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 6: Design Challenge Prototype and Test	Materials
Module 6 Overview: 1.6.1 Prototype 1: Build 1.6.2 Prototype 1: Requirements Evaluation 1.6.3 Elaborate to Prototype 2 1.6.4 Prototype 2: Build 1.6.5 Finalize Design	1.6.0 EDPL Map
1.6.1. Prototype 1: Build ***Students will work in their groups to build their initial prototype.***	**Student Handouts:** N/A
Engage: 5 min **View: 1.6.1. BID WOW!** ● This is a Namib Desert Beetle. ● Do you notice anything interesting? ● How does this look similar to the lotus leaf? ● **Class Discussion** on what students think ● **Play video: Beetle Collects Water** (in ppt) **Explore: 40 min** *(Group)* ● Build your prototype following your conceptual design. ● Students should take photos of all prototypes so they can add them to the EDPL. ***Teacher Notes:*** ● *Teachers should walk around and check in with groups to guide them as they build their prototype.* ● *Teachers can project the **Cardboard Attachment Techniques image** on the board.* **Extend: 5 min** *(Group)* **EDPL:** Upload images of Prototype 1 to the "Prototype" tab in the EDPL. Link your prototype to the conceptual design in "Ideate" that is the design you followed when building your prototype 1.	**Student Materials:** Materials students bring in for their prototype: Cardboard boxes Scissors Tape Glue Fabric -School Facilities- 3D printers **Instructional PPT's & Materials:** 1.6.1. BID WOW! 1.6.1. Cardboard Attachment Techniques image **Teacher Resources:** N/A **Web Resources:** N/A

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1.6.2. Prototype 1: Requirements Evaluation

Students evaluate their design prototype 1 using their design requirements. They will test the insulation properties of their prototype/performance criteria using Govee Sensors. Students will export data during the next class.

Before the Lesson: Teachers should use **1.4.3 Thermal Regulation Experiment TEACHER DIRECTIONS PPT** to reset the sensors and prepare for the prototype test.

Engage: 5 min

View: 1.6.2. BID Ideation

- You are designing and creating a new type of sustainable light.
- List three organisms that could inspire your light. Sketch an idea of your light inspired by each of your organisms.
- **Class Discussion** on what students brainstormed

Explain: 5 min

Today we will evaluate each group's initial prototype using your design requirements. Your group will test the effectiveness of your prototype using Govee Sensors. You will use the **1.6.2. Design Requirements Evaluation** handout to evaluate your prototypes.

View: 1.6.2. Design Requirements Evaluation

Teacher Note: *Teachers will model how to use the handout to demonstrate how students will evaluate their prototypes.*

Explore: 15 min *(Group)*

Design Requirements:

- You will work in your group to complete your evaluation of your prototypes.

Evaluate: 20 min *(Group)*

Test Setup:
Now, we will test the thermal insulation requirement of our prototype using the Govee sensors like we did in the thermal regulation experiment. We are going to set up the experiment like we did before.

Teacher Notes:

- *Help students to turn on the sensor and make sure the sensors are recording before wrapping up the class*
- *Make sure students put the sensor in a good location so that the temperature will be measured properly.*
- *Students will record the data overnight and review during the next class.*

Student Handouts:

1.6.2. Design Requirements Evaluation

Student Materials:

1. Jars
2. Govee sensors
3. Ice
4. Double sided tape
5. Scissors

Instructional PPT's & Materials:

1.6.2. BID Ideation

Teacher Resources:

1.4.3. Thermal Regulation Experiment TEACHER DIRECTIONS PPT

1.4.4. Thermal Regulation Part 2: Analyze Data TEACHER DIRECTIONS

Web Resources:

N/A

- *Teachers should make sure the sensors are recording data before wrapping up the class. Teachers will need to download data before the next class using **1.4.4. Thermal Regulation Part 2: Analyze Data TEACHER DIRECTIONS** as a guide.*

Extend: 5 min *(Group)*

Teacher Note: *Clean up and let students know they will export data and conduct data visualization at our next class.*

If you finish setting up your experiment and get cleaned up early, you can start working on setting up a new Test in the EDPL.

EDPL: Create a new test in the EDPL for prototype 1, select the requirements the test is evaluating, and input the steps required for the test.

Teacher Note: *It should not be too difficult for students to create a test in the EDPL and input the test steps since students have done this test before in the thermal regulation experiment and should be familiar with the steps.*

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1.6.3. Elaborate to Prototype 2

Students will export and plot their data to understand how their design performs against their requirements. They will use this data to make changes to their design and plan a second prototype.

Prior to the lesson: Teachers should export student data according to the directions linked here: **1.4.4 Thermal Regulation Part 2: Analyze Data TEACHER DIRECTIONS.** Teachers should share the individual .csv data files with each student team using the teacher's preferred communication tool.

Engage: 5 min

View: 1.6.3. BID WOW!

- What from nature could have inspired the Eiffel Tower?
- Think about things that have similar structures. What in nature has a lattice structure?
- **Class Discussion** on what students think
- **Play video: Eiffel Tower and Bones** (in ppt)

Evaluate: 20 min *(Group)*

Now we are going to analyze our data from our test yesterday to see how our first prototype was at fulfilling our thermal insulation requirement. You will follow similar steps for data analysis as you did when we completed the thermoregulation experiment.

Teacher Notes:

- *The teacher will share the Google sheet with students, so that students can simply copy and paste their data to the sheet and get plots.*
- *The students will plot their data on the Google sheet.*
- *Walk around the discuss with each group how well their prototype thermally insulated based on their design requirements.*

Elaborate: 20 min *(Group)*

With information from data collected from our thermal insulation test of prototype 1, make changes to your conceptual design for prototype 1. You will build your second prototype from this conceptual design. Make sure to think about how well your first prototype fulfilled the thermal insulation requirement.

Make a plan for building your second prototype. Don't forget, you will need to bring in the materials you will make your second prototype from tomorrow.

Extend/Wrap Up: 10 min *(Group)*

Student Handouts:

N/A

Student Materials:

Microsoft Excel or Google Docs

Instructional PPT's & Materials:

1.6.3. BID WOW!

Teacher Resources:

1.4.4 Thermal Regulation Part 2: Analyze Data TEACHER DIRECTIONS

Web Resources:

N/A

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EDPL: ● Update the EDPL test with your Govee sensor test results for prototype 1. ● Upload your conceptual design for prototype 2 to the “Ideate” tab in the EDPL. Include what you changed from your conceptual design for prototype 1 in the description of the conceptual design for prototype 2. ***Teacher Note:*** *Encourage students to be mindful about things they change from their first prototype. They need to document what they change in their solution and why they think that change was needed.* You will be completing your second prototype in our next class and need to **bring in any materials needed.**	

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1.6.4. Prototype 2: Build

Students will work in their groups to build their second prototype. They will test it using the Govee sensor to test the insulation performance. They will review the data at the next class.

Before the Lesson: Teachers should use **1.4.3. Thermal Regulation Experiment TEACHER DIRECTIONS PPT** to reset the sensors and prepare for the prototype test.

Engage: 5 min

View: 1.6.4. BID Ideation

- You are designing and creating a new umbrella that can be used in heavy downpours. Your umbrella must be water-repellent, of course. What in nature is good at shielding from the rain? What about being water repellent?
- List three things in nature that exhibit water-repellent properties. Your umbrella also needs to be light and strong to be easy to carry yet also able to withstand heavy downpours and gusty winds. List three organisms that are light yet strong.
- **Class Discussion** on what students brainstormed

Explore: 30 min *(Group)*

- Build your second prototype following your prototype plans.
- **EDPL:**
  - Upload images of prototype 2 to the EDPL.
  - Link prototype 2 to your conceptual design for prototype 2.

Teacher Notes:

- *Teachers need to make sure that students have all the materials they planned to work with.*
- *Teachers need to walk around and check students are aware of what they need to build their prototype. If there are any students struggling with starting to build their prototype, talk and help them to start prototyping.*

Evaluate: 20 min *(Group)*

Test Setup:
Just like we did for prototype 1, set up a Govee sensor to test the **thermal insulation requirement** of your design.

EDPL:

- Create a test for prototype 2 with the steps of the thermal regulation test.

Teacher Notes:

- *Help students to turn on the sensor and make sure the sensors are recording before wrapping up the class*

Student Handouts:

N/A

Student Materials:

Materials students bring in for their second prototype

Prototype Test Materials:
Jars
Govee sensors
Ice
Double sided tape
Scissors

Instructional PPT's & Materials:

1.6.4. BID Ideation

Teacher Resources:

1.4.3. Thermal Regulation Experiment TEACHER DIRECTIONS PPT

1.4.3 Thermal Regulation Part 2: Analyze Data TEACHER DIRECTIONS

Web Resources:

N/A

• *Make sure students put the sensor in a good location so that the temperature will be measured properly.* • *Students will record the data overnight and review during the next class.* • *Teachers should make sure the sensors are recording data before wrapping up the class. Teachers will need to download data using **1.4.4 Thermal Regulation Part 2: Analyze Data TEACHER DIRECTIONS** as a guide.* **Extend: 5 min** *(Group)* ***Teacher Notes:*** *Clean up and let students know we will export data and conduct data visualization at our next class.*	

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1.6.5. Finalize Design

Students will export and plot their data to understand how their design performs against their requirements. They will use this data to make FINAL changes to their design, which will be recorded in the EDPL.

Prior to the lesson: Teachers should export student data according to the directions linked here: **1.4.4 Thermal Regulation Part 2: Analyze Data TEACHER DIRECTIONS.** Teachers should share the individual .csv data files with each student team using the teacher's preferred communication tool.

Teacher Note: Teachers may choose to allow students an extra day to prepare a 3rd prototype if needed, in which case the or the presentation lesson may be moved to another day.

Engage: 5 min

View: 1.6.5. BID WOW!

- What are some special characteristics of owls?
- What products could be inspired by an owl?
- **Class Discussion** on what students think
- **Play video: Owl** (in ppt)

Evaluate: 20 min *(Group)*

Now you will analyze your data to see how well your second prototype fulfills the thermal insulation requirement.

EDPL: Log the results of your second prototype test in the EDPL.

Teacher Notes:

- *The teacher will share the Google sheet with students, so that students can simply copy and paste their data to the sheet and create plots*
- *Students will plot their data on the Google sheet.*
- *Discuss how well their prototype thermally insulated following their design requirements.*

Elaborate: 20 min *(Group)*

Use the data from your second prototype test to make any final changes to your prototype/solution design.

EDPL: You can log your changes in the Research Notes section of the EDPL or in the description of their second prototype conceptual design or prototype 2 rather than creating a new conceptual design and prototype in the EDPL for their final design.

Student Handouts:

N/A

Student Materials:

Microsoft Excel or Google Docs

Instructional PPT's & Materials:

1.6.5. BID WOW!

Teacher Resources:

1.4.4 Thermal Regulation Part 2: Analyze Data TEACHER DIRECTIONS

Web Resources:

N/A

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Teacher Note: *Research Notes are fine for these changes because they should be minor. Students don't have to create an entirely new conceptual design and prototype in the EDPL. They can if they want to though.* **Wrap Up: 10 min** *(Group)* You have completed your final modifications and changes to your solution. Your group will work together during our next class to create a 2-3 minute "pitch" presentation. Make sure all of your notes are in order and your EDPL is updated as this will make it easier to create your presentation.	