Human Centered Design: Masks and Backpacks

The Lemelson Foundation
improving lives through invention

Grade Levels: Grades 6-12

4 Activities/ Duration: 60 Minutes to several sessions

Content Areas
Engineering, Design Thinking

Disciplinary Core Ideas
Defining a Problem, Developing Possible Solutions, Optimizing the Design Solution

Crosscutting Concepts
Influence of Science, Engineering, and Technology on Society and the Natural World

Science and Engineering Practices
Asking Questions and Defining Problems, Analyzing and Interpreting Data, Constructing an Explanation and Designing Solutions, Engaging in Argument from Evidence

Next Generation Science Standards (NGSS)
MS-ETS1, HS-ETS

Learning Objectives/Outcomes

- Learners will use HCD to engage in engineering activities.
- Learners will engage in the engineering of Masks and Backpacks to meet specific criteria.
- Learners will design, revise, and redesign their proposed solutions.
- Learners will evaluate design solutions that best meet the design criteria.

INTRODUCTION

In this lesson, learners will utilize Human Centered Design (HCD) to make personal protective masks. Following this activity, learners will engage in a longer HCD project. In the first activity, the learner will be the "user" of the mask they design. In the second activity, the learner will focus on the needs/wants of someone else (e.g. friend, neighbor, classmate, etc.). Each activity will ask learners to document their thinking while using HCD, and to show how HCD informed their solution.

BACKGROUND

The first step in HCD is for the inventor, learner or engineer, to develop "Empathy" for a user to better "Define" a problem from that user's point of view. In the following steps of "Ideate" and "Prototype," the learner considers radical ways to solve the problem and then applies STEM concepts and practices to create a prototype for the user to interact with. In "Test" learners evaluate how their invention could solve their own and other users' problems.

HCD is a reiterative design process that learners often engage with as they move from building empathy with the user, defining the problem from their perspective, ideating on possible solutions, prototyping something tangible, and then testing the solution. Throughout the HCD process, feedback from the user is essential because they define the problem from their point of view and inform what a possible solution can be. Providing learners with an ongoing connection to a "user" who they get feedback from is essential throughout the HCD process.

A major strength of using HCD to teach engineering design is that it broadens learners' social and emotional engagement in the design project. The thing the learner is inventing is meant to enhance the quality of life of someone else, and therefore has value to him or her because of the impact it has on others. HCD is an excellent framing tool to add to engineering activities or project lessons you, or someone at your school or organization, are already doing. Table 1 shows each part of HCD and provides tips on how to facilitate and integrate HCD into an engineering challenge. This lesson plan adapts one engineering challenge activity and then outlines a longer HCD project.

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MATERIALS

For Mask:

- Household Items
- Cloth
- String/Rubber band

For Backpack:

- Paper Cups
- Straws
- Paper Towels
- Rubber Bands
- Paper Clips
- Tape
- Balloons
- Plastic Bags
- Glue
- Corks
- Foam Pieces
- String
- Foil
- Pipe Cleaners
- Small Containers
- Miscellaneous Items

How can I use the Human Centered Design Process to invent something for someone else?

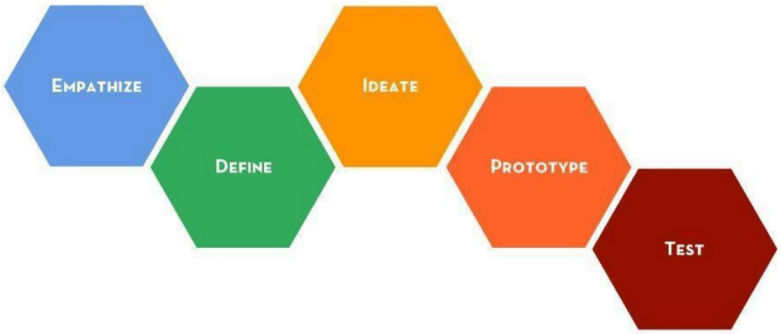

Table 1. Human Centered Design Tips for focus, direct instruction, activities, and prompts

1. Empathy: Connecting with the User

- Focuses on promoting empathy between learner and user that informs the learner's understanding of a problem and possible solutions.
- Direct instruction on what empathy is and how inventors use it to enhance the quality of life of others.
- Activities: Interviews, video blogs, letters, observations, videos/pictures/drawings of the "problem", stories of others the user resonates with, ongoing feedback.
- Prompts for adapting engineering design challenges: Who is the user for the engineering challenge? Whom are we engineering this solution for? What are their needs?

2. Define: Understanding the problem and possible solutions from the users perspective

- Focuses on problem finding and identification using key criteria discovered during the empathy stage.
- Direct instruction on problem identification and defining a problem.
- Activities: Creating a checklist of needs/wants, rank design needs/wants, check-ins with user to see if the learner is really addressing the key problem of the user (note: the learner only needs to address a small part of the overall problem).
- Prompts for adapting engineering design challenges: How did we define "what was needed" to successfully complete the challenge?

3. Ideate: Considering radical ways to design a solution

- Engages students in brainstorming and creativity exercise, such as SCAMPER, to draw attention to ideating during engineering design activities that can be completed in multiple ways.
- Direct instruction on brainstorming and creativity to inform design
- Activities: SCAMPER, what could this be? (e.g. draw a symbol on a board and asks learners to write everything it could be), improv theater games, and identifying how they brainstorm during engineering design challenges.
- Prompts for adapting engineering design challenges: How did you or your team decide on the design? Was it an explicit process? Did you or your team do any drawing, doodling or discussing? How can we think of alternative solutions? How many solutions can we come up with to the scenario?

Lesson Activities

Table 1 (Continued): Human Centered Design Tips for focus, direct instruction, activities, and prompts

4. Prototype: Applying Science, Technology, Engineering, and Math to invent something tangible, and then engaging in redesign to create an optimal solution

- Learners apply STEM concepts to create a prototype that meet the needs of the user they empathized with.
- Direct instruction on how to fail fast and learn fast through prototyping (e.g. modeling) and getting feedback from a user (e.g. observe them interacting with the invention) and/or key design criteria (e.g. defined during the empathy stage).
- Activities: have learners conduct standardized tests to meet specific criteria, complete engineering activities that require multiple revisions, create and scale a design, and draw attention to how learners make revisions by collecting information through prototyping that informs their design.
- Prompts for adapting engineering design challenges: How did you or your team decide what to change about your design? Did you only change some or part of your design, why or why not? How did you know your design was the "optimal" design? What were other designs you considered, and how did you know the one you decided on was better?

5. Test: Showing how the solution meets the needs of the user and marketing the invention

- Youth learn how inventions are patented, trademarked, and marketed by completing activities that detail the patent process and that require them to create skits to model an invention.
- Direct instruction on how to fail fast and learn fast through prototyping (e.g. modeling) and getting feedback from a user (e.g. observe them interacting with the invention) and/or key design criteria (e.g. defined during the empathy stage).
- Activities: have learners conduct standardized tests to meet specific criteria, complete engineering activities that require multiple revisions, create and scale a design, and draw attention how learners make revisions by collecting information through prototyping that informs their design.
- Prompts for adapting engineering design challenges: How did you or your team decide what to change about your design? Did you only change some or part of your design, why or why not? How did you know your design was the "optimal" design? What were other designs you considered, and how did you know the one you decided on was better?

1 Personal Protective Masks and Human Centered Design (HCD)

Use the PowerPoint and worksheet provided. Decide on what prompts you want students to use in the PowerPoint and walk them through creating and making a mask using HCD. Have them design and test their mask using HCD and share their experience with the class. Tell learners that inventors can play important roles enhancing the quality of lives of others in society. For example, during the COVID-19 outbreak many inventors are coming up with ways to make personal protective masks at home. During this first activity, learners track their thinking as they move through the stages of HCD while creating a mask from household items.

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Activity Outline	Teacher-Led Instruction	Learning and Supplemental Activity
Introduction What is HCD and why are masks important during COVID-19?	Direct instruction on HCD and the prompt of the design challenge.	Reading from Wired magazine about COVID-19 and Surgeon General Adam Jerome's "how to" video.
Making the Mask Engineering Design Challenge	Direct instruction on learners are to track their HCD process.	Complete the prompts in the HCD worksheet as they are completing the design challenge. Note, the worksheet is in a word document and can be adapted to other engineering design challenges (see Design Squad resources)
Sharing Your Process Learners will share how they engaged or did not engage in each step of the process	Facilitates online, or 1 on 1 discussion.	Complete the reflection prompts on the HCD worksheet, and then share with other learners about how they used HCD to make their own mask.

Video Explaining how to make a mask:
https://www.wired.com/story/how-to-make-a-cloth-face-mask/

Link to Background Reading:
https://www.lemelson.org/during-a-health-crisis-look-for-the-inventors/

2 The Design a Backpack Challenge

The design a backpack (or anything else a user they can interact with may want) challenge is a one to two-week project. The challenge can be completed in a shorter time and in person. However, the adaption presented here is for distance learners. To complete the design challenge, learners need to select a user for whom they will make something, in this case, the best backpack they have ever had. The 'backpack' being invented in the challenge can be replaced with other items, such as a wallet, app or anything else that addresses a need of the user. An ideal user will be of easy access to the learner, e.g. someone who lives in their home, class, or someone they can video call.

Activity Outline	Teacher-Led Instruction	Learning and Supplemental Activity
Introduction Design a Backpack Challenge	Direct instruction on HCD and the prompt of the design challenge.	Have students select a user for their backpack
Empathy Engineering Design Challenge	Direct instruction on interview skills and what they can ask their user	Complete the interview worksheet.
Define Learners will define what an "optimal" backpack for their user would be.	Direct Instruction on problem identification	Complete the define portion of the worksheet.
Ideate Learners will ideate on different aspects of their design.	Direct instruction on how learners will use SCAMPER to ideate on their design	Complete the SCAMPER portion of the worksheet
Prototype Learners will prototype part of some of their design.	Direct instruction on prototyping and how they can make all or part of their design	Create something someone can interact with and get feedback
Test Learners will test/market their design.	Direct instruction on marketing their backpack and documenting how their user uses the backpack	Create a marketing pitch, video, or something else to share their invention

Wrapping Up:
Once students have built, tested, and revised their designs, have each group share out how their designs changed through the testing process. If using, the students share the worksheet in class, or virtually. Following this activity, teachers can select specific user groups (e.g. elderly, veterans, students, families, etc.) and their class could work collaboratively on the same project, but in small groups, to solve a problem or address a need of the specific user group.

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References

- The d. School at Stanford University is credited with creating Human Centered Design and the "Design a Backpack" challenge that was adapted here. https://dschool.stanford.edu/
- The lessons presented here are part of the iINVENT summer program offered as part of Oregon State University's Precollege Programs for middle school aged youth. https://precollege.oregonstate.edu/iinvent-summer-camps
- This lesson was also developed from Oregon MESA's invention toolkit for youth. https://oregonmesa.org/

Acknowledgements

This lesson was developed with funds from the Lemelson Foundation
https://www.lemelson.org/
https://inventioneducation.org/

SCAFFOLDING EXTENSIONS

Rory Cooper - Highlighting an Inventor

Rory Cooper is the founder and director of the Human Engineering Research Laboratories (HERL) at the University of Pittsburgh and has a distinguished career in human centered design. He is an amazing individual and he and his team have designed countless technologies that make life better for people with disabilities and differing abilities. Rory Cooper is an inventor who applies HCD in their everyday work.

https:/www.uspto.gov/kids/Cooper.html
https://www.youtube.com/watch?v=sIc5PVDLQMM
https://www.herl.pitt.edu/

Lesson: Inventing in a Pandemic for the Tiniest Among us

The response to stop the spread of COVID-19 has prompted a wide range of creative and inventive solutions. In this lesson, you'll learn about "The Shield Team" made up of teachers, students and makers from across the country who are 3D printing face shields for health care workers, as well as what universities are doing to create life-saving personal protective equipment (PPE). Doug Scott, engineering and robotics teacher, Hopkinton High School, Hopkinton, Massachusetts, developed this lesson.

https://www.pbs.org/newshour/extra/lessons-plans/lesson-plan-inventing-in-a-pandemic-for-the-tiniest-among-us/
https://twitter.com/mrscottbot

Design Challenges to Adapt

PBS Design Squad provides online and printable design challenges for youth of all ages. The materials usually come in English and Spanish, have video supports, and use household items.

https://pbskids.org/designsquad/build