Innovation Curriculum

Workshop Day 1*

Prepare, Research, Brainstorm, Design, Plan, Build

Lesson Overview:
Students will begin the Global STEM Alliance (GSA) Innovation Process by completing the following steps:

1. Choose a challenge and build a team
2. Research the problem they want to solve
3. Brainstorm solutions
4. Choose the best design or concept to develop
5. Make a plan to develop and test the chosen solution
6. Build a prototype or model of the solution

**If conducting the Innovation Workshop in 1 day or less, this lesson should take about half of the time allotted for the entire workshop.*

Workshop: Day 1

Lesson Overview: The Global STEM Alliance (GSA) Innovation Process is intended to guide teams or individuals to apply principles of scientific research and design thinking to solve real-world problems. Developed specifically for teen and young-adult solvers, this 10-step process provides a useful framework for creative problem-solving and engages students in applying STEM skills and knowledge in ways that reflect the work of STEM professionals.

This curriculum is designed to help educators guide students through the process during an intensive 1–2 day workshop.

During Day 1, students will begin the Global STEM Alliance (GSA) Innovation Process by completing the following steps:

1. Choose a challenge and build a team
2. Research the problem they want to solve
3. Brainstorm solutions
4. Choose the best design or concept to develop
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Time Frame
8 hours for 2-day workshop / 4 hours for 1-day workshop

- Part 1: *Form Groups* - 30-45 min / 15 min
- Part 2: *Research* - 60 min / 30-60 min
- Part 3: *Brainstorm* - 60 min / 30 min
- Part 4: *Design* - 60 min / 30 min
- Part 5: *Plan* - 60-120 min / 60 min
- Part 6: *Build* - 2-3.5 hours / 60-90 min

Core Concepts

- A strong team includes members with shared interests but diverse talents
- Feedback makes the design process more efficient and solutions stronger
- Focused research is necessary to define and understand a problem
- Brainstorming ideas freely, without judgment, can lead to innovative solutions
- Evaluating ideas carefully will help you select your best idea to design
- A hypothesis is a preliminary, testable explanation for a phenomenon or for how something will work, based on minimal evidence
- Designing and testing a solution requires forming a hypothesis about how it will work or what results it will provide
- Before building a solution, it is important to determine what kind of prototype or model best suits the design and can be tested

Lesson Objectives
Students will be able to:

- Build a team
- Research and define a problem
- Brainstorm ideas for solving the problem
- Evaluate possible solutions and chose the best solution to design
- Form hypotheses about how their proposed solutions will work
- Devise an appropriate plan for developing prototype solutions
- Determine appropriate methods for testing and evaluating their hypotheses using their prototyped solutions
- Build a model or prototype of their solution

Lesson Inquiry Question: What is involved in generating a viable and innovative idea and prototype to solve a problem?

Preparation: Prior to the workshop, you may wish to gather research materials and invite subject matter experts and/or individuals affected by the problem to be present for interviews during the Research part of the workshop. To save time, you may also choose a design challenge ahead of time so that participants may focus their time on the design process.

Materials Needed

- Journals (optional)
- Challenge statement(s) – see Appendix A
- Innovation Process Overview – see Appendix B
- Poster paper and sticky notes (for Brainstorming)
- Templates for Deliverable 1 – see Appendix C
- Sketch paper and pens
- Supplies for building models or prototypes(will vary, but may include paper, pens, cardboard, string, tape, wireframe or storyboard app, etc)

Journal Opportunity (optional)
Students who are keeping science journals may want to make note of the challenge they select, initial ideas about a solution, and questions they hope to explore and answer as they go through the design process.

Part 1: Form Groups

Estimated Time
30-45 minutes (2-day workshop)
15 minutes (1-day workshop)

Preparation: Display or distribute challenge statements.

Procedure

1. You may want to begin the workshop with an icebreaker such as the following: https://www.mindtools.com/pages/article/newLDR_76.htm

2. Assign students to a challenge, or invite them to choose a challenge. Note that students will spend a significant amount of time on this project, so they should consider their choice carefully if given the option.

   Option 1: Invite students to select from the challenges on Launchpad. If your students plan to submit their completed solutions for judging, they should select a current challenge. Otherwise, they may also consider past challenges.

   Option 2: If you or your students do not have access to Launchpad, you may have students choose from one of the three Challenge Statements in Appendix A.

   Option 3: Using the challenges on Launchpad or in Appendix A as models, work with students or on your own to create customized challenges appropriate to the goals and focus of your course or organization. The GSA Innovation Process may be used to address any issue or problem that requires creative problem-solving. For guidance on creating your own challenge, see Additional Resources on p. 22.

   NOTE: In the interest of time, you may wish to offer a single challenge. Omitting the time spent choosing a challenge may be necessary for 1-day workshops, especially. On the other hand, choice can offer more engagement, so a limited selection of 2 options may be a reasonable compromise.

   If allowing students to choose a challenge, encourage them to use the following questions to guide their choices:
   - How have my academic background and strengths prepared me for this challenge?
   - What practical, hands-on experiences have I had that might help me design a solution to this challenge?
   - What is my level of interest in this challenge? Am I passionate or curious about the

issue(s) it addresses?
- What community is this challenge designed to serve? How much access will I have to that community for purposes of research and feedback?

3. Provide time for students to ask clarifying questions about the challenges.

4. Have students arrange themselves into areas of the room or groups according to their challenge choice to prepare for Step 5. If the facilitator will form groups, have students record their choice on a list or via some type of technology such as clickers or Google Form.

5. Assign students to teams or invite them to form teams with other students who have chosen the same challenge. Ideally, each team should contain 4-6 students. If possible, consider the following as you group students into teams:
   - **Academic background:** Consider whether it would be beneficial for team members to bring a variety of academic knowledge and experience to the team, or if it's important that all members have completed specific coursework pertinent to their challenge.
   - **Individual Strengths:** Try to ensure that team members bring diverse academic and personal strengths and experiences to their team, such that students don't end up on a team in which, for example, everyone excels in math or project planning, while no one has strong research or communication skills.

6. Explain to students that their team's success will depend on their ability to work together effectively. Encourage team members to spend time getting to know each other better. Lead the groups through a "getting to know you" activity such as in the link in Step 1, or suggest that they discuss topics such as the following:
   - Favorite STEM topics
   - Hobbies
   - Future plans
   - Goals for the project
   - Individual strengths (e.g., data analysis, project planning, communication, or presentation design)

7. *For a 2-day workshop*, distribute the Innovation Process Overview (Appendix B) to students and review it together, identifying the main tasks to complete in each step. Using this information, guide students to make a plan for their team to work collaboratively, identifying each member's key strengths and determining the role and tasks for which each member will be responsible. This plan will be relatively brief unless the workshop is

being broken up over a period longer than 2 consecutive days.

The division of labor may vary according to students' individual strengths and the specific challenge they have chosen. However, the following are possible roles and tasks that a project plan might include:

Roles*

- Chief Designer: Takes the lead during steps that require creativity and construction of the solution. These steps include tasks such as *design*, *plan*, *build*, *iterate*, and *refine*.
- Communications Director: Responsible for communicating about the project to the instructor, other teams, and the Launchpad community (for teams participating in a current challenge). This person may also coordinate communication between the group and potential advisors and/or mentors.
- Data Analyst: Responsible for creating appropriate data collection methods prior to testing and leading the creation of questions to solicit feedback from others on the team's designs. Also leads analysis of data collected from testing, and generating graphs, charts, or other visuals to display data appropriately.
- Director of Research: Takes the lead on conducting and compiling initial research prior to brainstorming, helps to inform Chief Designer by providing relevant background information throughout the process, and collaborates with Chief Designer and Data Analyst to determine how test results might influence further development.
- Presentation Planner: Leads creation of the final presentation (slide deck or video). Also responsible for documenting the process with video and/or photographs for use in the final presentation.
- Project Manager: Oversees each step of the process and insures that work is distributed fairly by helping those in other roles to delegate and manage their tasks effectively. The Project Manager maintains a calendar and/or checklist of tasks and responsible parties, checks in with others throughout the process, runs team meetings (such as brainstorming sessions), and assigns new tasks as they arise.

Note that individuals assigned to a given role should assume responsibility for related tasks, but students should not work alone to complete their tasks. The Project Manager (and the instructor) can help ensure that each step is a group effort, with individuals taking the lead and others providing support.

Tasks

- Create a project plan and/or calendar that includes subtasks, due dates/times, and responsible parties
- Request, plan, and conduct interviews

- Conduct and summarize online research
- Plan, perform, and analyze experiments
- Design visual models and displays
- Write reports
- Document work with photos and/or videos
- Register group on Launchpad and upload relevant reports and updates (as applicable)

Students may also benefit from reviewing Create a Project Plan, a resource from IDEO's Design Kit that outlines five steps to create a project plan.

Part 2: Research

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

Preparation: Explain to students that the first step in the innovation process is to research the challenge they chose. During this step, students will define the specific problem they want to solve and learn as much as they can about factors that contribute to the problem. If students will be locating materials independently, share some of the following resources before they begin.

- How to Do Internet Research: This resource from Frankfurt International School presents eleven rules to help students conduct effective online research
- Evaluating Internet Resources: A tutorial from the Georgetown University Library on evaluating internet resources
- More About Evaluating Internet Resources: Guidance from the University of California Berkeley Library on evaluating the appropriateness and credibility of online resources

Procedure

1. Take a few minutes as a full group, or in smaller groups, to assess what participants already know about the challenge topic and what they need or want to know. Utilizing a KWL (Know, Wonder, Learn) chart or concept map may help focus the discussion.

2. Have students identify an initial set of resources to use in their research. In the interest of time (or in the event of limited Internet/library access), you may choose to curate a set of research sources and materials for each challenge, and limit students to using those materials. Resources might include the following:
   - Relevant articles and research papers, online or from the library
   - Short videos on the subject

3. As time permits, you may want to make arrangements for your students to interview experts and/or people affected by the problem to be solved. Share some or all of these resources to guide students who will be conducting interviews.
   - Interviewing Experts: This resource from IDEO's Design Kit presents five steps to follow when interviewing an expert
   - Interviewing Individuals: IDEO's Design Kit presents four steps to follow when interviewing an individual, as well as a short video that offers an example of how interviewing individuals can help illuminate potential needs and/or resources
   - Interviewing Groups: IDEO's Design Kit presents four steps to follow when conducting

a group interview

**Whenever possible, interviews with people affected by a problem can add depth and perspective to the scope and reality of the challenge. If live interviews are not possible, consider creating or finding videos of people affected by the problem. Perhaps solutions have been suggested in the past that have not worked. The people affected by the problem may have unique perspectives as to what the problem really is and why previous solutions were unsuccessful. Through interviews such as these, students can gain empathy that may help them to approach the challenge from a user-driven perspective. This perspective may lead to innovative and realistic solutions that address underlying challenges and really work.*

4. Direct students to use the research materials and resources to learn as much as they can about the problem they plan to address. Point out that their research should answer the following basic questions.
   - What problem will we attempt to solve?
   - What causes and factors contribute to this problem?
   - Whom does the problem affect?
   - What other solutions have been attempted? What were the results of these solutions?

5. As they conduct their research, students should create brief summaries of the key information learned from each source. Most teams will benefit from designating one member (the Director of Research or similar role) to keep track of and compile a list of sources used and related summaries. Advise students to keep careful records of their sources so that they can cite them in their final report if needed.

Part 3: Brainstorm

Estimated Time
60 minutes (2-day workshop)
30 minutes (1-day workshop)

Preparation
Explain that the next step in the process is to brainstorm solutions to the problem. During this step, students will generate as many possible solutions as they can.

Brainstorming is an essential part of the design process. It offers an opportunity for every team member to contribute ideas and bring his or her unique experiences, background, and perspectives to the process. As students brainstorm together, each student's ideas typically spark other students' ideas. Be sure to allow students plenty of time for this step.

Before teams engage in their first brainstorming session, invite them to review the following resources for guidelines and ideas about how to brainstorm effectively. Each of these resources can be found in the Bootcamp Bootleg created by the dSchool at Stanford University's Institute of Design. You will need to download the PDF and then go to the noted page. Alternatively, the cards are numbered.

- *Brainstorm Rules*: card 28; page 31. Brainstorm Rules can also be accessed as a webpage in IDEO's online Design Kit. This resource offers seven rules for productive, creative brainstorming.
- *Facilitate a Brainstorm*: card 29; page 32. This resource provides the "why?" and the "how?" of facilitating a brainstorming session.
- *How Might We?:* card 26; page 29. This four-step method for turning challenges into design solutions can also be found as a webpage in IDEO's Design Kit.

Procedure
1. Distribute poster paper and sticky notes. Ask each team to appoint a facilitator to lead their brainstorming sessions. The Project Manager would be a good choice, if they have this role. You might also want to print and distribute one or more of the above resources for teams to refer to as they brainstorm.

2. Invite students to conduct their first brainstorming session, reminding them to listen and record all ideas without judgment. Students can start by writing or sketching ideas on sticky notes and then posting the notes to the poster paper or wall. As initial ideas are shared, conversations will begin, and new ideas will come up. Be sure that *all* ideas are

recorded—even those that seem unlikely, silly, or ridiculous. Unlikely ideas often lead to clever or interesting solutions that work! Students will evaluate their ideas during the next step.

Feedback Opportunity: Review each team's list of ideas before they move on to the next step, guiding them to do additional brainstorming as needed.

Part 4: Evaluate Ideas and Design a Solution

Estimated Time
60 minutes (2-day workshop)
30 minutes (1-day workshop)

Preparation: Explain to students that during this step they will evaluate the ideas they generated during brainstorming and choose their best idea to develop and design.

Procedure

1. Share the following resource with students and ask each team to choose a method (Post-It, Four Categories, or Bingo) to use for the initial step in the selection process.
   - Brainstorm Selection: Stanford University's Institute of Design offers advice on selecting the best ideas from a brainstorming session in their Bootcamp Bootleg (see card 30; page 33)

2. Guide teams to narrow the ideas generated during brainstorming according to the method they selected in Step 1. Encourage students to retain any ideas that the team is excited about or intrigued by. Remind students that this is just the first step in the selection process—they are not yet choosing a final idea and do not need to narrow their ideas *too* much.

3. If teams are unsatisfied with the results of Step 2, encourage them to repeat the step. Instead of repeating the same method used in Step 2, they may wish to choose a different method from Brainstorm Selection, or try the Gut Check method below. Share the following resource with teams who might benefit from it.
   - Gut Check: IDEO's Design Kit presents four steps for evaluating the ideas from a brainstorming session

Feedback Opportunity: Check in with each team to find out how their selection process is going. If teams are struggling, sit in on a selection session and offer guidance. Encourage teams to try different selection methods as appropriate.

4. Once teams have selected their most exciting and promising ideas, it's time to group related ideas into more complex, robust solutions. Share the following resource for teams to use as a guide to group ideas. Teams should create several bundles of ideas, and ideas may be included in more than one bundle.
   - Bundle Ideas: IDEO's Design Kit offers four steps to group related brainstorming ideas

5. Now it's time for teams to choose their best bundle of ideas and shape it into a concept or design that they will develop and test. Share the following resource to guide students' work.
   - Create a Concept: IDEO's Design Kit shares five steps for refining ideas into a design concept

Part 5: Plan

Estimated Time
60-120 minutes (2-day workshop)
45 minutes (1-day workshop)

Preparation: Share with students that each team will make a plan to build and test their proposed solution. They will form a hypothesis about how their solution will work, decide on an appropriate format or model for building the solution, and determine how best to test and evaluate the solution. Before beginning, it may be helpful to introduce or review the Terms and Concepts at the end of this lesson.

Procedure

1. Explain to students that the first step in planning is to form a hypothesis, an informed explanation about how they think their solution will perform. One way to write a hypothesis is as an if/then statement: "If I do *x*, then *y* will happen." Hypotheses should be testable. In other words, if an experiment is conducted, students must be able to identify the kinds of results that would support the experimental hypothesis and the kinds of results that would disprove the hypothesis (or support a null hypothesis). Students will use the models or prototypes they build in Part 2 of this lesson to test their hypotheses.

   Example: Consider the traditional engineering challenge of designing a contraption that will allow a raw egg to be dropped from a second-story window and land without cracking. An example hypothesis could state: “The use of a parachute will cause enough drag to slow an egg’s falling speed sufficiently to prevent breakage when dropped from a second-story window.”

   For a particular experiment, a more detailed or specific experimental hypothesis should be generated, such as, “The use of a 1 meter by 1 meter tissue paper parachute will prevent an egg from breaking when dropped from a height of 4 meters,” or “The use of a 1 meter by 1 meter tissue paper parachute will work better at protecting an egg from breakage than a 1 meter by 1 meter plastic bag parachute when dropping an egg from a height of 4 meters.” Students should also consider what the null hypothesis would be. For example, “The use of a 1 meter by 1 meter tissue paper parachute will NOT protect an egg from breaking when dropped from a height of 4 meters.”

2. Invite students to think about how they will test their hypotheses, and how they will model or prototype their solutions to conduct their tests. Will they gather feedback from potential users of their solution, or conduct scientific experiments, or both? Will they use a representation of their solution, such as a mock-up or sketch, or build a real working

prototype? Encourage students to think about how they can best test their hypothesis, rather than how they can build a mock-up of their design solution. In other words, their prototype may not need to look like the final solution at all in order to test a particular variable. As students consider the variable, or variables, that they would like to test, they should also consider and identify dependent and independent variables, as well as a control.

> *Example*: The egg-drop hypothesis above might be tested using scientific experiments that consider the independent variables of parachute materials and/or parachute area to see if the dependent variables of egg drop speed or egg breakage are affected. If several independent variables are considered, there may be several experimental hypotheses (and several tests) that can help students determine whether they can support the general hypothesis they have proposed. A control, such as an egg without a parachute, should also be tested.
>
> On the other hand, if students are certain that a particular type of parachute will work, but are concerned that people who regularly drop eggs from second-story windows may have difficulty using the new technology, they may want to gather feedback from potential users or even conduct experimental tests of actual users dropping the eggs using the parachutes. A control may be an informed experimenter (presumably someone who knows how to correctly use the parachute).

There are many options for creating models or prototypes to meet the rigors of testing. Different solutions and hypotheses may require different types of prototypes/models. Share this list of possible models. Be sure students are familiar with each model and invite them to add their own ideas to the list.

- Diagrams
- Flow charts
- Sketches
- Wireframes (see linked resource in Build, Step 1, below)
- Storyboards (see linked resource in Build, Step 1, below)
- User experience maps (see linked resource in Build, Step 1, below)
- Working prototypes

3. Ask each team to discuss and decide what model or prototype they will build. Show student the available supplies for prototyping (or provide a list). Share the following resources to help teams with this decision.
   - Determine What to Prototype: IDEO's Design Kit shares four steps to help students decide how to prototype their ideas
   - Identify a Variable: The Bootcamp Bootleg from Stanford University's Institute of

Design explains the *why* and *how* in "Identify a Variable" (card 37; page 40).

Once students have settled on a model or prototype, ask them to reconsider their hypotheses. Will they need to express one or more experimental hypotheses to address the actual tests they will perform with their model or prototype?

Feedback Opportunity: Before moving on to the next step, meet with each team to be sure they have decided on an appropriate, useful way to build or represent their solution. As needed, use questions such as the following to prompt students to reconsider their plans.

- What is the hypothesis you wish to test?
- How will you test this hypothesis? If there are multiple independent variables, how will you test each one?
- What will be your dependent variable(s)? What variable(s) will you control?
- What will be your experimental hypothesis and null hypothesis?
- What results do you expect if your hypothesis is supported? What results do you expect if your hypothesis is disproven?
- Are there other questions you hope to answer with your test(s)?
- How will you use the prototype you plan to build to answer your question(s)?
- Would another type of model or prototype be easier to build, or provide more or better answers? Will you need more than one model or prototype to test various aspects of your solution?

4. Guide students to finalize their plans for testing and evaluating their solutions. If they plan to conduct scientific experiments, remind them to identify the variable(s) they will test, their experimental and null hypotheses for each test, and the method(s) they will use to test each one. If they plan to conduct user testing, suggest that they consider how they will identify and connect with users in their target audience. Remind students that the purpose of their tests is to help determine whether their hypotheses are supported and to answer other questions they may have about their solutions. Ask students to consider whether the testing methods they are planning will satisfy those objectives. Also remind students that their testing must be achievable given the available time and resources in the workshop.

Deliverable 1

Before students begin to build their models or prototypes, distribute the Deliverable 1 template (Appendix C). If time allows, ask teams to present their responses orally to the group.

- **Proposed Solution:** Describe the design or concept you will test. Briefly summarize the research and brainstorming that led you to this solution.

- **Hypothesis:** State the hypothesis you plan to test.
- **Research Plan:** Outline the methods you will use to test your hypothesis or investigate the viability of your solution.

Part 6: Build

Estimated Time
2-3.5 hours (2-day workshop)
60 minutes (1-day workshop)

Preparation
Tell students that it is now time to begin building their models or prototypes according to the plans they made in Part 5. Point out that it's not necessary or expected that students will get everything right on the first try. Prototyping is an iterative process in which you modify your design as you go, based on what you learn. During the course of the next lesson, teams will test their solutions and then have an opportunity to iterate and revise their designs. For an overview of the process, share the following resource.

- Rapid Prototyping: IDEO's Design Kit outlines the process of rapid prototyping a design solution

For information and guidance about how to build a prototype to test, share and review the following resource with students.

- Prototype to Test: The Bootcamp Bootleg from Stanford University's Institute of Design offers information and tips on prototyping to test (card 34; page 37)

Procedure
1. Once teams have gathered materials and assigned tasks to each member, they can begin building.

   If computers and Internet are available, teams that would like to develop a website or app can use the following web-based tool to develop wireframes, mockups, diagrams, and other kinds of prototypes.* Invite students to use the app as applicable. This tool provides several layers of prototyping, so encourage students to use only the functionality they need and not get bogged down in details that are irrelevant to their prototype or testing.

   - Moqups: A web-based tool for collaborative wireframing and prototyping

   Teams planning to create storyboards or user experience maps may find the following resources helpful.

   - Storyboard: IDEO's Design Kit explains how to create and use a storyboard in four steps
   - User Experience Map: This guide from IDEO provides instructions and examples for

making a User Experience Map

**Wireframes, storyboards, and user experience maps can all be created using pens, markers, and paper. In fact, pen and paper may be faster if the app requires too much of a learning curve. In the absence of the necessary technology, or given limited time, encourage participants to consider how they can use pen and paper to create a testable prototype.*

2. Check in with each team as they build, offering guidance as needed. If students are struggling to build testable models, guide them through the following steps.
   - Review their research plan
   - Ask students to explain how they will use their model in executing their research plan
   - Guide students to make any necessary adjustments or revisions to better prepare the model for testing

3. Encourage groups to photograph and/or video record the building process and the final prototype or model to be used in their final presentation.

Terms and Concepts

brainstorm: to generate ideas and solutions through spontaneous group discussion
challenge* or *innovation challenge: a fixed period of time during which individuals or teams compete to design creative solutions to real-world problems
facilitator: someone who leads and coordinates a process
***hypothesis*:** a suggested answer/explanation to a scientific question or a solution to a scientific or engineering problem/challenge. A hypothesis must be testable in that it can be supported or disproven depending upon observable evidence (observation, in this case, includes use of the 5 senses and any additional tools that enhance the senses such as a microscope or electronic sensors, etc.).

experimental hypothesis or alternative hypothesis: a prediction of what will be the results of a particular test *if the hypothesis is supported*. Typically the experimental hypothesis suggests that there *is* a relationship between two variables - an independent variable that the experimenter is manipulating/changing and a dependent variable that the experimenter is observing. For the egg drop example, one experimental hypothesis could be, "Fewer eggs will break when using a 3 meter square tissue paper parachute will minimize the chance of cracking an egg shell when an egg is dropped from a height of 4 meters."

null hypothesis: a prediction of what the results will be if the hypothesis is disproven. Generally a null hypothesis suggests that there is not a relationship between two variables - that changing or manipulating one variable will *not* affect the other.

***prototype*:** a preliminary model that may be tested and updated. Prototypes may be functional or non-functional.
***variable*:** a feature, factor, or quantity that may or does change in an experiment.

independent variable: a variable that the experimenter *changes* in an experiment. An experimenter might change the material used to make an egg parachute or the size or shape of an egg parachute to see if these variables have an effect on the outcome of the experiments. Ideally, an experiment should only have one independent variable per experiment so that the results can be clearly attributed to any observed changes.

dependent variable: a factor that may or may not change due to a change in an independent variable. These are the variables about which the experimenter is making observations, measuring, and collecting data. There may be one or more dependent variables. In the case of an egg drop, this may be as simple as a broken or unbroken shell, or the experimenter may develop a range of egg shell observations (small crack, several cracks, completely smashed, etc.).

controlled variable: a factor that is purposefully kept the same throughout an

experiment so that it can not inadvertently affect the dependent variables. If an experimenter wants to test different material types to see which works best to protect a dropped egg, the size of the parachute and the shape of the parachute are variables that should be controlled. The height of the drop, the landing surface, and other factors that may affect if and how an egg breaks should also be controlled.

***wireframe*:** a visual guide or schematic that gives a skeletal view of a website or app. A wireframe can be useful for the design phase of a website when considering how to arrange website elements to meet certain goals in function and user interactivity.

Additional Resources

Design Thinking

The GSA Innovation Process is based on an approach called *design thinking.* The process is outlined throughout the workshop.

- To learn more about the philosophy behind design thinking, watch this short video. What Is Human-Centered Design?
- For in-depth information, download this free PDF. (You'll need to sign up first.) Field Guide to Human-Centered Design

Designing a Challenge

For tips and guidance on developing your own innovation challenge, check out the following resources.

- Frame Your Design Challenge. Steps and a video to guide you through the process.
- Reframe as a Design Challenge. While the example design challenges are focused on how educators can design education solutions, the steps and examples are clear and can easily translate to any kind of challenge.

Team Building

If you're working with students who don't know each other well, these sites offer instructions for a variety of "icebreakers" and team-building activities.

- http://www.icebreakers.ws/get-to-know-you
- http://www.ventureteambuilding.co.uk/team-building-activities-for-teens/

Research

This resource from BrainPOP includes several lessons on conducting effective Internet research and evaluating online sources.

- https://educators.brainpop.com/bp-topic/internet-search/

Brainstorming

For further information on the *hows* and *whys* of effective brainstorming, check out these sites.

- https://k12teacherstaffdevelopment.com/tlb/how-can-i-facilitate-brainstorming-in-the-classroom/
- https://www.mindtools.com/brainstm.html

Plan

Students may find the following resources helpful when formulating hypotheses about their solutions.

- http://www.sciencebuddies.org/science-fair-projects/project_hypothesis.shtml
- http://www.wikihow.com/Write-a-Hypothesis

Build

These resources offer more information and ideas about prototyping, and might be especially useful to students planning to build a functional prototype.

- http://ideasuploaded.com/2011/05/31/how-to-make-an-invention-prototype-cheaply/
- https://www.entrepreneur.com/article/80678
- https://www.fastcompany.com/3045934/passion-to-profit/how-to-go-from-idea-to-prototype-in-one-day

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

Hyperlink Index

Launchpad: Innovation Challenge online platform where challenges can be selected and student teams can compete for prizes. https://joinlaunchpad.com/challenges

Create a Project Plan: This resource from IDEO's Design Kit outlines five steps to create a project plan. http://www.designkit.org/methods/9

What Is Human-Centered Design?: Short video explaining Design Thinking. https://vimeo.com/106505300

Field Guide to Human-Centered Design: PDF guide to Design Thinking. (*You'll need to sign up first.*) http://www.designkit.org/resources/1

Frame Your Design Challenge. Steps and a video to guide you through the process. http://www.designkit.org/methods/60

Reframe as a Design Challenge. While the example design challenges are focused on how educators can design education solutions, the steps and examples are clear and can easily translate to any kind of challenge. http://td4ed.businessinnovationfactory.com/curriculum/define/reframe-design-challenge

http://www.icebreakers.ws/get-to-know-you: Handy ice-breakers for new groups.

http://www.ventureteambuilding.co.uk/team-building-activities-for-teens/: Handy ice-breakers for new groups.

How to Do Internet Research: Eleven rules for effective online research from Frankfurt International School. http://esl.fis.edu/learners/advice/internet.htm

Evaluating Internet Resources: A tutorial from the Georgetown University Library on evaluating internet resources. http://www.library.georgetown.edu/tutorials/research-guides/evaluating-internet-content

More About Evaluating Internet Resources: Guidance from the University of California

Berkeley Library on evaluating the appropriateness and credibility of online resources. http://guides.lib.berkeley.edu/evaluating-resources

Interviewing Experts: Five steps to follow when interviewing an expert from IDEO's Design Kit. http://www.designkit.org/methods/43

Interviewing Individuals: Four steps to follow when interviewing an individual from IDEO's Design Kit. http://www.designkit.org/methods/2

Interviewing Groups: Four steps to follow when conducting a group interview from IDEO's Design Kit. http://www.designkit.org/methods/20

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

- *Brainstorm Rules*: card 28; page 31.
- *Facilitate a Brainstorm*: card 29; page 32.
- *How Might We?:* card 26; page 29.
- *Brainstorm Selection*: card 30; page 33
- *Identify a Variable:* card 37; page 40
- *Prototype to Test:* card 34; page 37

Gut Check: Four steps for evaluating the ideas from a brainstorming session from IDEO's Design Kit. http://www.designkit.org/methods/42

Bundle Ideas: Four steps to group related brainstorming ideas from IDEO's Design Kit. http://www.designkit.org/methods/30

Create a Concept: Five steps for refining ideas into a design concept from IDEO's Design Kit. http://www.designkit.org/methods/31

Determine What to Prototype: IDEO's Design Kit shares four steps to help students decide how to prototype their ideas. http://www.designkit.org/methods/34

Rapid Prototyping: IDEO's Design Kit outlines the process of rapid prototyping a design solution. http://www.designkit.org/methods/26

Moqups: A web-based tool for collaborative wireframing and prototyping. https://

moqups.com/

Storyboard: IDEO's Design Kit explains how to create and use a storyboard in four steps. http://www.designkit.org/methods/35

User Experience Map: This guide from IDEO provides instructions and examples for making a User Experience Map. https://d3gxp3iknbs7bs.cloudfront.net/attachments/5c28e26a-ba7f-44f4-859b-e82658264287.pdf