculum are aligned with the Next Generation Science Standards (NGSS) and International Society for Technology and Education (ISTE). You will find the standard alignments at the top of each activity in the facilitator notes.

# World Smarts: Human Centered Design Curriculum

## Modules

Click on the module below to access the content 

Module 1

**Introduction to Human Centered Design and UN Sustainable Development Goals**

Module 2

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**Define**

Module 4

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Module 6

**Prototype**

Module 7

**Test and Refine Prototype**

Module 8

**Communicate Results**

# MODULE 1

## Introduction

# Module 1

## Introduction to Human Centered Design and UN Sustainable Development Goals

In this unit, students will be introduced to the World Smarts program, Human Centered Design, the United Nations Sustainable Development Goals, and identify team roles and characteristics of effective team collaboration.

1 hour 45 minutes

UN SDG video, Youth Contributions to the UN SDGs handout, Internet access, Eating Better with Rory Cooper handout, plastic utensils, paper, tape, cardboard, paper clips, and rubber bands, index cards and prototyping supplies

### OBJECTIVES

- Identify the goals of the World Smarts program
- Explore the UN Sustainable Development Goals and research past student solutions
- Learn about Human Centered Design, and apply the process to create an assistive device
- Assign team roles

### ACTIVITIES

- What are the UN SDGs?
- UN SDG project research
- Effective Team Norms
- Human Centered Design
- Rory Cooper and Assistive Devices Design Sprint
- Team Leadership Roles

## Welcome to the World Smarts Program

- Ask student volunteers to share what they are most excited about and what they hope to accomplish through this challenge.
- Encourage your student team to "think globally, act locally" and understand that small actions lead to larger changes over time. Explain that they will have the opportunity to explore student group projects from around the world that are working on these same goals.

## What are the UN SDGs?

- Ask students what they already know about the UN SDGs and sustainable communities and climate action. Record their initial thoughts and see how they change over the course of the challenge.
- Show students to the UN SDG Introductory Video (embedded in slide)
- Questions are intended to prompt discussion and gauge initial students' interests and beliefs in their ability to contribute to SDGs.
- One way to ensure that all students can share their thoughts is through a "Think- Pair- Share" model, where students reflect individually, then share their answers with a partner, and then each pair shares their thoughts with the whole group.


## How are Global Youth Contributing to the UN SDGs?

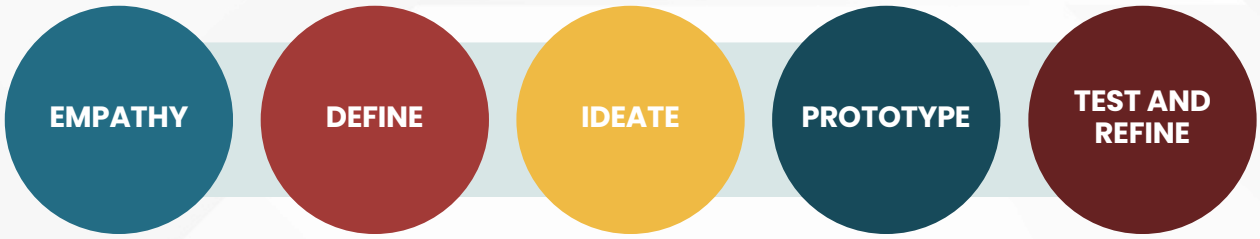
- Explain that many students around the world are contributing to each of the UN SDGs through local action.
- Assign each student (or pairs of students) an SDG that they will explore at the Ciena Solutions Challenge by Digital Promise. Depending on group size and desired focus, this can be all the goals, ones of interest that students identified, or teacher-directed.
- Distribute **Youth Contributions to the UN SDGs Handout** (electronically or on paper). Ensure that students can locate projects for their goal in the Ciena Solutions Gallery.
- Demonstrate to students that they can browse projects by goals from the filter menu on the left.
- Give students time to explore projects and record their responses.
- Have students share out with the class about the project they selected.

## Brainstorming Characteristics of Effective Teams

- Based on students' research of teams from the Ciena Solutions Gallery, help students identify characteristics of effective teams. If using an interactive whiteboard, you may want to write directly on the slide; otherwise, use a board or chart paper to record students' responses as you walk them through this activity.
- Explain to students that in World Smarts: Human Centered Design they will be working as a team to create their own solution to a specific problem they identify through human centered design.
- Based on what the students viewed in the Ciena Solutions Gallery:
  - What makes an effective solution?
  - What evidence did they see of effective teamwork? Facilitate a brainstorming session with the students and record their thoughts on the slide.

## Human Centered Design

- Review each step with students, asking them for examples that they saw in their research at the Ciena Solutions Gallery. The following questions could be discussed as a whole class, as a Think-Pair-Share activity, or with students individually writing their responses, based on preference of instructor and time available:
  - What examples of empathy did you observe in your chosen project?
  - How did the student team identify the problem they chose to solve?
  - Why did the students choose their solution to the identified problem? What other ideas did they consider?
  - How did the student team test their solution? What ways did they improve it or what improvements did they recommend for the future?
- Explain that they will have the opportunity to walk through a quick design sprint in the next activity (Rory Cooper and Assistive Devices)




## Design Sprint: Rory Cooper and Assistive Devices

- Guide students through a design process using an activity from the Rory Cooper Trading Card Lesson Plan. The Eating Better with Rory Cooper is the ENGAGE part of a larger 5E lesson plan (invent an assistive device). If time permits, students can walk through the entire design process, which includes researching a specific disability for which an assistive device might be needed.
- As students share their ideas with the larger group, have them provide feedback in the form of "I like, I wonder" phrases to help them provide positive and constructive feedback.
- Other Trading Card [MR1] activities can be substituted to better align with specific course content, including Ellen Ochoa (physics, graphic design) and T. David Petite (computer networking) and Dr. Marian Croak (energy, computer science).
- As students share their ideas, refer to the Human Centered Design diagram on prior slide and ask them for examples of their work in each stage in this design sprint. (Reassure them if a step was missing that it was due to a quick build to introduce the process, and that more time will be spent in each stage of the World Smarts program).

***Note:*** *The* ***5E lesson plan*** *provides strategic scaffolding to engage students, enhance learning, and assess student learning.*

***ENGAGE*** *Pique student interest and assess prior knowledge*

***EXPLORE*** *Collect additional information about the topic*

***EXPLAIN*** *Make sense of the concepts and connect to real-world experiences*

***ELABORATE*** *Extend learning and apply knowledge*

***EVALUATE*** *Formative and summative assessments*

## Assign Team Roles

- Review each team leadership responsibilities with students, and help students select roles that best suit their strengths and interest.
- Make sure students have access to a list of assigned team leadership roles (either digitally or printed in classroom or meeting space) so that they can refer to them as needed.


### TAKE HOME MESSAGE

- The UN SDGs are a framework of goals agreed upon to improve health, sustainability, and each community.
- Human Centered Design is a process used by engineers to develop solutions for problems in any community.
- Effective teams collaborate, value the unique contributions of each team member, and delegate tasks based on individual strengths.

# MODULE 2
## Empathize

# Module 2

# Empathize

In this unit, students will explore how cultural differences impact teams, define sustainability and climate change, and learn how these differences in culture may impact solution design. Students will conduct empathy interviews to better understand the sustainability problems faced in their community.

1 hour 45 minutes

Cultural Iceberg Video, Sustainability Video, Sustainability Student Handout, Internet Access (for Ecological Footprint Activity), and Community Empathy Interview Questions

**OBJECTIVES**

- Understand the 'Cultural Iceberg'
- Understand Climate Change and Sustainability
- Understand the connection between Empathy, Design Thinking, and STEM
- Conduct empathy interviews in community
- Create a Mind Map

**ACTIVITIES**

- Count to 10 Challenge
- Cultural Iceberg
- Understanding Sustainability
- Understanding Empathy
- Empathy Interviews
- Mind Mapping
- Community Empathy Interviews

## Count to 10 Challenge

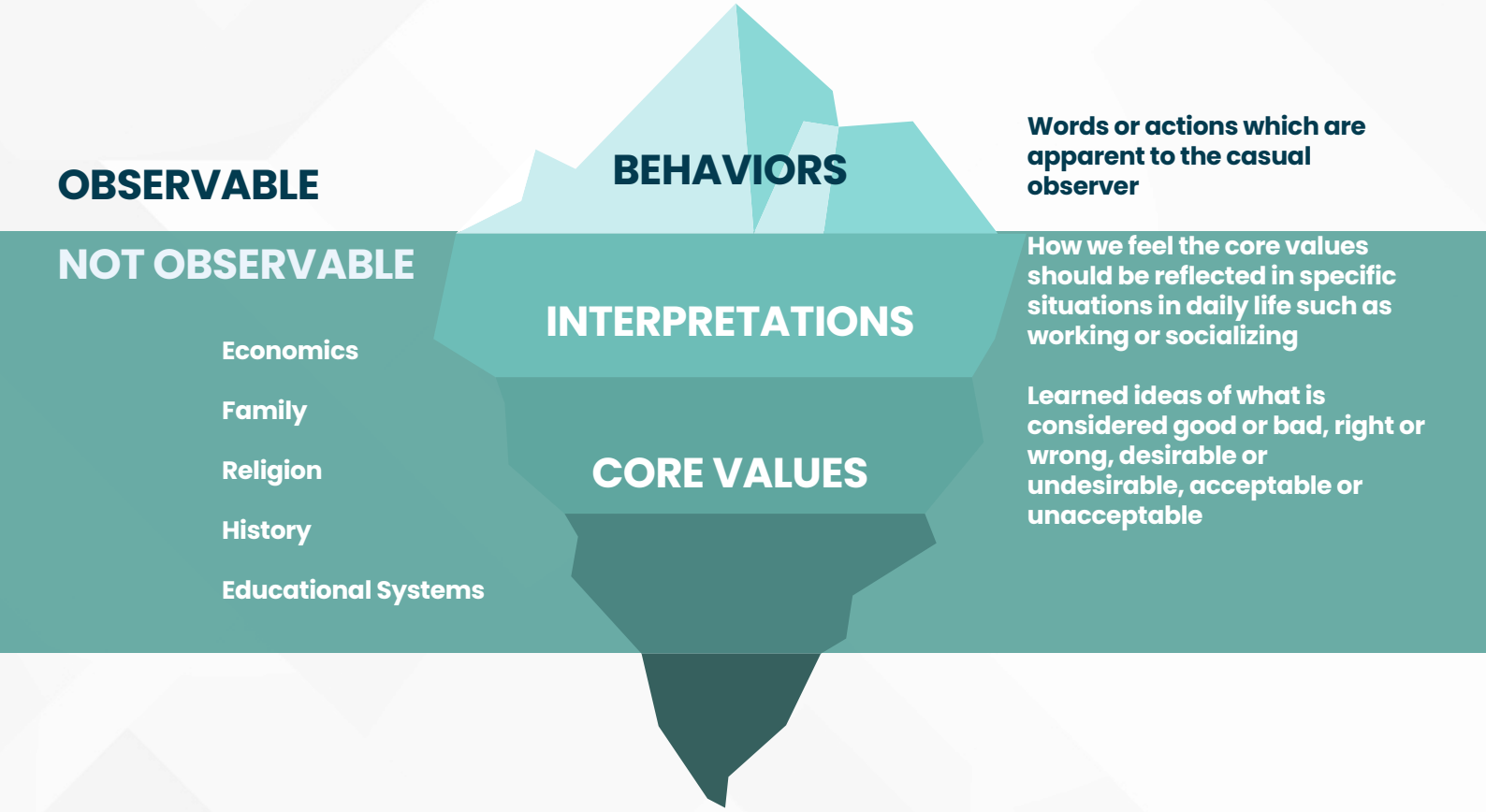
This activity helps students recognize the importance of communication and reading nonverbal cues from each other. It can also help the facilitator identify which students are more confident in public speaking, and which students will need additional encouragement to share their ideas.

- Students may communicate in nonverbal ways with each other, and if successful, you may want to challenge them to count to a larger number. It is recommended that you place the team in a circle prior to the start of this challenge to maximize nonverbal communication.
- Once students have succeeded, ask them the following questions, observing who answers and if they look to consider if others are speaking as well:
  - How were you able to communicate without speaking?
  - Was everyone in the group able to participate? If not, how might you accomplish this within the constraints of the challenge?
  - What role might culture play in this activity?
- Have students consider that different cultures may have different expectations for speaking in groups. One of the opportunities of working on a global team is learning how people from other cultures may differ in communications. If students are not familiar with communicating across cultures, refer to the cultural iceberg (with differences in authority, communication style, etc.) in the next activity.

# Cultural Iceberg

Culture is a combination of the ideas, values, behaviors, and customs that make up a group or society. It can bind people together or create tension and strife. Culture can manifest itself in our relationship to time, work, family, nature, and money, to name a few aspects. When different cultures come together, there are great opportunities for learning and growth, but there can also be challenges. When collaborating across cultures, it is important to keep in mind that what may be common or normal for you may not be common or normal for another culture.

- Show students the embedded Cultural Iceberg Video, then have them discuss the following questions:
  - What stands out to you about the iceberg?
  - How would you define your culture?
  - Have you ever been in class with or friends with someone from a different culture? What stands out from that experience?
  - In a world that is highly connected, both in person and through technology, why is it important to understand different cultures and be able to connect with people from all over the world?



## Understanding Sustainability

- Use the video and question prompts to provide a foundation on sustainable design.

  Humans & Energy Video

- Questions for sustainability and climate change video and link to ecological footprint calculator (on the next slide) can also be found on Empathize | Climate Change and Sustainability Student Handout.
- Encourage students to consider both positive and negative behaviors of individuals and industries that impact or mitigate climate change.

***Note:*** *The* ***Footprint Calculator*** *can help students connect daily actions with solutions to mitigate climate change; however, many of these choices may be out of the control of the student. Students do not have to use their actual information but can use the calculator to determine behavioral impacts.*

- Some ideas for students to start considering:
  - How cities can apply sustainability principles: Cities can move our world towards a sustainable economy by using more renewable materials, improving efficiency, decreasing waste, recycling, and designing for sustainability. Students can consider doing this by:
    - Decreasing waste and pollution.
    - Keeping products and materials in use for as long as possible.
    - Protecting, revitalizing, and caring for our natural environment.

For a more in-depth analysis of climate and actions students can take, visit Smithsonian Climate Action Curriculum.

## Connecting Sustainability and Culture: Global Case Studies

- Ask students how sustainability and culture are related. Have students give examples from their own experiences if they have them.
- Explain that good solutions take into consideration the community which will use the product, and that the students will be looking at some case studies for examples.
- The article for students to read can be found in the resources for the Empathize section; depending on student access to technology, decide prior to this lesson:
  - How many case studies you would like the students to examine (there are 6 total cited in the article; depending on class/team size, you may want to select a few or all for the students to read.
  - Whether you want to print out the article (or section) for each group or provide access to the digital copy through your school's Learning Management System.
  - If the reading level of the article is not appropriate for your cohort of students, consider using a Large Language Model like ChatGPT to simplify the text of the case study.
- Assign groups and have students identify:
  - The original product.
  - What cultural difference made the product fail in the new market/country.
  - One solution to make the product more effective across cultures.
- Have each student group share their findings with the whole class. Once all groups have presented, ask students what these case studies had in common? Explain that empathy can help prevent these product failures.

## Understanding Empathy

- Ask students "What is 'empathy' or what does it mean to empathize with others?"
- Ask them to give examples of empathy they have seen.
- Show The Importance of Empathy Video.
- Ask students to answer the following questions after watching the video:
  - What is empathy?
  - How do we show empathy to others? Can you describe a time when you were empathetic?
  - Why is empathy the "centerpiece" of the design thinking process?
- How can you practice empathy as you collaborate with your team?

## Community Empathy Interviews

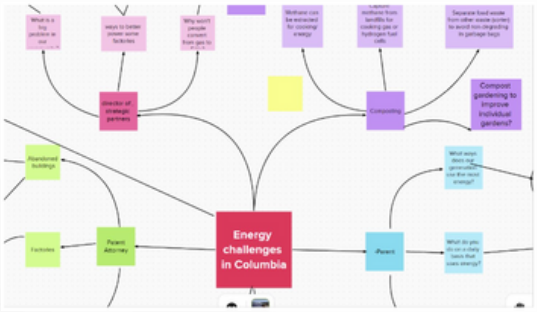
Empathy interviews are essential in making sure both the problem and solution are grounded in the needs of the community. The main takeaway from this experience should be that students recognize the need to expand their knowledge of community needs to understand the challenges faced by others.

- Ask students, "Think about who is in your community. Who is impacted by these SDGs? Who is a leader or producer? You can interview people you know such as family members, teachers, and friends, or people you don't know at local stores or companies.
- Brainstorm a list of people you could interview related to the Sustainable Cities and Communities.
- Have the team **Researcher** record brainstormed list and the **Director** facilitate the brainstorming session.
- Help students recognize that they can ask families and others they know for their day-to-day experiences (they do not necessarily have to know "experts" in sustainability).

***Tip:*** *It is highly recommended that the educator models the empathy interview process for the students by inviting a community expert into the classroom (or virtually). Students can use the same questions as they will use later and gain more insight into the specific challenges their community is facing. Some suggestions include first responders, social workers, any school employee working in outreach, or anyone who can provide the students with a different perspective.*

## Mind Mapping

- Decide whether you want students to create a digital or paper Mind Map
  - Digital is beneficial in that students can have access anytime and if technology is available, they can add any additional interviews and information as they occur; it may be best to appoint the Researcher or another team lead with editing privileges as many online mind maps can be unwieldly and lead to students accidentally deleting each other's work.




  - Paper Mind Maps are very visual and helpful to refocus students throughout the challenge when displayed in class; if using a board, it is recommended that you take photos of the final product so that students can refer to it if needed.

## Conduct Community Empathy Interviews

- Prior to students interviewing community members, help them brainstorm some individuals to ask, and go over basic professional norms, such as introductions and thanking the person (preferably both in person and with a follow up note or email).
- Students may use the "Empathize | Community Empathy Interview Questions" handout to help guide their interviews.
- Have students add their information from their interviews during the next meeting or class and let them draw the connections they see to determine what challenges exist in the community. As students share their results, keep empathy in the center of their ideas, gently deterring students from making assumptions by asking for clarification on interview responses, and avoiding suggestions for solutions at this point in the design process.


### TAKE HOME MESSAGE

- The first step in Human Centered Design, **Empathize**, requires a deep exploration into the needs and challenges of the community.
- Interviewing different voices in the community provides a wealth of perspectives to help define a challenge for developing a solution.

# MODULE 3

## Define

# Module 3

# Define

In this module, students will explore the foundational skills needed to classify problems and develop a clear, structured approach for solving them. Students will learn how to assess the feasibility and urgency of identified problems, using various tools and frameworks to ensure relevance to sustainability.

1 hour 20 minutes

Index cards, Who Becomes an Inventor Student Handout, chart paper and sticky notes or board, markers or interactive board to create matrix and record ideas, Doodle or another voting software (optional)

### OBJECTIVES

In this module, students will:

- Classify identified problems based on their feasibility and need.
- Construct a problem statement for developing a solution.

### ACTIVITIES

- Who Becomes an Inventor?
- Partner Empathy Interviews
- Using a Needs Matrix to Prioritize Problem
- Choose a Problem and Write a Problem Statement

## Who Becomes an Inventor?

This activity is intended to help students clearly define what problem interests their team the most and to see how one teen was successful in undergoing a similar needs assessment process.

- Give each student an index card before playing Dasia Taylor's story on PBS News Hour
- As they watch the video, instruct students to listen for how she used empathy to solve a problem she identified.
- Students will use the problems they wrote down on the index card after watching the video.
- Ask students to reflect on their empathy interviews.
  - What were some challenges identified by the community members you interviewed?
  - On your index card, write down 2-3 problems that you discovered from your interviews that you think are most pressing.


***Note:*** *There are questions from PBS Newshour Classroom that accompany the video on the Define: Who Becomes an Inventor Student Handout. Decide whether you would like to have the students write the answers to the questions while watching the video, or just discuss them as a class after viewing.*

## Partner Empathy Interviews

After discussing the video as a large group, students will get into pairs and use the **Partner Empathy Interview Handout** to ask each other about the problems they wrote on their index card.

Each person should use their empathy interview skills to expand on each problem and why it matters to their partner.

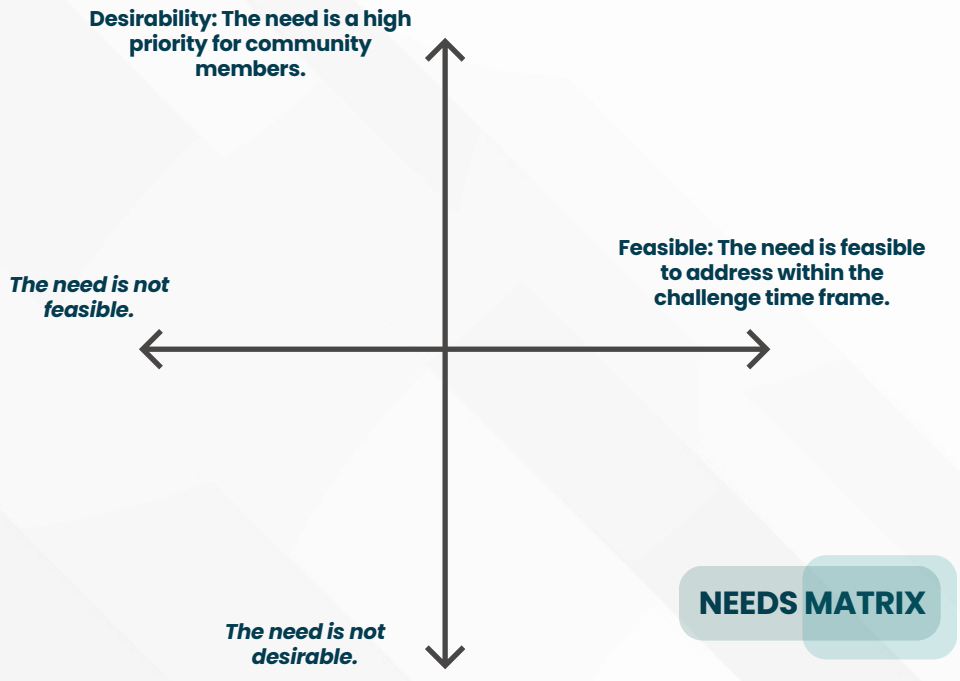
Encourage students to write down the responses of their partner on their sheet. The idea of having them interview each other is to expand on the importance of each problem and personal interest, which they will use in the next activity.

***Note:*** *There are two distinct types of 'Empathy' interviews. One, the* ***Community Empathy Interview****, is conducted with community members in Module 2. The other, the* ***Partner Empathy Interview****, is conducted with a classroom member in Module 3.*

## Using a Needs Matrix to Prioritize Problems

- Students will use the problems they discussed in their partner interviews for this activity.
- Students place each problem on the matrix based on two scales: desirability and feasibility.
- Students can use the matrix on the screen or recreate on paper and add their problems to the matrix. It is recommended that students use sticky notes as they may decide to adjust placement as other ideas are added. Have the students discuss the merits of each idea for both desirability and feasibility and come to a consensus, rather than just have each pair be responsible for placing their own idea on the matrix.

***Tip:*** *Discussing each problem as it is placed on the matrix prevents the natural tendency to overprioritize one's own ideas. Remind students that while all problems are valid, some will be more feasible to create a solution for in the time constraints.*



## Choose a Problem and Write Problem Statement

- Review the needs matrix and identify the problems that are in the upper right hand quadrant, i.e., ,most desirable and feasible.
- Have students discuss the merits of the top 2-3 ideas and then vote on the best idea. To vote, use paper or a quick online survey platform).
- Once the problem has been identified, have students rewrite the problem in the following format: "[Who]...needs a way to [what] because [why]".
- Have the **Team Relations Manager** record the problem statement as students suggest it, then help them be more specific:
  - ***Who*** = who specifically was interviewed? Are these teens in our school? People from a certain neighborhood? Who does the problem most directly impact? While the problem in question may apply to more than one group, ideal solutions may vary.
  - ***What*** = help them be as specific as possible for the user's needs, going back and asking follow-up questions to the person interviewed if needed. The more students can narrow down the need, the more likely the solution will meet that specific need.
  - ***Why*** = help students frame the justification in terms of sustainability, and the UN SDG targets. Have students revisit their research on UN SDGs if needed.

**[Who]...needs a way to [what] because [why]**

**[User/person affected] ... needs a way to ... [user's needs] ... because ... [reason/justification]**

***Tip:*** *Once students have rewritten their problem statement to be as specific as possible, find a place to display the problem statement in the room or workspace (or on the digital platform) so that students can refer to it as needed.* ***The rest of the design process should be grounded in this problem statement.***

## Additional Research for Problem Statements

- If students have an idea of an area in sustainability that they want to tackle but are struggling to define the problem well enough to write a clear problem statement, have the team take a step back and complete some additional research on the area of sustainability that most interests them.
- In the Define folder, there are excellent resources from the Smithsonian that can provide needed scaffolding to help students better select a problem. Choose the lessons and activities that are most beneficial for your team, based on the category they identify (transportation, common spaces, housing, or resources). The entire module Sustainable Communities can be found at https://ssec.si.edu/sustainable-communities.

## TAKE HOME MESSAGE

- Choosing a problem to tackle through Human Centered Design should be based on empathy interviews and the priorities of the community.
- Problem statements should clearly define who has the problem, what the solution needs to address, and why the problem needs to be solved.

# MODULE 4

Ideate

# Module 4

# Ideate

In this unit, students will explore how cultural differences impact teams, define sustainability and climate change, and learn how these differences in culture may impact solution design. Students will conduct empathy interviews to better understand the sustainability problems faced in their community.

30 minutes

SCAMPER Student Handout

**OBJECTIVES**

In this module, students will:

- Brainstorm solutions to their problem statement.
- Use the SCAMPER method to expand solution ideas

**ACTIVITIES**

- SCAMPER Challenge
- Brainstorming Solutions

## Rules for Brainstorming

- Show the short video of a group brainstorming ideas from IDEO.
- Ask students the following questions for discussion:
  - What group norms are they following?
  - How are they organizing and sharing their ideas with each other?
  - What strategies do you observe that would help your team generate ideas for your problem?
- As students generate their strategies, have the team Manager record recommended strategies.
- Prompt students to identify the following guidelines for brainstorming (a paper poster from IDEO with these rules is located in the Resources for the Ideate section): Defer Judgment, Encourage Wild Ideas, Build on the Ideas of Others, Stay on Topic, One Conversation at a Time, Be Visual, and Go for Quantity (IDEOU.com)

## SCAMPER Challenge

SCAMPER is one commonly used method for helping to expand quantity of ideas. More information on SCAMPER can be found at www.interaction-design.org/literature/topics/scamper

For the SCAMPER activity, students use the **SCAMPER Student Handout** or take a blank piece of paper and divide into eight boxes. The upper left-hand box is for the original idea, then students should write each of the words SCAMPER represents in the remainder of the boxes, one in each box (substitute, combine, etc.)

***Note:*** *Students are often hesitant to draw their ideas if they lack confidence in their artistic skills. If a student is reluctant to participate, demonstrate annotating sketches and other ways to make ideas known. Reassure that the point of the activity is to generate new ideas.*

- Follow the directions on the slide and be firm about the one-minute limit in drawing ideas! At the end of the activity, students retrieve their original paper and reflect on the ideas on their paper. Let the students ask one another about any unclear ideas.
- Emphasize to students that not every concept in SCAMPER will be applicable for every idea brainstormed, but the idea behind this activity is to get students to generate lots of ideas.

## Brainstorming Solutions to the Problem Statement

- Have students keep records of all the ideas generated to refer to in the next module, and as a backup if their selected idea does not work. If students have brainstormed on a whiteboard/chalkboard, one easy way to do this is to take pictures. The Team Relationships Manager and Photographer should collaborate to ensure that all teamwork is being documented.
- If students generate a limited list or struggle to get started, have them begin by researching solutions that have been already created, then use SCAMPER to think about how they can improve the idea or adapt it for their specific community's needs.


### TAKE HOME MESSAGE

- Brainstorming as a team is most effective when a team builds on each other's ideas and encourages the creativity of each participant.
- Generate as many solutions as possible, to have multiple options to consider when selecting an approach to your community problem

# MODULE 5

## Select Solution

# Module 5

# Select Solution

In this module, students will focus on the critical step of evaluating and selecting the most sustainable solution to address the identified problem. Students will apply various decision-making tools and techniques to ensure that the selected solution is aligned with the needs of the community.

1 hour 40 minutes

5 paper/plastic cups, 20 kebab sticks or plastic straws, and 1 plastic bag per group of 3 students; one tape measure, The Tower Game Handout, Decision Matrix Template

**OBJECTIVES**

In this module, students will:

- Use a decision matrix to objectively identify the best solution
- Select best solution based on community feedback and selection criteria.
- Create a solution statement

**ACTIVITIES**

- The Tower Game
- Decision Matrix for Selecting Solution
- Solution Statement

## The Tower Game

The Tower Game helps students develop decision-making skills by simulating real-world constraints and encouraging them to balance limited resources with long-term goals. It promotes critical thinking and collaboration as students evaluate trade-offs and make decisions under pressure, similar to selecting a sustainable solution. Through reflection, students gain insights into creating solutions that are not only effective in the short term but also sustainable over time.

- Explain to students that STEM professionals consider multiple factors when deciding on what solution to choose for a given problem.
- To demonstrate the need for multiple factors to be taken into consideration, students will work in teams in a quick design challenge, The Tower Game.
  - This icebreaker from the Project Management Institute Educational Foundation (PMIEF) is similar to spaghetti marshmallow tower-type challenges but incorporates several aspects of project management that will be beneficial to students while choosing a solution to prototype. This manual and other project management resources can be downloaded at https://www.pmi.org/pmi-educational-foundation/library.
  - When a team finishes, measure the height of the tower and write the remaining time (round up the minutes to the closest number) and the number of resources not used. Write the results on a spreadsheet and do not show them to the students until the end of the debriefing.

- Be sure to read the directions and criteria to students before starting the clock and ask if they have any questions. Once the clock starts students should not be reminded of the time or the specific criteria for success.
- Once time is up, measure the towers, count remaining resources, and use the spreadsheet in the Tower Game documents to determine the winner.
- Debrief with the students by asking them to discuss the following questions:
  - How did time, cost, quality, and risk each factor into your tower design?
  - What challenges did you encounter and how did you overcome them?
  - How does the Tower Game relate to the World Smarts STEM Challenge? Should you consider any of the same factors in determining the best solution for your problem statement?

***Tip:*** *Read the instructor directions from The Tower Game Handout before facilitating this game!*

## Using a Decision Matrix to Select the Optimal Solution

- Explain to students that just like in the Tower Game, many factors play a role in determining the optimal solution to a problem.
- Engineers use a decision matrix to weigh multiple considerations when selecting an approach.
- Have students open the "Decision Matrix" template and add their five best ideas from brainstorming to the template. Complete as a team, or recreate the matrix on a board and record ideas.
- Follow the directions in the Excel sheet to score each idea and determine the best solution.
  - Directions for creating the decision matrix are in the Decision Matrix Excel Workbook. If not using Excel, your team may need to manually add the scores from each of the considerations to determine the sum.
- Since every community is unique, students may decide to add or change some of the considerations on which they score each idea.
- The solution with the highest overall sum is the one the team will develop.

| | Idea #1 | Idea #2 | Idea #3 | Idea #4 | Idea #5 |
|---|---|---|---|---|---|
| **Description of idea** | | | | | |
| **Considerations:** | | | | | |
| **Feasibility (How likely would it be create this prototype together in time given?)** | | | | | |
| **Importance of item to community** | | | | | |
| **Sustainability (Can the idea be created from local materials or be repaired in the community?)** | | | | | |
| **Innovative concept (Is this an original idea or does something like it already exist?)** | | | | | |
| **Cost (How expensive is the idea in comparison to existing solutions?)** | | | | | |
| **TOTAL** | 0 | 0 | 0 | 0 | 0 |

**DECISION MATRIX**

## Write a Solution Statement

- Once the team has selected the solution they want to develop, have them rewrite the proposed solution to clearly define the focus.
- Have the **Manager** lead the team in the solution statement creation, and in determining if their solution is a goods or service. Use the following framework to rephrase the solution: "Our [STEM Innovation] helps [Description of Target User] who want to [Task or Goal to be Completed] by [Need or Problem the Solution will Address]".
- Have the **Team Relationships Manager** and the **Photographer** record their solution statement; consider displaying the solution statement next to the problem statement.

**Our [STEM Innovation] helps [Description of Target User] who want to [Task or Goal to be Completed] by [Need or Problem the Solution will Address]**


### TAKE HOME MESSAGE

- When selecting a solution for a problem, consider the unique needs of your community, the feasibility of a solution, and availability of materials needed.
- A decision matrix can help objectively select the best solution for a problem.

# MODULE 6
# Prototype

# Module 6

# Prototype

In this module, students will explore the prototyping phase of the design thinking process, where abstract ideas are transformed into tangible representations that can be tested and refined. Prototyping is a critical step in bringing concepts to life and assessing their feasibility, functionality, and user experience.

1 hour 10 minutes

Slow it Down! Challenge Instructions, 5 sheets of paper, 1 index card, 4 paper clips, tape, and scissors for each student group (ideally 2-3 students per group); Introduction Video

### OBJECTIVES

In this module, students will:

- Differentiate between types of prototypes
- Create a prototype for their solution
- Identify testing methods for their prototype

### ACTIVITIES

- Slow It Down Challenge
- Understanding Prototyping
- Selecting a Prototype
- Design Prototype

## Slow It Down Challenge

The Slow It Down Challenge gets students comfortable with the build-test-learn cycle of prototyping. This challenge can be completed with few resources and individually or in small groups, at the teacher's discretion.

- Have items assembled prior to challenge, including a copy of the instructions if desired. It may be a good idea to mark 6 feet with tape on the wall and the target on the floor. If you have a safe way of students dropping from a taller height (like from a staircase), it makes it easier to time the drop.
- More information (and design challenges) can be found at Discover Engineering.
- Show students the introductory video from Dr. Joan Higgenbotham, check for understanding, then let students prototype and test.
- For the debrief, decide if you want to facilitate a whole group discussion, or have students write their reflections as an exit ticket:
  - How did your group decide on a design? What principles, if any, of aerodynamics did you incorporate in your prototype?
  - Did you make changes to your prototype? How did those impact its success? How did you know?
  - How often did you test your prototype? Why do engineers run multiple trials of the same conditions when testing a prototype?
- Emphasize the importance of testing prototypes and learning from those tests to make improvements. Explain that the prototype they develop for World Smarts will need to be tested in order to refine to make it a better solution. More guiding questions available from Discover Engineering.

## Understanding Prototyping

- Read the definition of prototyping and the four classifications of prototypes with the students (on slide)
- Ask them to classify what prototype they created in the following design sprint/challenges:
  - Eating well with Rory Cooper (proof of principle)
  - SCAMPER solutions (visual in drawings)
  - Slow it Down (functional)

## Prototype Exemplars

- Show one or both of the presentation videos from prior World Smarts: Human Centered Design Curriculum teams (embedded in slides).
- Ask students:
  - What problem was the binational team addressing?
  - How does their solution work?
  - What kind of prototype did the team choose?
  - Explain that in the next step, students will choose the prototype that best illustrates their solution.

## Selecting a Prototype

- Students should brainstorm a list of ideas for their prototype. The **Manager** should facilitate a discussion of these questions to help the team decide on a prototype:
  - Should the team create an app? A drawing? A website? A survey? How can you and your team show or describe the solution to beneficiaries?
  - What kind of prototype will you and your team build?
  - How will you test the prototype and determine whether your target audience will be interested? How will you get their feedback? (e.g., social media, focus groups, a survey, phone calls, etc.)
- As students decide on a prototype for their solution, help the **Prototype Developer** determine who will assist in the creation of the prototype. The **Director** should consider how to use other team members' talents to get started on communicating results.

## Design Prototype

- The **Prototype Developer** will coordinate the design of the prototype. Online prototype sites:
  - Sketchup: 3D Design Software | 3D Modeling on the Web | SketchUp www.sketchup.com
  - Invision App: Collaborative Prototype Development Tool www.invisionapp.com
  - Justinmind: Rapid prototyping and design tools www.justinmind.com
  - AppLab: App Development that can generate code from placing objects: www.code.org/tools/applab

- Delegate tasks to complete prototype: At this point in the building process, **all team members** should be completing different tasks. Here are some examples of differentiated tasks:
  - **Identifying Local Experts:** Research local experts, organizations, and/or companies that could assist locally and share out findings to the rest of the team.
  - **Researching STEM Processes:** Conduct independent research about how to build the prototype, including materials, formulas, and scientific processes needed. Researchers also identify what needs to be tested.
  - **Researching Technology**: Research and experiment with different types of technology.


### TAKE HOME MESSAGE

- Decide what type of prototype is most appropriate for your solution.
- Delegate tasks as a team to find local experts, research methods of testing physical prototypes, and identify appropriate technology.

# MODULE 7

# Test and Refine Prototype

# Module 7

# Test and Refine Prototype

This module focuses on testing and refining prototypes to evaluate their effectiveness in solving the identified problem. Students will conduct user testing to assess the impact of their prototype and use the feedback gathered to make targeted improvements, ensuring the final solution meets user needs and expectations.

at least 1 hour

*No materials needed for this module.*

**OBJECTIVES**

- Test prototype to determine impact on solution.
- Make improvements to their prototype based on user feedback.

**ACTIVITIES**

- Test Prototype
- Feedback from Stakeholders
- SWOT Analysis

## Test Prototype

The process students will complete is called the "Design-Test-Learn" loop in the world of product development. As a team or company develops a new product, they go through several of these loops, learn from each, and build upon what they have learned.

How students will test their prototype will depend on the type of prototype they have selected. Use the following questions (on slide) to help students develop their testing methods:

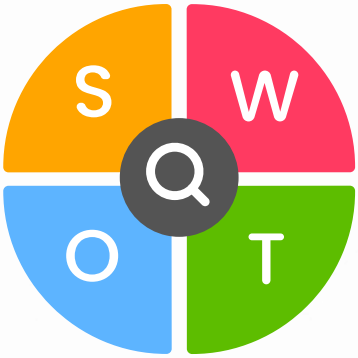
- Proof of Principle Prototypes
  - What data do you need to verify that it's working?
  - How well is it solving the initial problem?
  - How can you improve its function based on your initial tests?
  - Share your data and concept potential beneficiaries for feedback
- Form Study or Visual Prototypes:
  - Share your concept with potential beneficiaries and ask for feedback
  - Contact the people you conducted empathy interviews with or create a survey questionnaire:
    - What did they like about your concept?
    - Was there something they didn't like? Is there something that needs to be improved or changed?
    - Would they be willing to pay for this service or product

***Note:*** *As students develop their testing methods, have them consider both quantitative and qualitative data, and what will be most persuasive for communicating with different audiences.*

## SWOT Analysis

Just as with the prioritization matrix in the Defining section, the SWOT analysis of the prototype can be done on the slide with an interactive whiteboard, or recreated on a board or chart paper.

- Students should classify feedback on their prototype into Strengths, Weaknesses, Opportunities, and Threats.
- Students can work as a whole team or in pairs/small groups to take all the compiled testing results and feedback and classify each component as strengths, weaknesses, opportunities, and threats. If working in smaller groups, then have the students compare their matrices and discuss any differences. This may allow to view some feedback from different perspectives.
- Help students debrief their SWOT analysis with the following guiding questions:
  - What are the greatest strengths of your solution? How can the team maximize these benefits?
  - What parts of the solution need improvement? How can the team minimize these weaknesses?
  - What opportunities might exist to improve the prototype?
  - What are the greatest challenges to the successful implementation of the team's solution?




### TAKE HOME MESSAGE

- Use a "Design-Test-Learn" feedback loop to continuously learn from each prototype test.
- Apply a SWOT Analysis to evaluate the effectiveness of your team's solution.

# MODULE 8

# Communicate Results

# Module 8

# Communicate Results

In this module, students will learn how to effectively communicate their project results through a storyboard for a video pitch or in-person presentation. They will develop the skills to present their findings clearly and compellingly, using visual storytelling techniques to engage the community and convey the impact of their work.

1 hour 55 minutes

Cultural Iceberg Video, Sustainability Video, Sustainability Student Handout, Internet Access (for Ecological Footprint Activity), and Community Empathy Interview Questions

**OBJECTIVES**

- Create a storyboard for a video pitch or in person presentation
- Communicate results to the community via presentation or video

**ACTIVITIES**

- Presentation Skills
- Storyboard
- Video Pitch/ Presentation Creation and Practice

## Presentation Skills

The final stage in human centered design is sharing the solution with the community!

- The **Prototype Presentation Coordinator** should lead the team through preparing either an in-person presentation for the community or a video pitch to share with stakeholders.
- In both types of presentations, your team should focus on telling your story- what problem did you identify? How does your prototype address that challenge? What challenges and successes did you face along the way?

***Note:*** *Depending on* ***your school's social media policies*** *and student interest, you may want to consider expanding the definition of presentation to social media campaigns, infographics, interactive brochures, or another informal method of presentation.*

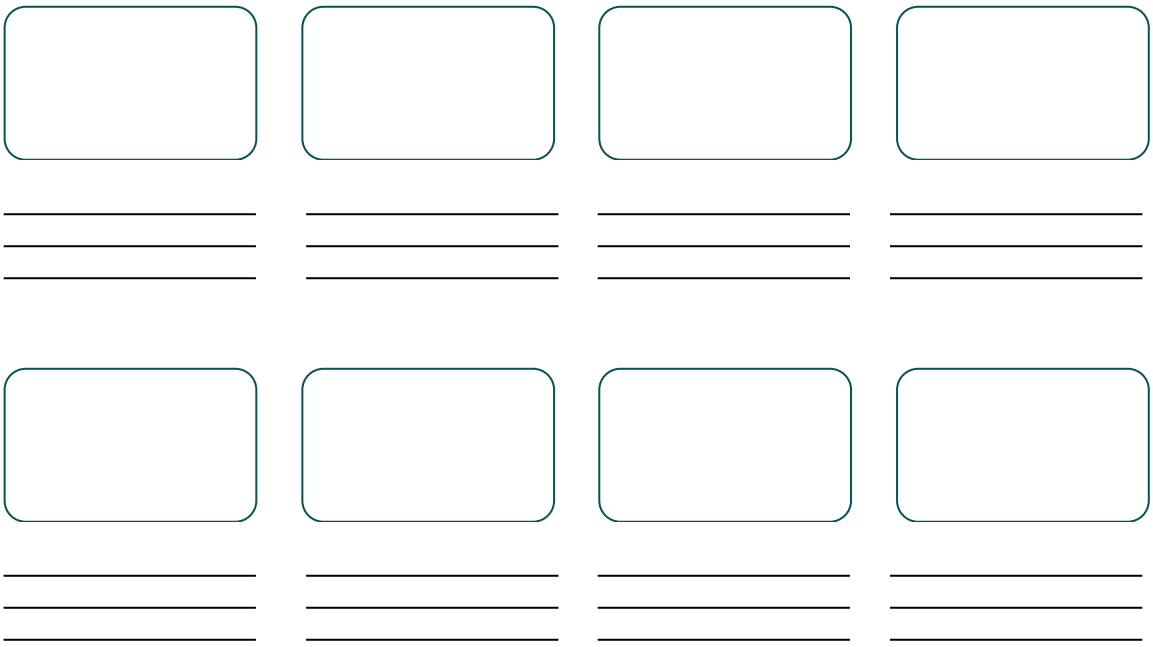
Many students (and adults) struggle to prepare effective presentations. This video gives an outline of what to include and should help students storyboard if they haven't had experience with presentations in the past.

- Have students watch the TED Talk by Phil Waknell, then discuss the following questions:
  - What are the 3 magic ingredients of great presentations?
  - How do you transform an audience?
  - How will your team follow these strategies to create an effective presentation to share your World Smarts: STEM Solution prototype?

## Creating a Storyboard

- Have the **Presentation Manager** lead the discussion as to what should be said in the presentation (either live or video), and what should be seen (slides for live).
- Encourage students to stick to their storyboards as they work on their videos, or revise them as needed, to ensure they are staying aligned with the human-centered design process.
- Recommend additional resources for support with creating the storyboarding such as Storyboard That to help students tell an effective, compelling story.

Project Name: _____ Page:___ of ____
By: _____ Date: _____



### TAKE HOME MESSAGE

- Effective presentations communicate not only the solution, but the journey taken through human centered design.
- Storyboarding is a useful technique to ensure presentations are engaging and include all important components.

# Support

For additional support or resources, please contact:

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