BIRDEE Unit 1 Lesson Plans

Unit 1 Modules & Themes tinyurl.com/birdeeunit1LP

Module 1 Launcher: Connecting Nature to the Engineering Design Process				
Connect Nature to Engineering	**Empathy & Customer Discovery**	**Reverse Engineering & Requirements**	**Define Problem Requirements**	**Ideate a Solution for Conceptual Design 1**

Module 2 Launcher: The Lotus Effect				
Benchtop Prototyping	**Testing the Lotus Effect**	**Conceptual Design 2**	**Design Review**	**Introduce EDPL**

Module 3 Design Challenge: Identify & Understand				
Design Challenge Intro: BID & EDP	**Understanding the Problem and EDPL**	**Understanding Existing Engineering Systems with SFM**	**Product Analysis and Reverse Engineering**	**Existing Products and Ideate**

Module 4 Design Challenge: Heat Transfer & Thermal Regulation				
Understanding Thermoregulation Systems in Nature with SFM	**Conceptual Design 1**	**Thermal Regulation Experiment Part 1: Intro & Setup**	**Thermal Regulation Experiment Part 2: Analyze Data**	**Thermal Regulation Part 3: Additional Data/BID Analogy**

Module 5 Design Challenge: Ideation & Evaluation				
Design Challenge Part II	**Conceptual Design 2**	**Ideate: Learn about the Morpho Matrix**	**Conceptual Design 3: Morpho Matrix**	**Evaluate to Prototype 1**

Module 6 Design Challenge: Prototype & Test				
Prototype 1: Build	**Prototype 1: Requirements Evaluation**	**Elaborate to Prototype 2**	**Prototype 2: Build**	**Finalize Design**

Module 7 Design Challenge: Communicate Solution

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Create a Pitch Presentation	**Class Presentations**			

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Unit 1 Module 5: Design Challenge Ideation and Evaluation	Materials/Notes
Module 5 Overview: 1.5.1 Design Challenge Part II 1.5.2 Conceptual Design 2 1.5.3 Ideate: Learn about the Morpho Matrix 1.5.4 Conceptual Design 3: Morpho Matrix for the Design Challenge 1.5.5 Evaluate to Prototype 1	**1.5.0. EDPL Map**

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1.5.1. Design Challenge Part II

Students will be introduced to the second client memo. They will work in groups to define the problem, including revision to the client's needs and wants. Then, students will ideate a solution or part of a solution using ideation techniques. Students should be reminded to integrate what they learned in the thermal regulation experiment and from the second Client Memo in their ideas.

Engage: 5 min

View: 1.5.1. BID WOW!

- How do humans stay cool on warm days?
- What happens when a computer gets too warm?
- **Class Discussion** on what students think
- **Play video:** Sweating Robots (in ppt)

Explain: 5 min

View: 1.5.1. Client Memo II

EatEZ has sent us another client memo with more details on their design needs. Many clients provide new information during the course of a project that may change your understanding of the problem and potential solutions. As the client's wants and needs change, you may need to revise how you define the problem. This will also impact the design requirements and your overall design solution.

Explore: 20 min *(Individual then Group)*

First, individually read the 1.5.1. Client Memo II reflecting on the problem and request of your client. Then, discuss the memo with your group and complete **1.5.1. Identify the Client's Problem Part II.**

EDPL: Make any necessary changes in the EDPL (Identify the Problem, Understand the Problem–Requirements) with the new information you learned from the second client memo.

Explain: 5 min *(Class Discussion)*

Now, we will ideate more solution ideas since we have gotten new information from the client and learned about thermoregulation and heat transfer.

Class Discussion

- What were your "big takeaways" from conducting the thermoregulation experiment? List three ideas that struck you as important for product design.
- What were your big takeaways from the second client memo?

Student Handouts:

1.5.1. Identify the Client's Problem Part II

Student Materials:

1.5.1. Client Memo II

*notebook or printer paper for SCAMPER

Instructional PPT's & Materials:

1.5.1. BID WOW!

BIDI Graphic

1.1.5. SCAMPER Organizer

Teacher Resources:

N/A

Web Resources:

BIDI Graphic

1.1.5. SCAMPER Organizer

View: BIDI Graphic Remember, if you choose to incorporate some of the biology we have explored in your design ideas, follow the BIDI steps. Select the biology concept you want to incorporate into your design idea and then integrate it into your design idea. **Extend: 10 min** *(Group)* Now we will Ideate more solution ideas. You can brainstorm and use the SCAMPER tool if you wish. You will do this on notebook or printer paper. **View: 1.1.5. SCAMPER Organizer** on the board ***Teacher Note:*** *In 1.5.2., students will create a group conceptual design using these ideas.*	

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1.5.2. Conceptual Design 2

Students will integrate their ideas from 1.5.1 into their second conceptual design. They will upload this design to the EDPL and catch-up on any missing work in the EDPL, if needed.

Engage: 5 min

View: 1.5.2. BID Ideation

- You are designing and making a new type of underwater robot that must be able to squeeze into tight spaces. What could you look to in nature for inspiration?
- List three organisms that live underwater, are small, and move in different ways. Give a short description of how each organism moves. How would this inspire a robot?
- **Class Discussion** on what students brainstormed

Explain: 5 min

With your solutions ideas from 1.5.1, you will complete the **1.5.2. Conceptual Design 2** organizer as a group.

Explore: 25 min *(Group)*

Conceptual Design 2
In their groups, students will complete the **1.5.2. Conceptual Design 2** organizer.

Extend: 15 min *(Group)*

EDPL: Upload conceptual design 2 to Ideate and EDPL Catch-Up time

- Make sure all your work is uploaded into the EDPL. You can use this time to add Research Notes, etc. from the Thermoregulation Experiment or catch up on other information that needs to be logged in the EDPL.

Student Handouts:

1.5.2. Conceptual Design 2

Student Materials:

N/A

Instructional PPT's & Materials:

1.5.2. BID Ideation

Teacher Resources:

N/A

Web Resources:

BIDI Graphic

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1.5.3. Ideate: Learn about the Morpho Matrix

Students will be introduced to the Morphological Matrix ideation tool. The class will go through a Morphological Matrix example together (headphones and earphones).

View: 1.5.3. Let's Learn about the Morphological Matrix

Teacher Note: *Guided powerpoint for the day. Teacher Directions for each slide can be found in the speaker notes.*

Engage: 5 min

Teacher Note: *Teacher will have Slide 2 of the ppt up on the board as students come into class. Have a short* ***Class Discussion****:*

- What are some similarities and differences in the structures of headphones/earphones?

Explore: 20 min *(Individual worksheets but work in Groups, Class Discussion)*

Morphological Matrix Headphones (Slides 3-7)
We are going to explore how different sets of headphones use different structures to accomplish the same function.

Teacher Notes:

- *Teachers will lead a* ***Class Discussion*** *about the functions of headphones and earphones.*
- *Students will list different structures different headphones use to accomplish each function in* ***1.5.3. Morphological Matrix Ideation–Headphones and Earphones****.*
- *Teachers lead a* ***Class Discussion*** *about the different structures different headphones use to accomplish each function and allow students to fill in the morphological matrix on the board.*

Explain: 15 min *(Class Discussion)*

Morphological Matrix Ideation Tool (Slides 8-13)
The Morpho Matrix is an ideation tool.

- ***Teacher Note:*** *Class will work together to analyze existing headphones and figure out which structures were combined from the morpho matrix created in the 1.5.3. worksheet to create a specific headphone.*

Evaluate: 10 min *(Individual and Class Discussion)*

Sketching headphone example (Slides 14-16)
You have to be careful with combining ideas from a Morphological Matrix because sometimes ideas may not go together.

Student Handouts:

1.5.3. Morphological Matrix Ideation–Headphones and Earphones

Student Materials:

N/A

Instructional PPT's & Materials:

1.5.3. Let's Learn about the Morphological Matrix

Teacher Resources:

1.5.3. Morpho Matrix Ideation Headphones TEACHER KEY

Web Resources:

N/A

● Practice combining structures by sketching a set of example headphones based on what structures are circled in the morpho matrix. ● **Class Discussion:** ○ What do your headphones look like? ○ Do your headphones look strange? ○ Would you buy these headphones? You have to be careful when randomly selecting structures from a morpho matrix and putting them into a solution because it may not produce a viable solution that fulfills all your requirements. Just because your solution has all the functions it needs does not mean it fulfills all of your requirements.	

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1.5.4. Conceptual Design 3: Morpho Matrix for the Design Challenge

Students will use the morphological matrix to ideate design ideas for the design challenge. They will then combine an idea from each function into a conceptual design and evaluate that idea in terms of their product requirements. Students will create their third conceptual design.

Student Handouts:

1.5.4. Morphological Matrix

Student Materials:

N/A

Instructional PPT's & Materials:

1.5.4. BID Ideation

Teacher Resources:

N/A

Web Resources:

BIDI Graphic

Engage: 5 min

View: 1.5.4. BID Ideation

- You are designing and creating a new drone. This drone must be able to carry packages as big as a box of crayons, but small enough to be sneaky. What in nature could you draw inspiration from for your new drone?
- List three organisms that could inspire your drone. Sketch the structure of these organisms that allows them to fly and be sneaky. How are these structures different from each other?
- **Class Discussion** on what students brainstormed

Now, we are going to ideate and create a conceptual design. Remember, if you use biology to follow the BID steps, do your biological concept selection and biological design integration.

View: BIDI Graphic

Explore: 20 min *(Individual worksheet but work in Group)*

Morphological Matrix

Use the first page of your **1.5.4 Morphological Matrix** worksheet and begin filling in functions your solutions needs to be able to achieve. Functions can be taken from EDPL requirements, **1.5.1. Identify the Client's Problem Part II**, or **1.3.1. Identify and Define the Client's Problem** (all these worksheets have functions your solution should have on them).

Then, begin brainstorming a range of different ways each function could be achieved. Include a description and a sketch for each idea. Remember to look at existing thermal regulation and thermoregulation solutions. Also, what animals in nature could inspire ways to achieve each function?

Explain: 5 min

Now that you have different structure ideas for each function, combine a structure idea from each row into a conceptual design. Then, you will evaluate that design and create another design from your matrix based on your evaluation. Even if your ideas seem like they are crazy or like

they won't go together well, you should still try it because you never know, some of the best ideas happen by accident!

Explore: 20 min

Combination of morpho matrix: *(Individual)*
Creation of third conceptual design: *(Group)*

Work on pages 2 and 3 of your worksheet. Your first combination of ideas from the morpho matrix will be chosen randomly *(**Teacher Note:** teacher can provide dice for the students to use to make sure they choose their structures randomly, if desired)*. The second combination you will choose the structures while considering how the structures will interact in the final design. Consider how both combinations address the problem requirements and the strengths and weaknesses of each combination. Lastly, share your design ideas and its strengths and weaknesses with your group and create your third conceptual design.

Teacher Note: *The teacher can also have each group share their design with another group or with the class, if there is time.*

Extend: 10 min *(Group)*

EDPL: Log your third conceptual design in the EDPL Ideate section.

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1.5.5. Evaluate to Prototype 1

Students will evaluate their three conceptual designs in the EDPL and create a final conceptual design that the group will prototype. Students in each group will work together to create a plan for gathering prototype materials.

Engage: 5 min

View: 1.5.5. BID WOW!

- What could have inspired the change from the ice climbing ax on the left to the ice climbing ax on the right (see images on slide 2)?
- What organisms in nature do similar things to an ice climbing axe?
- **Class Discussion** on what students think
- **Play video:** Ice Climbing from 1:40-2:30 (in ppt)

Explain: 5 min

You will complete the **1.5.5. Conceptual Design 4: Initial Prototype** handout, which has 4 parts - Evaluate conceptual designs in EDPL, Sketch Initial Prototype, Plan for materials, and a check to make sure you have integrated what you have learned into your design.

Teacher Note: *It may be helpful to show this video on how to make a cardboard prototype to students.*

View: How to make a cardboard prototype

Explore: 25 min *(Group)*

Part 0: Review the information you have learned throughout the unit, along with your previous conceptual designs. Work in your group to evaluate your conceptual designs in the **EDPL** "evaluate" tab. Choose if a design is likely/unlikely to fulfill a requirement and give a reflection (or explanation) on your choice.

Part 1: Sketch the plan for your initial prototype. This sketch will be detailed, and include dimensions (Width x Length x Height) and labels for each portion of their system. If needed, add specific details of "zoomed in" subsystems.

Part 2: Work together to identify materials needed to complete your prototype, and create a plan for gathering the materials needed to build your design.

Teacher Note: *Remind students that they should use simple, readily available materials (paper, cardboard, old fabric samples, tape, glue,etc.)* ***They will need to bring in these materials to the next class.***

Student Handouts:

1.5.5. Conceptual Design 4: Initial Prototype

Student Materials:

N/A

Instructional PPT's & Materials:

1.5.5. BID WOW!

How to make a cardboard prototype

Teacher Resources:

N/A

Web Resources:

N/A

Evaluate: 5 min *(Group)*

Part 3: Check
Did your group integrate what you have learned about existing solutions, inspiration from biological systems, and heat transfer to this prototype?

Extend: 5 min *(Group)*

EDPL: Upload images of your prototype 1 and conceptual design into the "Ideate" section of the EDPL, if your group made changes to your design from conceptual design 3.