Innovation Curriculum

Workshop Day 2

Test, Analyze, Iterate, Refine, Present

Lesson Overview:
Students will continue the GSA Innovation Process by completing the following steps:

1. Test their solutions
2. Analyze the results of their tests
3. Modify their solutions based on the test results
4. Retest, as time permits
5. Make any final revisions to their solutions
6. Present their solutions

Workshop: Day 2

Lesson Overview: Students will continue the GSA Innovation Process by completing the following steps: 1) test their solutions, 2) analyze the results of their tests, 3) modify their solutions based on the test results, 4) retest, as time permits, 5) make any final revisions to their solutions, and 6) present their solutions.

Time Frame
8 hours for 2-day workshop / 4 hours for 1-day workshop

- Part 1: *Test* - 120 min / 45 min
- Part 2: *Analyze* - 60-120 min / 45 min
- Part 3: *Iterate and Retest* - 1-2.5 hours / 60 min
- Part 4: *Final Revisions* - 60 min / 15 min
- Part 5: *Present* - 120 min / 75 min

Core Concepts

- Testing is required to determine whether a solution is viable
- A solution can be revised and refined according to feedback collected from testing
- Initial design solutions are rarely perfect or final
- Iterating improves a solution and makes it more responsive to users' needs

Lesson Objectives
Students will be able to:

- Use a model or prototype to test a solution
- Collect and analyze feedback and data
- Summarize feedback and data, identifying trends and themes
- Modify their solutions based on test results
- Create thorough and effective presentations of their solutions

Lesson Inquiry Question: What can we learn from testing a solution?

Preparation: If possible, arrange for experts and/or potential users to visit the workshop and participate in the testing process. Print out hard copies of resources that students may find useful.

Materials Needed

- Journals (optional)
- Supplies for testing models/prototype (calculators, cameras, tablets or smartphones, paper, pencils, etc)
- Supplies and materials for modifying and retesting solutions (will vary; see Day 1)
- Templates for Deliverable 2 – see Appendix C
- PowerPoint or other software for making slideshow or video presentations

Journal Opportunities (optional)

As they complete this lesson, students who are keeping science journals may want to use them before and after each step (testing, analyzing, and iterating) to set personal learning goals for the step and evaluate how well those goals were met. Once they have completed the lesson, students may also want to use their journals to:

- Record how their thinking about their solutions changed over the course of several iterations
- Summarize what they learned from the process as a whole

Part 1: Test

Estimated Time
2 hours (2-day workshop)
45 min (1-day workshop)

Preparation: In preparation for testing, encourage teams to briefly review their Research Plans in Deliverable 1. Be sure each team member has a role to play and tasks to perform in the testing process.

Remind students that before they begin testing they must clearly identify the following:

- The variable(s) they are testing, including:
  - independent variable(s)
  - dependent variable(s)
- The method(s) they will use to obtain reliable results, including:
  - controlled variables and *how* they will be controlled
  - procedural steps
  - observational study vs. controlled experiment
  - control group vs. experimental group (if applicable)
  - data collected
  - feedback collected (from whom and questions)
  - number of samples (i.e., how many times the test will be repeated)

Procedure

1. Experimental Testing or Observational Studies
   - If the group is conducting a scientific experiment or observational study, encourage students to consider how many times they will repeat the experiment to obtain accurate results. When determining how many samples will be recorded, the general rule is that more is better. A sample size of 30 or more is ideal from a statistical perspective. That said, 30 or more repetitions may not be practical due to time and resource constraints. Smaller sample sizes yield results that are less reliable (less statistically significant), though they may be sufficient.

2. User and Expert Feedback
   - Time constraints may limit students to testing their solutions with other workshop participants. Even participants who are not end-users or experts may have useful feedback. Encourage user testing and/or expert review as time permits.
   - If students are conducting user testing, suggest that they establish a list of questions and a procedure to gather feedback in a systematic way. Have students consider whether they can conduct a scientific experiment or observational study *in addition to* gathering user feedback, or by asking specific questions for which the responses may be analyzed statistically. Share the following documents, as applicable, to help

students plan.

- Get Feedback: IDEO's Design Kit outlines four steps for getting feedback on a prototype
- Test Your Prototype & Get Feedback: This resource provides instructions and a template for capturing and incorporating feedback on a prototype
- Testing With Users: The Bootcamp Bootleg from Stanford University's Institute of Design explains why and how to test a prototype with users and provides a 4-step procedure for testing in "Testing with Users" (card 35; page 38)

3. Remind students to gather and record feedback and results carefully as they test their solutions. Most teams will benefit from assigning one person to be in charge of this task. Encourage them to create tables or charts for data collection to keep results organized.

4. Remind students to take photographs and/or video footage during the testing to be used in the final presentation. They should consider images/video of methods, supplies, interviews, and results.

Part 2: Analyze

Estimated Time
1-2 hours (2-day workshop)
45 min (1-day workshop)

Procedure
1. Invite teams to review and analyze the data they collected during testing. There are a variety of options for doing so. Have students use one or more of the following tools, depending upon skill level.
   - Visual graphs and charts, such as histograms, bar graphs, box plots, and pie charts
   - Descriptive statistics, such as mean, median, mode, range, percentiles, and standard deviation
   - Advanced statistical analyses, such as hypothesis testing using *t*-distributions or *z*-distributions, or Chi square testing

   For more information about statistical analysis, see Additional Resources on p. 11.

2. As they complete their analyses, encourage teams to consider and respond to questions such as the following.
   - Do our test results support our hypothesis? Why or why not? How do we know, based on our statistical analysis?
   - Have we chosen the best tools for statistical analysis? Should we try anything else?
   - Is there a relationship between variables? Is it a correlation or a causative relationship? How do we know?
   - Do the test results answer other questions we were testing for? If yes, what are the answers? If no, why not? Were there problems with our testing methods? Did we collect enough data and feedback from enough sources?
   - If our results were unexpected, why?
   - How can we revise and improve our solution and/or testing methods in the next iteration?

Feedback Opportunity: Check in with each team to ensure that they are analyzing and interpreting their data correctly, and to help them troubleshoot any issues that have arisen or make sense of results that puzzle them.

Part 3: Iterate (and Retest)

Estimated Time
1-2.5 hours (2-day workshop)
1 hour (1-day workshop)

Procedure
1. Have students modify their solutions according to their test results. Share the following resource to guide them.
   - Integrate Feedback and Iterate: IDEO's Design Kit provides four steps for integrating feedback and creating the next iteration of a design solution

2. Encourage students to retest their modified solutions if time permits, following the same procedure outlined in Part 1, but making any necessary modifications to improve their testing methods.

3. Have students analyze their new data and feedback, and repeat the process of modifying, retesting, and analyzing as time permits.

4. Students should continue to document their iterations using photos and/or video for use in their final presentations.

Deliverable 2
Distribute the Deliverable 2 template (Appendix C). Have students outline the following in 2 pages or less. If time permits, invite students to present their findings orally to you or their peers for review**.**

- **Data/Feedback:** Summarize the data you obtained from experiments and/or feedback you gathered.
- **Lessons Learned:** Summarize the most important findings from your testing.
- Include a visual representation (e.g. photo, sketch, diagram, flow chart, etc.) or description of your prototype with your submission.

Part 4: Refine

Estimated Time
1 hour (2-day workshop)
15 minutes (1-day workshop)

Procedure

1. Once students have completed their final round of testing, ask them to analyze their latest data and feedback.

2. Encourage students to review their previous iterations to identify the most effective elements of their solutions.

3. Invite students to complete any final revisions to their solutions. Revisions should be based on testing and analysis. What worked? What didn't work? What is the solution they will present as a response to the challenge? This ultimate solution may be written out or represented by a visual or physical prototype.

4. Students should take photographs and/or video of their solutions to use in their final presentations.

Feedback Opportunity: Before they begin work on their final presentations, meet with teams to review their design solutions, offering guidance on any final questions or issues they may have.

Part 5: Present

Estimated Time
2 hours (2-day workshop)
75 min (1-day workshop)

Preparation: Explain to students that they will now create final presentations of their solutions. They may choose to create a brief slideshow (approximately 15–20 slides) or video (approximately 2 minutes). Each presentation should include the following elements.

- **Problem:** State the problem you tried to solve
- **Background:** Summarize any relevant research or background information, and be sure to cite your sources
- **Hypothesis:** State the hypothesis you investigated
- **Methods:** Describe the methods you used to collect data or feedback
- **Results:** Summarize the results of your testing
- **Solution:** Describe your solution

Help students gather any supplies or resources they may need to complete their presentations. Share the Sample Report (Appendix D) as a model. This presentation describes how a student improved and tested the design of a paper helicopter.

Procedure

1. Allow enough time for teams to complete their presentations.

2. Have each team present their solution to the class.

3. To conclude the project, have teams submit their final work to you and via Launchpad (if they are participating in a current challenge). Each submission should include the following items.
    - The team's final slideshow or video presentation
    - A short (1 page or less) executive summary that outlines the problem, the hypothesis, and a brief overview of the solution
    - A brief summary (1 page or less) **from each team member** describing the experience of working with his/her team and mentor, if applicable

4. If you plan to evaluate students' work yourself, use the Success Rubric (Appendix E) to guide you.

Terms and Concepts

- ***data***: observations and/or measurements collected in a study, investigation, or experiment.
- ***data analysis***: the process of evaluating data using analytical and logical reasoning. Data analysis can include graphical representations, descriptive statistics, and hypothesis testing statistics.
- ***causation:*** a relationship between two variables in which changes in one variable cause changes in the other variable. A controlled experiment is usually necessary to determine a causation relationship.
- ***correlation:*** a relationship between two variables. As one variable changes, the other also changes in a predictable pattern. One variable may cause the other, or both variables may be caused by a third variable (known or unknown). Sample studies generally can only show correlation relationships between variables.
- ***controlled experiment:*** data is collected by randomly dividing subjects into two groups: the control group and the treatment group. In the case of testing a parachute for an egg drop, researchers could drop half of the eggs using the test parachute (the treatment group) and half of the eggs without the parachute (the control group). The results from the two groups can be compared to determine if the treatment actually resulted in a statistically different outcome. While a *controlled experiment* gives more reliable results, there are times when creating a control group and treatment group is not practical. In some cases, the act of controlling variables can alter a situation such that the results are not useful in reality. For example, it is often not practical to create control groups and treatment groups in studies of animal behavior in the wild. When animal behavior studies are conducted in captivity, the experiments can be controlled, but the results may only be true in captivity and may not translate to behavior in the wild.
- ***observational study***: data (measurements, survey questions, etc.) is collected without attempting to affect or manipulate the the subjects of the study. In the case of testing a parachute for an egg drop, researchers could simply drop the sample eggs (the subjects), using the parachutes, to see if they break or not. The results from an observational study may not show as strong of a correlation between the parachute and egg breakage, because it is unknown how many eggs may have broken without the parachute and if the parachute actually affected the results.
- ***iterate*****:** to perform repeatedly

Additional Resources

Test

These resources offer more information about designing experiments and conducting various types of research.

- Designing Studies (Khan Academy)
  https://www.khanacademy.org/math/statistics-probability/designing-studies#experiments-stats-library
- Designing a Study (Schmoop)
  http://www.shmoop.com/basic-statistics-probability/designing-study.html
- Research Designs
  https://explorable.com/research-designs

Analyze

Students may find the following resources helpful when analyzing data and conducting statistical analyses.

- What is Data Analysis?
  http://study.com/academy/lesson/what-is-data-analysis-definition-overview.html
- Statistics and Probability
  https://www.khanacademy.org/math/statistics-probability
- t-Tests
  http://www.statisticshowto.com/t-test/
- Box-and-Whisker Plots
  http://www.shmoop.com/basic-statistics-probability/box-whisker-plots.html
- Scatter Plots and Correlation
  http://www.shmoop.com/basic-statistics-probability/scatter-plots-correlation.html

The Scientific Method

This resource explains six steps of the scientific method—from asking and researching an initial question to presenting the results of testing and analysis—with links to additional information about each step.
http://www.sciencebuddies.org/science-fair-projects/project_scientific_method.shtml

Present

Students may find the following resources helpful when creating their presentations.

- How to Create a PowerPoint Slide
  http://www.readwritethink.org/files/resources/lesson_images/lesson1063/CreatingPowerPointSlide.pdf
- How to Create a PowerPoint Presentation
  http://www.instructables.com/id/How-to-Create-a-PowerPoint-Presentation/
- How To Make An Amazingly Professional PowerPoint Presentation
  https://www.youtube.com/watch?v=iqI149PD4v4
- How to Turn Your Presentation Into a Video
  https://support.office.com/en-us/article/Turn-your-presentation-into-a-video-c140551f-cb37-4818-b5d4-3e30815c3e83
- How to Create Video Presentations
  https://www.movavi.com/support/how-to/how-to-create-video-presentation.html

Hyperlink Index

Integrate Feedback and Iterate: IDEO's Design Kit provides four steps for integrating feedback and creating the next iteration of a design solution. http://www.designkit.org/methods/4

Get Feedback: IDEO's Design Kit outlines four steps for getting feedback on a prototype. http://www.designkit.org/methods/57

Test Your Prototype & Get Feedback: This resource provides instructions and a template for capturing and incorporating feedback on a prototype. https://d3gxp3iknbs7bs.cloudfront.net/attachments/174c74a3-a4d4-475b-be39-4097cdf620ce.pdf

Bootcamp Bootleg: Resource cards created by the dSchool at Stanford University's Institute of Design. https://dschool.stanford.edu/resources/the-bootcamp-bootleg

- *Testing With Users:* card 35; page 38