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Human-Centered Design for Elementary Grades: Designing Assistive Technologies for the Human Body

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Introduction

At the core of any academic curriculum is the idea that we want to develop citizens who are knowledgeable problem-solvers as they tackle the challenges of improving the quality of life for themselves and the world around them. One approach that has been heavily utilized in universities and businesses in recent times is known as Design Thinking. “The Design Thinking process has become increasingly popular over the last few decades becauseit was key to the success of many high-profile, global organizations—companies such as Google, Apple and Airbnb have wielded it to notable effect, for example. This outside the box thinking is now taught at leading universities across the world and is encouraged at every level of business.” [1] While the heart of this unit is the Design Thinking process, I have also connected it to an academic area in which students will be able to apply and practice what they learn. For this, I have chosen *life science concepts related to the human body* as outlined in both NGSS and Connecticut State Standards. I mention this because you could take the background knowledge and lessons centered on the Design Thinking processes and apply it to other academic areas if desired. However, should you choose to use this unit in its entirety you will find the ideas and content within to be a valuable teaching resource for meeting elementary life science concepts related to the human body. This unit will be divided into two sections: Human-Centric Design Thinking and Understanding Disabilities of the Human Body and How We Might Help Them. The unit, as written, should take about nine to ten 45 minute lessons to complete (time depends on the complexity of the project to be prototyped and tested).

As a unit that follows the Yale-New Haven Teachers Institute model, much of what I have written is based on the thirteen two-hour seminar sessions spent with a Yale professor and a small group of about a dozen New Haven teachers, as well as additional outside reading and research. This year, I had the privilege of working with Dr. Anjelica Gonzalez, Professor of Biomedical Engineering at Yale University. Our seminar, titled “Human Centered Design of Biotechnology,” explored practices in design thinking through the lens of biotechnology. The discussions, activities, and learning during those seminar sessions are the inspiration for this unit.

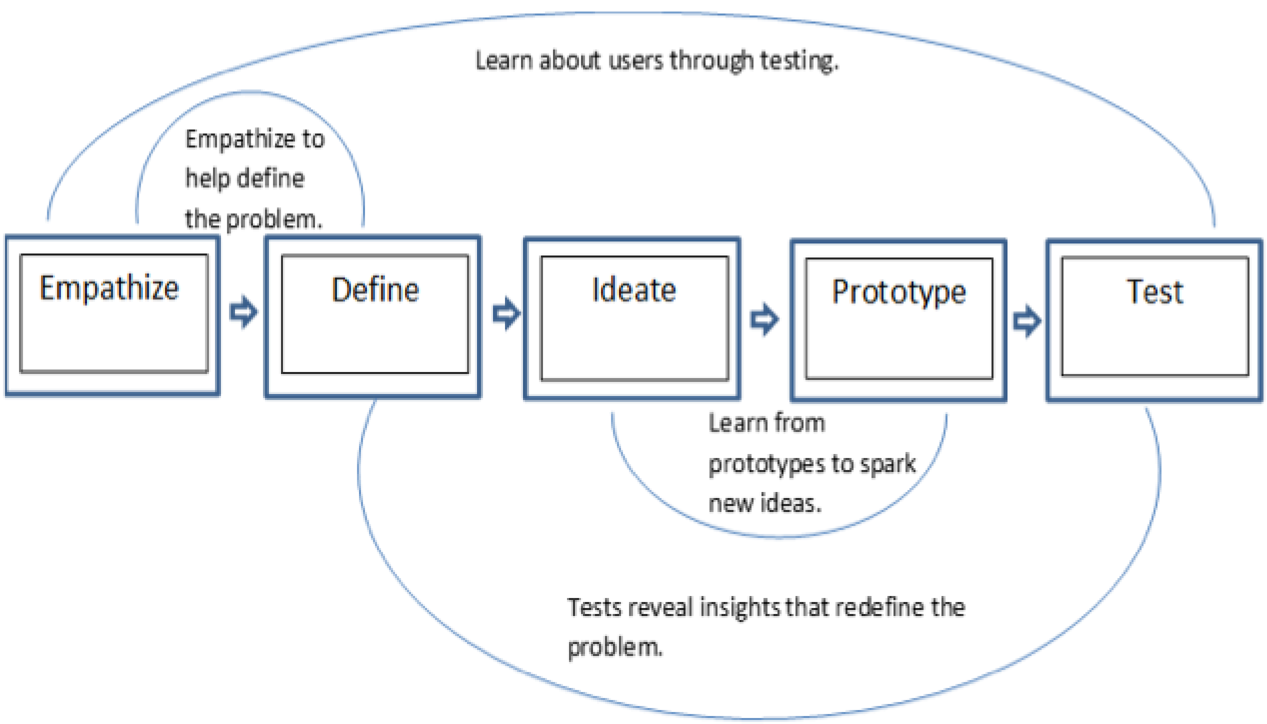
Human-Centered Design

What is Human-Centered Design?

“Coming up with an idea is easy. Coming up with the right one takes work. With design thinking, throwing out what you think you know and starting from scratch opens up all kinds of possibilities.” [2]

“Embracing human-centered design means believing that all problems, even the seemingly intractable ones like poverty, gender equality, and clean water, are solvable. Moreover, it means believing that the people who face those problems every day are the ones who hold the key to their answer. Human-centered design offers problem solvers of any stripe a chance to design with communities, to deeply understand the people they’re looking to serve, to dream up scores of ideas, and to create innovative new solutions rooted in people’s actual needs.” [3]

During our first seminar, Dr. Gonzalez introduced us to the Human Centered Design Thinking model. The model is segmented into five distinct stages, but the progression between those stages is not necessarily linear. The five stages are Empathize, Define, Ideate, Prototype and Test. Each stage serves an important purpose, and, as part of the process, are designed to work together. A lot of back and forth between each phase is expected, as new ideas are added and knowledge and insight are gained, evaluated, and processed until the desired solution or a variety of solutions to the task at hand has been reached. Each stage should be considered as an important part that contributes to the whole of the process, but not necessarily as sequential steps.



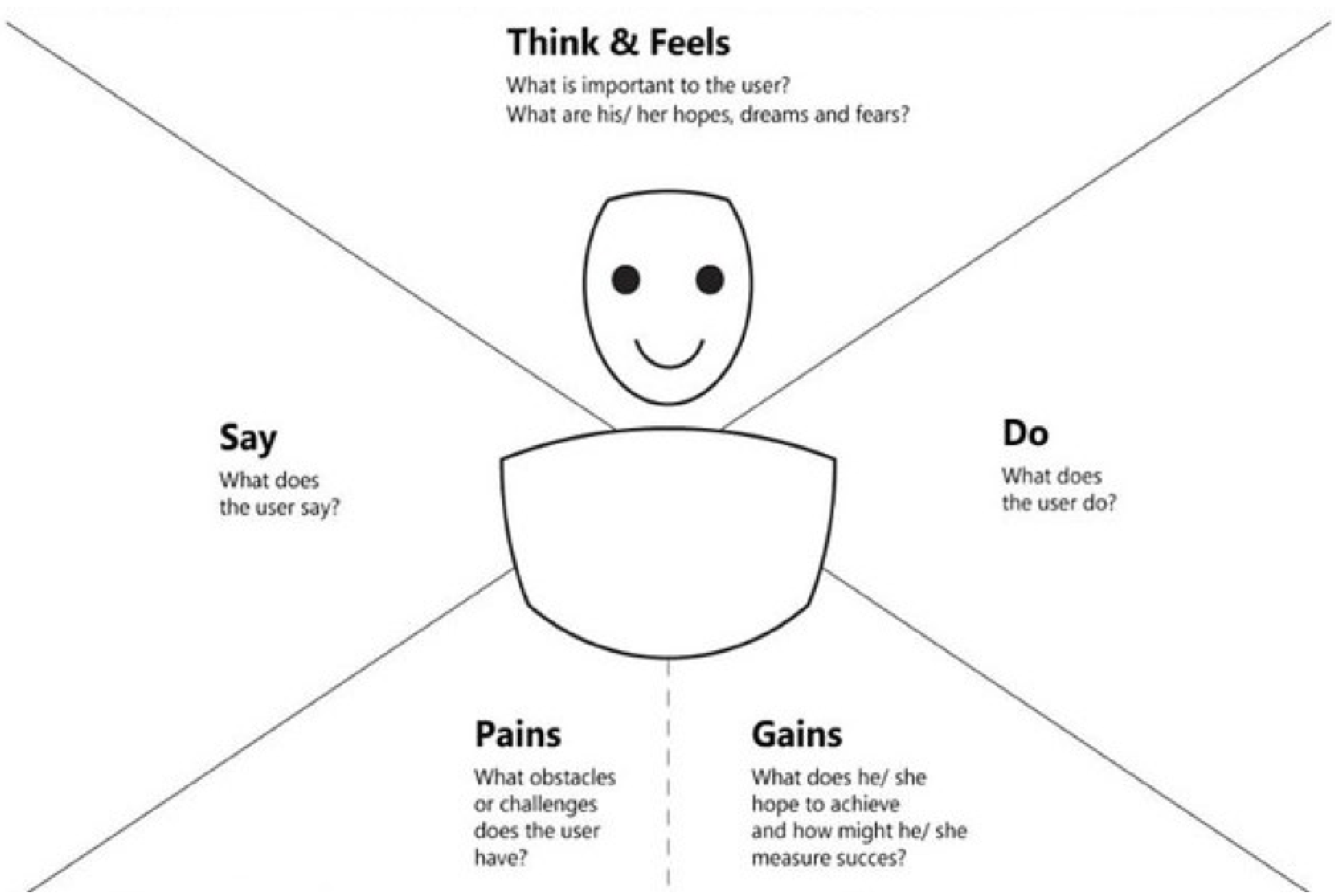
Empathize

Empathy is the ability to understand and appreciate what another person, or group of people, is experiencing from their point of view and is a crucial part of thinking in a human-centric manner. “You never really know a man until you understand things from his point of view, until you climb into his skin and walk around in it." [4] It takes empathy to understand the needs of those you are trying to help. In business, this could be a phase of researching and understanding the needs of your customers, or the needs of your employees and using this understanding to develop corporate policies. You may have heard about companies that have gone to great effort to retain and keep happy employees. Google is a famous example, and was recognized in a 2018 Forbes Technology Council article as "the tech company with the best corporate culture." Flexible schedules, a fun work environment (you can even bring your dog to work), shared company values, a focus on innovation, and a growth mindset are a few reasons for Google's success. Employees who feel valued and included in decision making tend to be loyal and satisfied.

In our seminar, we discussed the difficulties experienced in the transfer and usage of medical equipment in developing countries that could be aggravated by partial and incomplete understanding of the cultural, social, economic, and institutional factors of the region. Consider the following example, taken from a 2018 National Academy of Medicine article about sustainability challenges in medical device donations: "In eastern Uganda, a regional hospital receives a much-needed donation: an x-ray machine that appears to be in good working condition upon arrival. The hospital staff quickly puts the machine to use, only to have it fail during a procedure. With no trained biomedical technicians at the hospital, the machine sits unused for months. Eventually, an available technician is finally located in Kampala. He travels to the hospital and examines the machine, identifying the replacement part that is likely needed, but he cannot verify the part without the machine's accompanying manual. The hospital finds the new part to be costlier than anticipated and must be special ordered because it is not available in the country. When balancing the costs against the other demands on its limited budget, the hospital administration regretfully decides it cannot afford to spend time and money on securing the new part. Despite the need for its services, the x-ray machine remains out of use." 5 This is a frequent occurrence with donated medical equipment in many developing countries, but is not just limited to the cost of a replacement part. In fact, relatively simple material failures, like a power cord that does not match the countries electrical system or the instructions presented in a foreign language, are the cause of most discarded and disused medical devices. According to a World Health Organization Guidelines for Health Care Equipment Donations, "in the Sub-Saharan Africa region a large proportion (up to 70 per cent) of equipment lies idle due to mismanagement of the technology acquisition process, lack of user-training and lack of effective technical support." [6] While companies that donated medical equipment may have had good intentions, the lack of empathy and incomplete understanding of the situation in these countries has led to huge stockpiles of unused, and possibly broken or outdated equipment that sits in medical equipment graveyards.

As applied to this unit, this is the stage where students will develop an appreciation for the challenges a person encounters when faced with a disability. For example, when researching what it is like to be blind, students will attempt to engage in regular activities while blindfolded. They will discover for themselves what it feels like to have to walk down a hallway, write their name on a piece of paper, or perform another routine task, all without sight. They might read stories, watch videos, or even interview people with a vision disability. The philosophy here is to drop preconceived notions and develop a comprehensive understanding of the experiences and feelings of the people that are involved in a situation. Not only do we want to understand their needs, we also want to understand why they will or will not embrace certain solutions.

A useful tool to help develop empathy is through a technique called Empathy Mapping. "An empathy map consists of four quadrants, each reflecting the four key traits that the users demonstrated/possessed during the observation stage. The four quadrants refer to what the users: **Said**, **Did**, **Thought**, and **Felt**. Determining what the users said and did are relatively easy; however, determining what they thought and felt is based on careful observation of how they behaved and responded to certain activities, suggestions, conversations etc. (including subtle cues such as body language displayed and the tone of voice used)." [7]



The above image is an example template for an empathy map that can be used with students.

Define

The goal of the "define" stage of Design Thinking is to clearly articulate the problem you are trying to solve. Without clearly defining the problem, you run the risk of developing ineffective approaches to possible solutions. The goal is to frame the problem correctly in a manner that will generate a variety of questions and ways of thinking about the problem. In the define stage, all the information that was gathered in the empathy stage is analyzed and distilled to a core problem statement. That core problem statement should be succinct, actionable, free from imposed limitations (so as not to hinder divergent thinking), and phrased as a question. Framing the defined problem statement as a question using the stem "How might we…" or "What can we do to…" encourages creative ideas about the solution. Asking the right question, in just the right way, will serve as a guide and beacon to a variety of creative responses. It is important that the problem statement be not too broad due to lack of focus, yet not too narrow as to impose limitations to ideas. For example, an unrefined and broad problem statement such as "How might we improve public education?" is too wide a scope to make a meaningful impact. A narrow question, such as "How might we help Jon learn to read The Cat in the Hat?" might be great if you are Jon trying to learn to read that book, but not much help to other students, or even Jon's reading ability beyond the one text. The define stage might be messy and require several revisions, but the result should be a "just right" statement that produces a variety of responses. A statement such as "How might we help 3rd grade students with dyslexia become better readers?" is more specific by helping us focus on who (3rd graders with dyslexia) and the desired and measurable result (become a better reader). Once established, the problem statement will serve as a guide to the rest of the process. There is a bit of flexibility here as well, since further work throughout the Design Thinking process can possibly lead to further revisions of the problem statement if it helps to refocus the task at hand.

“A well-developed problem statement helps to focus on the specific needs that you have uncovered. It also creates a sense of possibility and optimism that allows team members to generate ideas in the Ideation stage, which is the third and following stage in the Design Thinking process. A good problem statement should have the following traits:

- **Human-centered**. This requires you to frame your problem statement per specific users, their needs, and the insights that your team has gained in the Empathize phase. The problem statement should be about the people the team is trying to help, rather than focusing on technology, monetary returns, or product specifications.
- **Broad enough for creative freedom.** This means that the problem statement should not focus too narrowly on a specific method regarding the implementation of the solution. The problem statement should also not list technical requirements, as this would unnecessarily restrict the team and prevent them from exploring areas that might bring unexpected value and insight to the project.
- **Narrow enough to make it manageable**. On the other hand, a problem statement such as, “Improve the human condition,” is too broad and will likely cause team members to easily feel daunted. Problem statements should have sufficient constraints to make the project manageable.

As well as the three traits mentioned above, it also helps to begin the problem statement with a verb, such as “Create”, “Define”, and “Adapt”, to make the problem become more action-oriented. [8]

Ideate

In the ideation stage, the goal is to make sense of the data that has so far been collected and identify opportunities for design. The first step is to generate a lot of ideas related to the problem statement. This can be through a brainstorming process (more on this later), or another method that encourages generating a quantity of ideas. Some ideas will lead to further expansion or may be bundled with other ideas, and some may be discarded. This is a time for asking the right questions, developing innovating solutions, and exploring those solutions through feedback from a variety of sources. Feedback will be exchanged, and rough prototypes to communicate and try ideas may even be constructed.

There are many ways to facilitate the ideation stage in a classroom, but the following are some I found to be the most effective in a 4th grade classroom.

Brainstorm: An effective brainstorming session, where ideas are generated quickly with the focus on quantity, can be a powerful process if facilitated correctly. Putting a group of students down with a blank piece of paper and asking them to write ideas is generally not effective. Neither is having everyone shout out ideas all at once. Environment and culture have an impact on the creative process, and the Design Thinking approach is to establish a culture that encourages creativity. The environment should not be sterile, and participants should be able to freely hear and converse with one another. A time limit should be set, and the topic of focus should already be a clearly defined problem statement. One person should be designated to write or draw ideas on a whiteboard or poster paper. Another person should act as facilitator who will ask prompting questions should a group hit a lull in idea generation.

“At its most basic level, a brainstorm session involves sprouting related points from a central idea. Brainstorming is one of the primary methods employed during the Ideation stage of a typical Design Thinking process. Brainstorming is a great way to generate many ideas by leveraging the collective thinking of the group, by engaging with each other, listening, and building on other ideas. This method involves focusing on one problem or challenge at a time, while team members build on each other’s responses and ideas with the aim of generating as many potential solutions as possible. These can then be refined and narrowed down to the best solution(s). Participants must then select the best, the most practical, or the most innovative ideas from the options they’ve come up with.” [9]

According to the Institute of Design at Stanford d.school, the following guidelines are best practices for conducting a brainstorm session:

1. Set a time limit.
2. Start with a problem statement or goal and remain focused on that goal.
3. Defer judgement or criticism, including non-verbal.
4. Encourage a variety of ideas.
5. Build on each other’s ideas.
6. Aim for quantity.
7. Be visual.
8. One conversation at a time.

There are several methods for refining the brainstorming session to select the best idea or ideas. One such method is Post-It Voting, or Dot Voting. In Post-It voting, all members are given several votes (three to four should do) to choose their favorite ideas. Members can vote by using stickers or a marker to make a dot on the post-it note corresponding to the ideas they like. This process allows every member to have an equal say in choosing from the shortlisted ideas.

Another method is known as the Four Categories method. This method involves dividing ideas ranging from the most rational choice to the 'long shot' choice. The four categories are: the rational choice, the most likely to delight, the darling, and the long shot. Of course, these categories can be renamed to something more student friendly. Members then decide upon one or two ideas for each of these categories. This method ensures that a variety of ideas and innovative solutions are considered.

In the Ideation stage, the aim is to generate a large quantity of ideas. These ideas, in turn, may inspire newer, better ideas that can then be filtered and narrowed down into the best, most practical, choices.

Prototype

The purpose of the prototype stage is to create a working visual representation of the proposed solution. This gives the user something to interact with that is a scaled down version of what might be the final product. Testing and prototyping go together; since the outcome of manipulating and using the prototype is to elicit additional feedback. In business, this is the stage where it is most economical to fail early on, before a lot of time and money has been invested in a product or solution that is not optimal. “When designers want to determine and understand exactly how users will interact with a product, the most obvious method is to test how the users interact with the product. It would be foolhardy and pointless to produce a finished product for the users to test. Instead, designers can provide simple, scaled down versions of their products, which can then be used to observe, record, judge, and measure user performance levels based on specific elements, or the users' general behavior, interactions, and reactions to the overall design. These earlier versions are known as prototypes; they are not necessarily in the medium of the finished product as this may not be cost-effective in terms of time or money." (IDF) Depending on the situation, more advanced prototypes closer to the final model can also be used, although these would be more expensive and time consuming to create.

"Why should students create a prototype?

1. To ideate and problem-solve. Build to think.
2. To communicate. If a picture is worth a thousand words, a prototype is worth a thousand pictures.
3. To start a conversation. Your interactions with users are often richer when centered around a conversation piece. A prototype is an opportunity to have another, directed conversation with a user.
4. To fail quickly and cheaply. Committing as few resources as possible to each idea means less time and money invested up front.
5. To test possibilities. Staying low-res allows you to pursue many different ideas without committing to a direction too early on.
6. To manage the solution-building process. Identifying a variable also encourages you to break a large problem down into smaller, testable chunks." [10]

How to prototype:

1. Start building. Even if you aren't sure what you're doing, the act of picking up some materials (post-its, tape, and found objects are a good way to start!) will be enough to get you going.
2. Don't spend too long on one prototype. Let go before you find yourself getting too emotionally attached to any one prototype.
3. ID a variable. Identify what's being tested with each prototype. A prototype should answer a particular question when tested. That said, don't be blind to the other tangential understanding you can gain as someone responds to a prototype.
4. Build with the user in mind. What do you hope to test with the user? What sorts of behavior do you expect? Answering these questions will help focus your prototyping and help you receive meaningful feedback in the testing phase." [11]

Test

Once a prototype has been created, it is time to decide how to test that prototype with the end user. The purpose here is to still build empathy towards the user's needs by soliciting additional feedback based on the user's experience with the prototype. Ideally you can test within a real context of the user's life. For a physical object, ask the user to take it with them and use it within their normal routines. This testing phase will help inform the next iteration of prototypes, even if it means starting over with a different idea. It also provides an opportunity to gain useful insight by observing how the user interacts with the prototype.

How to test:

1. "Show don't tell. Put your prototype in the user's hands – or your user within an experience. And don't explain everything (yet). Let your tester interpret the prototype. Watch how they use (and misuse!) what you have given them, and how they handle and interact with it; then listen to what they say about it, and the questions they have.
2. Create Experiences. Create your prototypes and test them in a way that feels like an experience that

your user is reacting to, rather than an explanation that your user is evaluating.
3. Ask users to compare. Bringing multiple prototypes to the field to test gives users a basis for comparison, and comparisons often reveal latent needs." [12]

The design thinking model is an incredibly powerful and useful process for students to use whenever they are faced with designing solutions to help others. Like any process or skill, it will take practice to become good at it. Failures along the way are to be expected and accepted as a necessary part of growth. Students will need many opportunities to apply the design thinking model in order, and one such way I intend to imbed this process with 4th graders is when we study the human body. Students will learn about muscles and bones, the eye, the ear, the brain, and nervous system per the Connecticut State Standards. In this unit, students will use what they have learned to design an assistive device to help somebody suffering with an ailment or disability.

Part 2: Understanding Disabilities of the Human Body and How We Might Help Them

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Under the Next Generation Science Standards, there are several fourth-grade life science topics related to the human body. These include muscle and skeletal systems, eyes and vision, ears and hearing, and the brain and nerves. Once students have learned about these body systems as part of their regular fourth grade science education, this unit adds another layer that evolves into a focus on how we might help somebody who has a disability in one or more of these areas. Students will extend their learning of the human body as they apply the Design Thinking process to produce a piece of assistive technology.

Elementary-aged students have had some formal education of biology and it may be helpful to review what Connecticut students should know based on the life science standards for each grade level. In preschool through kindergarten, students learn to describe patterns of what plants and animals need to survive as well as identify common body parts. First graders make observations about heredity; such as young plants and animals look similar to, but not exactly alike their parents. Second graders learn the value of proper nutrition as well as study plants and animals from a variety of habitats. In third grade, students learn that organisms have unique and diverse life cycles that share a commonality of birth, growth, reproduction, and death. Fourth grade students learn more about internal and external plant and animal structures that support survival, growth, behavior, and reproduction. They also learn that animals, including humans, receive different types of information through their senses that are then processed by the brain in different ways.

Informally, most students of this age range understand human biology based on common life experiences. They know that germs can make you sick. They know bones can break and cuts and bruises hurt, but they also heal. They know some people have disabilities that affect mobility, hearing, and sight. They may also be aware of Autism and other disorders that affect behavior. With this background knowledge in mind, this unit will build on what students should already know by the time they reach fourth grade. As students learn about specific parts of the body and how they work (muscles and bones, eyes, ears, brain, and nerves), they will also learn about some common disabilities related to that body part or system.

Muscles & Bones

Broken bones are a clear and easily approachable topic for students to understand and relate to. Some students might even have direct experience with broken bones. In this section, a scenario with a student trying to go about everyday classroom tasks with a broken arm or leg is ideal. Simple tasks like walking down the hall with a broken leg or trying to write on a sheet of paper with a broken arm can be a challenge.

Another ailment to consider is arthritis. Arthritis is the swelling and/or tenderness of the joints. Stiffness and joint pain are two major symptoms of arthritis. Students who have studied this ailment can design something to make a task easier for a person suffering from arthritis in their hands. Examples include a writing utensil that can be held and used with minimal pain, or a pill bottle that retains child safety features but is easier to open.

The Eye

Partial or complete blindness, the lack of sight, is of course a major problem related to the eye. Students can try to build empathy for the blind by trying to perform a task, like walking down the school hallway, while blindfolded. They can then design a device or method for walking down the hall for those who are blind.

Another ailment related to the eye is color blindness. People who are color blind have difficulty distinguishing different colors, such as red-green (most common) or blue/yellow. This can make some classroom tasks difficult, especially when the identification of color is an important factor.

The Ear

Not being able to hear can have a serious impact on communication with other people. In this scenario, student will role-play what it is like to not be able to use their sense of hearing. They will then create an assistive device to help somebody who is deaf in the classroom.

Teaching Strategies

Since this unit is about the Design Thinking process, the secondary component connecting it to the human body is completely optional. However, I do believe it is a great starting part for introducing students to thinking about problems and solutions with understanding, creativity, and empathy. While students will learn the most by being an active participant in the process, I cannot see them doing this successfully without some direct teaching and modeling first. I will employ the following strategies to teach my students the Design Thinking model.

Direct teaching: Direct, implicit instruction of each step of the process will be presented to students. Students should be aware that it is the process that they are learning just as much as any content. Students should be able to recognize the five stages of the design thinking process and use the proper name and vocabulary related to each stage. Direct instruction will serve as the introduction to the process.

Anchor charts: Anchor charts, or posters, that detail the components of each stage of the design thinking process will be created and posted as a teaching aid. Students and teachers will be able to refer to them at anytime while learning and applying the design thinking model.

Role-playing: To help build empathy, students will role play what it is like to “walk in another person’s shoes” by using props to simulate blindness, deafness, and/or a broken bone. Care must be taken that students remain safe as well as respectful.

Modeling: Students will need to see the design thinking stages in action, modeled with appropriate actions and behaviors. I like to use a “fishbowl” technique of modeling, where myself and a few students will sit centered around the rest of the class. While we model the appropriate group interactions, the students outside the circle will make observations and take notes about what they notice to be discussed in a follow-up conversation.

Prototyping: I will have a variety of craft materials available for the construction of simple prototypes. Materials include different types of paper, post-it notes, index cards, pipe cleaners, paper clips, binder clips, push pins, aluminum foil, different types of string, rubber bands, craft sticks, straws, toothpicks, Styrofoam, biodegradable packing peanuts (they stick to each other when moistened), glue, tape, scissors, etc.… Additional materials can of course be added as it relates to the projects being created and whatever supplies are on hand.

Lessons & Activities

Lesson 1 (45 minutes): Introduce the Design Thinking model to the class using a PowerPoint or Google Slides. Model each stage of the process and introduce anchor charts (posters) for each stage. Discuss the value of Design Thinking and why it is important to build empathy and understanding of the task at hand.

After modeling, students will then begin research on a topic of their choice related to either blindness, color blindness, deafness, or a broken arm or leg. I have several books, iPad apps, and videos related to these conditions. Divide the class so you have at least three or four students for each scenario.

Lesson 2 (45 minutes): Model the entire design thinking process using a scenario created by the teacher. An example scenario can be something based on a story or classroom situation, but should be something they all have a common experience with. For my example, I am choosing to use myself as the subject. My problem? I woke up late and did not eat breakfast. Now I am at school and I am hungry. After explaining this sample scenario to the students, we will focus on building empathy. Students will be given an empathy map graphic organizer (like the one above) and one will also be displayed on the board. Students will use the organizer as a guide to ask me questions related to my situation of being hungry because I missed breakfast. From there, students will work with me to define a problem statement. In this situation, several possible problem statements can be generated, but they should all follow the frame of a “How might we…” sentence. “How might we help Mr. Ward wake up earlier in the morning so he has time for breakfast?” Or “How might we help Mr. Ward get a meal today?” are both good starting points.

Students will then continue to build an understanding of the disability they selected yesterday. Using props to help students respectfully experience these conditions will help students build empathy. Hand out a scenario for role-play and design thinking that is based on each condition. For example, “Robert broke his right arm after falling off his bike. The doctor put his arm in a cast, but Robert has had difficulty trying to write using a paper and pencil. As he tries to write, the paper keeps sliding around on his desk. It is also difficult to grip the pencil. Robert is right handed, so breaking his right arm has made the everyday task of writing very difficult for him. Yesterday, when trying to carry his lunch tray, his milk slid off the tray and he could not catch it in time. It spilled all over the floor and he was embarrassed."

Lesson 3 (45 minutes): Model brainstorming with the class using the problem statement from the previous lesson. Review the brainstorming anchor chart with the class. To model brainstorming, select three or four students to sit with you in the center, with the remainder of the class watching silently and making observations. Introduce special roles, such as a time keeper, facilitator, and note taker. The teacher should serve as facilitator and introduce the problem statement to the group after reminding everyone in the group of the brainstorming rules. The time keeper insures the group stays on task. Time for this demonstration should be ten minutes. The note taker should have access to a whiteboard or large chart paper to write down ideas. Start with the problem statement in the center of the board or page, and draw or write all connecting ideas and sub-ideas as all members contribute their thoughts. When the group seems to run out of ideas, the facilitator should decide if they have enough to work with or ask some prompting questions to illicit more suggestions. Some prompting questions could be, "What if we had unlimited money to make this happen?" or "Does anyone have any crazy sounding ideas (that are still on topic)?" After watching the brainstorming demonstration, lead a discussion about what students noticed. What worked well? What did not work so well?

Students will then apply brainstorming to their scenario. The teacher should insure there is a time keeper, note taker, and facilitator in each group. Student focus should be on generating as many ideas as possible in the time given (ten to fifteen minutes).

Lesson 4 (45 minutes): Using the class model of a hungry Mr. Ward and all the brainstorming ideas collected previously, model the use of Post-It Voting and the Four Categories Method to filter and select the best ideas.

Students will apply a selection method for their brainstorming data. When ready, students may also begin to construct a simple prototype of their idea.

Lesson 5 (45 minutes): I have a maker space in my class that consists of an assortment of crafting materials and tools. My students are already familiar with how to use these craft materials. In this lesson, I will model how to create several different prototypes for our class example. Once the prototypes are created, students will test them and prepare a way to present them to their subject (I will take on the role of their subject so I can provide feedback). After receiving feedback, students will revise or improve their designs, or start over with a different idea.

Lessons 6 and 7 (45 minutes each): Students will use this time to work on their prototypes and create something closer to a final design. During these times, I will conference with each group to discuss their progress and ideas.

Lesson 8 (45 minutes): Students prepare a 5 to 10-minute presentation of their proposed solution. They can use a variety of presentation methods, including PowerPoint, poster boards, demonstrations, etc.

Lesson 9 (45 minutes): Each group will present their work and receive feedback from the class.

Once students have learned to apply the Design Thinking model, keep using it! Many classroom topics can be taught using this method. You can expect to see organized collaboration, lots of creative ideas, and a great deal of problem-solving going on in your classroom as a result.

Appendix 1

Implementing District/NGSS Standards

Students who demonstrate understanding can:

3-5-ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

3-5-ETS1-2 Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

3-5-ETS1-3 Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

4-LS1-1 Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

4-LS1-2 Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.

At the upper elementary grades, engineering design engages students in more formalized problem solving. Students define a problem using criteria for success and constraints or limits of possible solutions. Students research and consider multiple possible solutions to a given problem. Generating and testing solutions also becomes more rigorous as the students learn to optimize solutions by revising them several times to obtain the best possible design.

Bibliography

Brown, Tim. "Design Thinking," no. June (2008).

Compton, Bruce, David M. Barash, Jennifer Farrington, Cynthia Hall, Dale Herzog, Vikas Meka, Ellen Rafferty, Katherine Taylor, and Asha Varghese. "Access to Medical Devices in Low-Income Countries: Addressing Sustainability Challenges in Medical Device Donations." *NAM Perspectives*, 2018. https://doi.org/10.31478/201807a.

Forbes Technology Council. "13 Reasons Google Deserves Its 'Best Company Culture' Award," 2018. https://www.forbes.com/sites/forbestechcouncil/2018/02/08/13-reasons-google-deserves-its-best-company-culture-award/#fb3ee8734828.

Ideo.org. "The Field Guide to Human-CenteredDesign," 2011. http://d1r3w4d5z5a88i.cloudfront.net/assets/guide/Field Guide to Human-Centered Design_IDEOorg_English-ee47a1ed4b91f3252115b83152828d7e.pdf.

Institute of Design at Stanford. “An Introduction to Design Thinking PROCESS GUIDE,” n.d.

Interaction Design Foundation. “Design Thinking.” Accessed July 30, 2019. https://www.interaction-design.org/literature/topics/design-thinking.

Lee, Harper. *To Kill A Mockingbird*. Harper Perennial, 1960.

Linke, Rebecca. “Design Thinking, Explained.” Accessed July 30, 2019. https://mitsloan.mit.edu/ideas-made-to-matter/design-thinking-explained.

WHO. “Evidence and Information for Policy (EIP) Organization of Health Services Delivery(OSD),” 2000.

End Notes

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[1] Forbes Technology Council, “13 Reasons Google Deserves Its ‘Best Company Culture’ Award.&rdquo

[2] Linke, “Design Thinking, Explained.&rdquo

[3] Ideo.org, “The Field Guide to Human-CenteredDesign.&rdquo

[4] Lee, To Kill A Mockingbird.

[5] Compton et al., “Access to Medical Devices in Low-Income Countries: Addressing Sustainability Challenges in Medical Device Donations.&rdquo

[6] WHO, “Evidence and Information for Policy (EIP) Organization of Health Services Delivery(OSD).&rdquo

[7] Brown, “Design Thinking.&rdquo

[8] Interaction Design Foundation, “Design Thinking.&rdquo

[9] Interaction Design Foundation.

[10] Institute of Design at Stanford, “An Introduction to Design Thinking PROCESS GUIDE.&rdquo

[11] Institute of Design at Stanford.

[12] Institute of Design at Stanford.
