Lesson 2: Identifying the Design Challenge

Credit: Getty Images 520087760: stellalevi: Wall covered with sticky notes

SUMMARY

This lesson introduces students to the first step of a biomimicry design thinking process: how to identify (or define) a design problem and its associated criteria and constraints. Students begin with a mind-mapping activity to help them explore various aspects of the biomimicry design challenge and to identify a manageable design problem their team can address. Teams work collaboratively to select an aspect of the design challenge to focus on. They summarize what they've decided by formulating a "design question" that identifies the context, constraints, and ultimate goal of their design.

STANDARDS

COMMON CORE STATE STANDARDS (CCSS):
Grades 9–10: RI.9–10.1, W.9–10.1a–e, W.9–10.2a–f, W.9–10.4–8, SL.9–10.1a–d, SL.9–10.2–6, L.9–10.1b–d, L.9–10.2a–c, L.9–10.3a, L.9–10.4a–d, L.9–10.5a–c, L.9–10.6, RST.9–10.1, RST.9–10.3, RST.9-10.9, RH.9-10.1, RH.9-10.4, RH.9-10.5, WHST.9–10.1a–e, WHST.9–10.2a–f, WHST.9–10.4–10
Grades 11–12: RI.11-12.1, W.11–12.1a–e, W.11–12.2a–f, W.11–12.4–8, SL.11–12.1a–d, SL.11–12.2–6, L.11–12.1b–c, L.11–12.2a–c, L.11–12.3a, L.11–12.4a–d, L.11–12.5a–c, L.11–12.6, RST.11-12.1, RST.11-12.3, RST.11-12.9, RH.11-12.1, RH.11-12.4, RH.11-12.5, WHST.11–12.1a–e, WHST.11–12.2a–f, WHST.11–12.4–10

NEXT GENERATION SCIENCE STANDARDS (NGSS):
Engineering, Technology, and Applications of Science: HS-ETS1-1

CLOUD EDUCATION FOR SUSTAINABILITY (EFS) STANDARDS & PERFORMANCE INDICATORS:
Grades 3–12: A5, C1, C3, C4, C6–12, C37, D2, G1, G4–7, H5, H6

TEXAS ESSENTIAL KNOWLEDGE & SKILLS (TEKS):
Environmental Systems: §112.37.c.3.A

OBJECTIVES

Students will be able to …
- ✓ Define the term "design question" and explain its value.
- ✓ Review and discuss examples of effective design questions.
- ✓ Demonstrate how to form an effective design question to suit an identified design challenge.
- ✓ Define an effective question for the Challenge project and describe it in a design brief.
- ✓ Consider the criteria, constraints, and systems that impact the design question.
- ✓ Explain the value of defining (scoping/identifying) design problems as part of a biomimicry design thinking process.

ESTIMATED TIME NEEDED

Two 55-minute sessions plus group work outside of class

KEY VOCABULARY

Biomimicry, design, sustainability, mind map, criteria, constraints, context, stakeholder

TOPIC TAGS

Biomimicry, design, sustainability, mind map, criteria, constraints, context, stakeholder, design in nature, challenge, project, defining problems, specifying criteria and constraints

PREVIOUS SKILLS NEEDED

Listening skills, teamwork and collaboration skills

ATTACHMENTS

- Mind Mapping the Design Challenge
- Detective Wall Worksheet
- Forming a Design Question Presentation
- Forming a Design Question Presentation Teacher's Notes
- Form Your Design Question Worksheet
- Form Your Design Question Worksheet Sample Answers
- Build-the-Box Activity
- Glass Half-Full Activity

MATERIALS

SESSION 1: MIND MAPPING THE DESIGN CHALLENGE

- ❑ Poster board, butcher paper, or large sheet of paper
- ❑ Set of colored markers

SESSION 2: FORMING A DESIGN QUESTION

- ❑ Poster board, butcher paper, or large sheet of paper
- ❑ Set of colored markers

BACKGROUND INFORMATION

The first step in any design process is to investigate and define the problem or opportunity the design will address. This may seem like a simple activity, but it is incredibly important because it sets the stage for the rest of the design process. Within the design process framework used for this module, we call this the "Identify" step, and the questioning and goal-setting activities it represents are essential to good design practice. This step also fosters critical thinking and analytical skills as design teams break complex problems into smaller, more manageable problems and specify the criteria and constraints their designs must meet.

IN ADVANCE

SESSION 1: MIND MAPING THE DESIGN CHALLENGE

Make sure you have a clearly identified general topic for the Challenge project (e.g., Green Schools, Food Scarcity, Climate Change, Land Management, Water Conservation, etc.). If applicable, review the support materials provided for the current Biomimicry Global Design Challenge theme to get familiar with the current topic. Make a copy of the Mind Mapping the Design Challenge instructions for each team (or project the instructions for the class to see) and set up a station for each team that includes the necessary supplies.

HOMEWORK ASSIGNMENT

Make a copy (or distribute an electronic copy) of the Detective Wall Worksheet to give each student as a group homework project. The goal is to help teams gain clarity about an aspect of the design challenge their team can focus on for their project. Design Thinking emphasizes using a variety of fun and visual exercises to help designers get clarity, so this is an effective tool for students to use at this stage. If time is short, however, you could simply instruct students to do research on their own and decide together what aspect of the design challenge they would like to focus on. Alternatively, you could have students conduct this exercise in the classroom.

SESSION 2: FORMING A DESIGN QUESTION

Review the session materials in advance. You may wish to give students more time to complete these activities, such as by adding another class day or assigning all or part of the final activity for homework.

Make copies of the Form Your Design Question Worksheet for each team. Also make a copy of the Build-the-Box Activity for each team (or project the instructions for the class to see). Make sure each team has access to a large sheet of paper and markers.

Credit: Getty Images 512366639: Roberto Westbrook: Young man holding digital tablet with arms out

ACTIVITY BREAKDOWN, SESSION 1: MIND MAPPING THE DESIGN CHALLENGE

Time	Exercise	Description
5 min.	Introduction	Discuss the purpose of the Identify step.
20 min.	Team Mind Mapping	Students work in teams to mind map the design challenge.
20 min.	Class Mind Mapping	Students share their results and create a class mind map.
10 min.	Wrap-Up	Reflect on the activity and discuss homework assignment.
Homework	Detective Wall	Have students work together outside of class to research their design challenge and show their findings in the form of a physical or virtual bulletin board.

ACTIVITY BREAKDOWN, SESSION 2: FORMING A DESIGN QUESTION

Time	Exercise	Description
10 min.	Introduction	Teams share their Detective Walls and the design challenge they have chosen for their project.
20 min.	Presentation	Share the Forming a Design Question presentation with students.
10 min.	Form a Design Question	Teams complete the Form Your Design Question Worksheet.
10 min.	Build the Box	Teams complete the Build-the-Box Activity to identify design constraints.
5 min.	Wrap-Up	Facilitate a final discussion.

Notes

IMPLEMENTATION, SESSION 1: MAPPING THE DESIGN CHALLENGE

1. **Introduction:** Remind students of the previous lesson, in which they learned how design thinking can be useful in the practice of biomimicry. Ask students to recall the five steps in the design process they discussed *(Identify, Explore, Create, Refine, Share)*. Then ask students to share what they remember about the first step in the process—the Identify step. Encourage them to look at their notes from the last class or the A Biomimicry Design Thinking Process Handout. Remind students that in the Identify step we "Identify a challenge to address, including its stakeholders, criteria, and constraints." Explain that the focus of this lesson is to learn more about this step. To that end, in this session and the next, students will complete some activities to help their teams select and define a specific design challenge.

2. Write the following quote on the board:
   "A problem well-defined is half solved." –John Dewey, education pioneer
   Engage students in a conversation about what Dewey might have meant by this statement. *(Sample answer: Understanding a problem/challenge is an important part of solving it.)*

3. Remind students of the general topic chosen for the Challenge. This may be the current topic of the Biomimicry Global Design Challenge or whatever other focus you have determined for the assignment. Topics commonly chosen for global design challenges and capstone projects are often very broad. Explain that these challenges are often too big to be solved by a single design solution. It's helpful to keep in mind, though, that many large, complex environmental and social issues are made up of many smaller, more specific problems that are interconnected. One effective way of addressing a large challenge is to identify some of those smaller problems and select just one to tackle.

4. Tell students that today they will be working in teams to complete an activity designed to help them uncover some of the problems associated with the Challenge topic. This can help them identify possibilities for a specific design challenge for their team's project.

5. **Team Mind Mapping**: Have students assemble into their teams and give each team a copy of the Mind Mapping the Design Challenge Worksheet.

6. Review the worksheet as a class, and then encourage teams to create their mind map. Remind students that they are mapping the problem, or challenge, NOT potential solutions.

7. **Class Mind Map:** Have each team share two or three key insights from their mind map with the class. While students are presenting, call on one or more student volunteers to create a classroom mind map on a chalkboard or whiteboard to consolidate all the teams' ideas.

8. **Wrap-Up**: Stimulate discussion about the mind-mapping experience using questions such as the following: Did the mind-mapping experience expand your thinking about the topic? What questions did it raise for you about the topic? What new bit of information did you discover? What did you learn from your teammates during this process? Did you find the mind-mapping experience helpful? Did the mind-mapping experience give you an idea for an area of focus for your project? If so, what are your ideas?

IMPLEMENTATION: SESSION 1: MAPPING THE DESIGN CHALLENGE, continued

9. **Homework:** Give students the Detective Wall Worksheet as a group homework project. The goal is to help teams gain clarity on an aspect of the design challenge their team can focus on for their project. Design Thinking emphasizes using a variety of fun and visual exercises to help designers get clarity, so this is an effective tool for students to use at this stage. If time is short, however, you could simply instruct students to do research on their own and decide together what aspect of the design challenge they would like to focus on.

10. Emphasize to students that the goal at this point in the design process is NOT to decide what they want to make or design, but rather to articulate the problem they want to solve or the impact they want to have. In order to do so, they will need to do additional research and/or speak with stakeholders to answer questions they encountered during the mind-mapping exercise.

IMPLEMENTATION: SESSION 2: FORMING A DESIGN QUESTION

1. **Introduction**: Have teams share their Detective Walls with the class and identify the specific problem area within the design challenge they have chosen for their project.

2. Tell students that in class today they will be exploring the context and constraints related to their selected problem and formulating a clear "design question."

3. **Presentation**: Show students the Forming a Design Question Presentation, using the Teacher's Notes to guide discussion.

4. **Form a Design Question**: Have students assemble into their teams and give each team a copy of the Form Your Design Question Worksheet. Instruct students to work together to complete the worksheet, expanding on the specific problem they shared at the beginning of class. Monitor the teams' progress and answer questions as needed.

5. **Build-the-Box Activity**: Share with students that all design problems have constraints, such as conditions the design needs to work in, or barriers to implementation like money, time, people power, or skills. Constraints create limitations, but they can also push us to be more creative! Give students some guidance on any established constraints related to the Challenge project and encourage them to think about other constraints that are specific to the design question they selected. It may be helpful for teams to refer to the context section of their Form Your Design Question Worksheet for ideas. Constraints may include:
    - Time: What is the deadline for implementation?
    - *Resources:* What are the requirements for materials? (e.g., must be biodegradable/recyclable)
    - *People:* What needs do prospective users or stakeholders have? (e.g., must be easy to use)
    - *Economics:* What budget or financial pressures affect the solution? (e.g., must be inexpensive to make so poor people can afford to buy it)
    - *Function:* Does the solution need to serve multiple purposes or offer several features?
    - *Conditions*: What physical, social, or other conditions could impact the success of the project? (e.g., must work even in a damp environment)

IMPLEMENTATION: SESSION 2: FORMING A DESIGN QUESTION, continued

6. Give each team a copy of the Build-the-Box Activity sheet (or project the instructions for the class to see). Also make sure they have access to a large sheet of paper and markers.

7. Have students work in their teams to complete the activity. They may need to finish the activity together for homework.

8. **Wrap-Up**: Facilitate a group discussion so teams can share their discoveries from the Build-the-Box Activity and ask any lingering questions they may have. Encourage students to get together after class as necessary to refine and improve their design question and/or identify design constraints.

ADDITIONAL TEACHING TIPS

1. **Sharing ideas**: Sometimes students will be worried about another team "stealing" their ideas and will resist talking about their design ideas and process with the class. Explain that this attitude is counter-productive. Encourage teams instead to share openly throughout the design process—this is the best way to learn. Reinforce the idea that students are not competing with each other and there are plenty of good ideas to go around.

2. **Stay Away from Solutions**: At the outset of a design challenge it can be very tempting for teams to discuss design solutions. Discourage this. At this stage in the design process, the goal is NOT for teams to decide what they will make or design, but rather to articulate clearly the problem they want to solve and make sure all team members are aligned on this goal. Discussing solutions too soon limits creativity.

3. **Evolving Design Questions**: As your students' teams continue to research and learn more about the problem they are designing for and some of nature's strategies, they may reconsider aspects of their initial design question and want to revise it. That's OK! Design is a process of learning and exploration, and the outcomes are strongest when prior assumptions are questioned in light of new information.

REFLECTION QUESTIONS

Use the following questions to prompt critical thinking and guide students to reflect about the lesson:

- Did the mind-mapping experience help you arrive at an area of focus for your project? Explain. *(Sample answer: Yes. I was a little overwhelmed when I heard about the topic of global warming. That's just so broad! Mind mapping helped us get some specific ideas about what we could do for our Challenge project.)*

- Do you think your team has identified a strong design question? What, if anything, could you do to make it stronger? *(Sample answer: Yes. It took several iterations, but I think we understand what we learned in the presentation about not wanting the question to be too broad or too narrow. Our final choice, I think, is perfect because it identifies a specific issue but allows for several possible avenues to address the issue.)*

- Do any of the design constraints pose a particular challenge for your team? If so, how can that challenge be overcome or addressed? *(Sample answer: Initially we were discouraged by the constraint on our budget. But then we realized that we might be able to use salvaged or donated materials, or raise money from donors to help cover any costs. This insight helped us focus less on the constraint as a negative and more on getting creative with our solution.)*

- Do you see any special opportunities within the design constraints? *(Sample answer: Yes. We have to have a prototype we can test in the school garden next semester. This is a bit intimidating, but it means that we'll have feedback very quickly on how the design is working, which will help us rapidly iterate and make it better.)*

- What is the value of defining (scoping/identifying) design problems as part of a biomimicry design thinking process? *(Sample answer: This whole process allowed us to get a LOT clearer about what we could focus on related to the Challenge. We all had vague ideas before, but this process helped us streamline those ideas to come up with a question that we all agree is a good focus for our project.)*

DIFFERENTIATION

You may find that after students choose their topics, it is beneficial to organize or reorganize groups around those topics. In other words, students could choose the group covering the topic they are most passionate about. Or you may wish to move students around so that their strengths are maximized and limitations are balanced.

Credit: Getty Images 173691969: stockcam: Post-it Note

ADDITIONAL INFORMATION

COMMUNITY CONNECTIONS

Use the Glass Half-Full Activity to help students get a sense of available assets in your community. At the beginning of any design challenge, there is a natural tendency for students (and all designers) to feel overwhelmed or unprepared. This exercise helps students shift their attention from those negative feelings to a sense of the bounty of resources and opportunities available to them.

You may wish to customize the categories to fit the specific challenge. Please note, too, that this activity works well as a classroom activity or for design teams specifically.

CROSS-DISCIPLINARY CONNECTION: LANGUAGE ARTS

Have students write a one- to two-page journal-style entry reflecting on the design process so far. Students could respond to questions such as the following: How do you feel about your design challenge after completing Step 1: Identify? Which activities were the most helpful to you and your team? Which were the least helpful? Did this lesson do what it was supposed to do—help you get clarity about your design challenge and spark ideas about assets and limitations? How do you feel about your progress toward your design challenge at this point? How do you feel about the methods you are using? Do you think those methods might be helpful in other aspects of your life?

ASSESSMENT OPPORTUNITIES

Use a checklist to monitor students' participation in group activities. Suggest students add to their Portfolio the photos of any group work they are particularly proud of, such as their work on the Mind Mapping, Detective Wall, Build-the-Box, or Glass Half-Full activities. You could also have students complete the Form Your Design Question Worksheet on their own for an individual grade and to check their understanding of group goals. The Reflection Questions above also provide an excellent opportunity to check students' understanding of key topics. The Cross-Disciplinary Connection: Language Arts could also serve as a helpful check-in on each student's progress so far.

TECHNOLOGIES

Many of the activities in these Challenge lessons encourage students to think through problems visually. Students may want to work with physical materials such as poster board, butcher paper, and markers, but you may also want to encourage them to explore the use of educational technology—especially if students find it difficult to meet together for homework projects. Suggest students do research and locate a bank of tools they can use to complete different types of activities throughout the Challenge. You may want to suggest a few options to get them started. There is a wealth of information on the Internet to help guide teachers and students to technology that suits specific needs. This article from Education World is one helpful resource: Technology Tools | Tools You Can Use.

ADDITIONAL INFORMATION, continued

RESOURCES/LINKS

For a variety of related resources, please see the Resource Bank for this grade level and theme. In addition, the following resources were cited in this lesson or relate specifically to this lesson:

Biomimicry Institute. (2015). Biomimicry Global Network. Retrieved from https://biomimicry.org/global-networks/
Biomimicry Institute. (2015). Biomimicry Toolbox. Retrieved from toolbox.biomimicry.org
Inspiration Software. (2016). Teaching and learning with mind maps. Retrieved from
        http://www.inspiration.com/visual-learning/mind-mapping
Leyden, Andrea. (2013, November 5). 10 mind mapping strategies for teachers. Retrieved from
        http://www.teachthought.com/pedagogy/10-mind-mapping-strategies-for-teachers/
Education World. (2016, September 22). Technology Tools | Tools You Can Use. Retrieved from
        http://www.educationworld.com/a_tech/archives/tools.shtml