



TEACHER DIRECTED LESSON PLAN

LESSON 7: Design-Build-Test Cycle

LESSON OVERVIEW	
<p>In this multi-day lesson, students will be given time to design, build and test the prototypes of their inventions. Using knowledge gained from previous lessons, students will go through the engineering design process. They will be asked to think about the importance of testing when evaluating their inventions. They must test their inventions to understand the value of testing design and function in order to improve upon their inventions. They will record all of their activities, data, and observations in their YIP Inventor's Journals or alternative logbooks as they design, build, test, and then re-design, re-build and re-test their inventions.</p>	
OBJECTIVE	
<p>Students will be able to create a solution to solve the problem they identified in earlier lessons. Students will use their previous research to develop and draw a design of their invention. They will build a model from this design and test the invention. They will then evaluate how to modify their original design and materials based on testing. Students will continue to modify their design and test to develop a most successful invention. Finally, students will be able to explain the importance of testing and re-designing in the invention process.</p>	
MATERIALS	
<p>Resources For the Teacher:</p> <ul style="list-style-type: none">• Slide Deck: Design-Test-Build Cycle (<i>optional</i>)• Script: Design-Test-Build Cycle (<i>accompanies slide deck, optional</i>)• Worksheet: Invention Testing Feedback Grid (<i>copy included in the YIP Inventor's Journal</i>) *Make extra copies if students have time to swap prototypes with more than one other peer.• Worksheet: Changes to My Prototype Plan Worksheet (<i>copy included in the YIP Inventor's Journal</i>)• Email/Take Home Letter template for families (<i>optional</i>)• Rubric: Invention Prototype rubric (<i>optional</i>) <p>Materials For Students:</p> <ul style="list-style-type: none">• Pens/pencils• Notebook or other paper for writing and drawing• YIP Inventor's Journal (hardcopy provided by teacher or use digital format)• Worksheet: Invention Testing Feedback Grid (<i>copy included in the YIP Inventor's Journal</i>)• Worksheet: Changes to My Prototype Plan Worksheet (<i>copy included in the YIP Inventor's Journal</i>)• Build materials (such as, but not limited to: recycled materials, tape, glue, scissors, clips, string, fabric, markers...)	

INSTRUCTION & ACTIVITIES

Teacher may lead the following lesson plan with flexibility to adapt as needed to fit technology and class format:

Note: This is a multi-day lesson that requires teacher guidance as well as independent work time. Students will need time to build and test their original invention. Much of the work can be done in class, at home, or in some combination of class and home. Teacher should assign a specific number of hours (we recommend 4-6 hours) to be devoted to design and building. Teacher may ask students to submit a record of their progress during this time. Teachers are strongly encouraged to host an “office hours” for students to connect with peers and with the teacher to ask questions and share ideas for invention improvement. All parts of this process should be documented in the YIP Inventor’s Journal or an alternative Invention Logbook (digital or hard copy). Logbooks of some kind are required for submission to the Northern New England Invention Convention and the Invention Convention US Nationals.

Note: Teacher may want to seek additional volunteers to help younger students with building as younger grades require more support with cutting, gluing, and skills involved. School staff and parent and community volunteers are good resources if permitted.

Note: If assigning work to be done at home, teacher is encouraged to communicate the requirements and expectations of the project with families, as well as the family’s role in this project. An email/take home letter template is provided.

Teacher Instruction:

Teacher may lead the following lesson plan with flexibility to adapt as needed to fit technology and class format.

1. Teacher may use slides and script to explain the Design-Test-Build Cycle or lead instruction and discussion on their own.

Teacher will share slide deck- Design-Test-Build Cycle with the class and use scripts as needed.

Teacher will explain the next step of the invention process which is the design, build and test phase. Teacher will explain the process and what students may consider as they work independently. Teacher will establish class guidelines around time required to work on projects at home, which components are to be submitted for teacher review and when submissions are due along the way, and how components are to be submitted. Teacher may also want to share Invention Prototype rubric on how inventions are evaluated to help students understand their task and the expectations for the final product. Finally, teacher should emphasize the importance of recording all steps of the process and all work in the YIP Inventor’s Journal or alternative Invention logbook.

2. Teacher will host a class discussion:

- How might you go about testing your original design once you build it?
- How will you know to try something different and that you need to make modifications to your first design?
- How will you be able to know what modifications you might want to make to your original design?

- Why is testing important to the invention process?

Note: Throughout the course of completing YIP and working on their own invention projects, students should complete the YIP Inventor's Journal. Teachers should train students to write in their journals whenever they are working on or even thinking about their inventions, they should be writing in their YIP Inventor's Journal (or alternative invention logbook). They can also write on lined paper/scrap paper and staple it to the journal later.

Student Proving Behaviors:

Recommendations for In-Class Learning

1. Peer-to-Peer Sharing- During the building and testing process, have students participate in a peer-to-peer sharing session. Allow pairs or small groups to meet and share where they are in the process, any testing they have done, and challenges they are facing. Teacher should encourage students to provide constructive feedback and positive comments to support the invention process. Teacher may use resources from brainstorming and partner sharing activities in previous lessons to support activity.

Ideas for Virtual Instruction:

1. *Teachers may create a class blog, or other virtual sharing platform. This journal can be a place where students can share how their projects are progressing. It is recommended that teacher sets guidelines for how this blog should be used appropriately by the class.*
2. *Teachers may ask students to work in pairs for peer support throughout this independent work period. Pairs may connect using tools such as email, phone/text, Google Classroom, Zoom or other school supported technology with parent/guardian permission.*
3. *Teachers may develop a check-in process for students to report on their progress, share ideas with teacher and/or peers, and to ask questions. Options may include, but are not limited to the following suggestions:*
 - i. *In format of the teacher's choice, the students must document and submit their work each time they work on their project at home.*
 - ii. *Host periodic class meetings to allow all students to share their progress.*
 - iii. *Ask students to take a weekly photo of design/prototype, and submit to a class blog so classmates can see.*
 - iv. *Following the first design-build-test cycle, ask students to reflect on what worked and what didn't work. Ask students to list 2 modifications they plan to implement in the next phase of the cycle. They should record their plans in their YIP Inventor Journal.*
 - v. *Give students an opportunity to post their problems and peers can give suggestions.*
 - vi. *Have students reflect on what is working and what is not working in a journal or check for understanding type of assignment.*

Activity: Peer Testing and Sharing

1. Ask students to get into pairs. Hand out copies of the Invention Testing Feedback Grid and Changes to My Prototype Plan worksheet, or have students use the worksheets included in their journals. If you have time for students to peer share several times, you will need extra copies of the Invention testing Feedback Grid to distribute.
2. Students will swap inventions and allow a peer to use, test and review the design model. Allow students 5 minutes to use and test their partner's prototype. Then allow them several

minutes to ask questions and share feedback. They should complete the Invention Testing Feedback Grid during this session.

Before beginning, guide students through what is appropriate when giving feedback. This will ensure that students give each other constructive feedback to help students provide useful, positive comments during a peer sharing session. YIP recommends using the following feedback models. You may wish to explain these models and what you expect of students as they give feedback.

- TAG Model: **T**ell something you like about it, **A**sk a question about it, **G**ive a suggestion to improve it
- Hamburger Model: **T**op bun is a positive comment about it; **H**amburger is the feedback that will be useful to help improve it; **B**ottom bun is another positive comment about it.

3. After testing and sharing, have students complete the Invention Testing Feedback Grid (included in the YIP Inventor's Journal) with their partner. The partner will share:

- What they liked about the invention they tested.
- What **ONE** suggestion do they have to make it better.
- What questions they have about the invention.

Then, the students will also use this feedback to fill in the box on the lower right: What new ideas were introduced?

Give each student about 3-4 minutes to share. You may wish to use a clock or timer to ensure each student gets equal time for feedback.

4. Ask students to consider this feedback and think about changes they can make to their original prototype to improve it. If possible, have them write down these modification plans or draw a new design for version 2 of the prototype. They should note any changes on the Changes to My Prototype Plan Worksheet (included in the YIP Inventor's Journal).

Note to teacher: If time allows, you may ask students to seek another user's feedback by having a second round of peer sharing. Use another Invention Testing Feedback Grid worksheet (included in the YIP Inventor's Journal) if needed.

Activity: SCAMPER Returns

This activity is optional but may be helpful to remind students how to design and re-design a solution to their proposed problem.

1. Teacher will lead students through a short group SCAMPER activity (see Lesson 3: Brainstorming). Teacher may choose to share slides: Slide Deck- Brainstorming.
2. Teacher will show students a kitchen utensil, such as a whisk. Then ask students to brainstorm a new use for the whisk using SCAMPER methods.

Ideas for Virtual Instruction:

1. Show a picture of a common gadget in your virtual classroom and ask students to brainstorm a new use for that gadget. You can show several gadgets to allow all students to contribute and practice.
2. Do a pair-share or small group version of the activity using Zoom breakout rooms or Google Classroom to allow them to SCAMPER together. Or do a class share of ideas.
3. Use a virtual platform of choice for students to submit their own brainstorming ideas as they think of a new use for an object (you may assign a specific object or ask them to find their own)

4. Ask students to share their drawings or ideas using photos or videos in a blog or virtual sharing format. Create a class gallery and then ask students to view and comment (positive and constructive) on their peers' submission.

CHECK FOR UNDERSTANDING

Teacher may wish to do one of the following to check for understanding:

1. In the format of the teacher's choice, ask students to think about their own invention. How can they test it? What data will they collect? Will their data have number, observations, or user feedback? What adults can assist?
2. In the format of the teacher's choice, ask students to write down one question they have about the expectations and requirements of their invention project.