Innovation Curriculum

Classroom Lesson 1

Prepare

Lesson Overview
Students will begin the Global STEM Alliance (GSA) Innovation Process by completing the following steps: 1) choose a challenge; 2) build a team; 3) make a plan to get feedback from their teacher(s), advisor(s), and/or mentor(s)

Lesson 1: Prepare

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 over a 10-week period typical of a GSA challenge.

In this lesson, students will begin the GSA Innovation Process by completing the following steps.

1. Choose a challenge
2. Build a team
3. Make a plan to get feedback from teacher(s), advisor(s), and/or mentor(s)

Time Frame: 1–2 weeks

- Part 1: Choose a Challenge - 30 min (in class)
- Part 2: Build Teams - 30–45 min (in class)
- Part 3: Working With Expert Advisors - 30 min (in class), 1–2 weeks (outside class)

Core Concepts

- Choosing an appropriate challenge involves several factors
- A strong team includes members with shared interests but diverse talents
- Soliciting feedback regularly makes the design process more efficient and solutions stronger

Lesson Objectives

Students will be able to:

- Choose a suitable challenge (unless instructor chooses the challenge)
- Build a team and make an appropriate plan for roles and division of labor
- Make a plan to solicit feedback and advice throughout the design process

Lesson Inquiry Question: What are my strengths as a designer and a team member?

Materials Needed

- Journals (optional)
- Challenge Statement(s)—see Appendix A
- Innovation Process Overview—see Appendix B
- Templates for Deliverable 1—see Appendix C
- Contact information for pre-identified advisors or mentors (optional)

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.

NGSS Alignment
For classes that complete all five lessons, the Innovation Curriculum strongly supports all eight of the Science and Engineering Practices (SEPs) of the Next Generation Science Standards (NGSS).

The Innovation Curriculum is directly aligned with the following Performance Expectations.

- ***HS-ETS1-1.*** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- ***HS-ETS1-2.*** Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

Educators may align the curriculum to additional Performance Expectations or other Disciplinary Core Ideas (DCIs) by selecting or designing an appropriate innovation challenge. Examples of possible Performance Expectation alignment include, but are not limited to:

- ***HS-ETS1-3.*** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
- ***HS-ETS1-4.*** Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.
- ***HS-LS2-7.*** Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
- ***HS-LS3-1.*** Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.
- ***HS-LS4-6.*** Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.
- ***HS-PS2-3.*** Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.
- ***HS-PS3-3.*** Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

Part 1: Choose a Challenge
(*skip this step if instructor chooses the challenge*)

Estimated Time
30 minutes (in class)

Preparation: Explain to students that they will begin the innovation process by choosing a challenge for which to design a solution. They will spend a significant amount of time on this project, so they should consider their choice carefully.

As applicable, display or distribute challenge statements for students to choose from.

Procedure

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. 11.

1. As students select 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?

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

3. Meet with any students who are having difficulty choosing a challenge and guide them to make appropriate choices, reviewing the questions above as needed.

4. If completing Parts 1 and 2 during the same class period, have students arrange themselves into areas of the room or groups according to their challenge choice to prepare for Step 2. If the instructor will form groups, have students record their choice on a list or via some type of technology such as clickers or Google Form.

Part 2: Build Teams

Estimated Time
30–45 minutes (in class)

Preparation: Explain to students that now that they have selected a challenge, they will form teams with other students who chose the same challenge. Display a list of names of students who chose each challenge or have students re-seat themselves in areas of the room according to the challenge they chose.

Procedure
1. 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. Consider the following as you group students or guide them to form their own teams.

- **Academic Background:** Consider whether it would be beneficial for team members to bring a variety of academic knowledge and experience to a team, or if it's important that all members have completed specific coursework pertinent to the challenge.
- **Individual Strengths:** Try to ensure that team members bring diverse academic and personal strengths and experiences to the teams, 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.

2. 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. Suggest that they discuss topics such as:

- Favorite STEM subjects
- Hobbies
- Future plans
- Goals for the project or reasons for choosing this particular challenge
- Individual strengths (e.g., data analysis, project planning, communication, presentation design)

3. Distribute the Innovation Process Overview (Appendix B) to students and review it together, identifying the main tasks to be completed 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 roles and tasks for which each member will be responsible.

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, as well as redistributing workloads as the project evolves.

Tasks

- Create a project plan and/or calendar that includes subtasks, due dates, 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)

Once roles have been determined and initial tasks have been assigned, teams should include this information in the "Team Dynamics" section of Deliverable 1.

Additional Resources

Students may also benefit from these resources.

- Expert Talk: Katy Kasmai on High-Impact Teams: Katy Kasmai, founder of Team Exponent and an engineering project manager at Google, discusses characteristics of successful teams
- Create a Project Plan: This resource from IDEO's Design Kit outlines five steps to create a project plan

Part 3: Working With Expert Advisors

Estimated Time

30 minutes (in class)

1–2 weeks (outside class)

Procedure

1. Explain to students that getting feedback is an essential part of the innovation process. In addition to soliciting feedback and advice from you at regular intervals throughout the process (suggested times and opportunities for providing feedback are noted throughout the remaining lessons), students might want to connect with experts in the community or online. Some experts can serve as advisors, providing a one-time interview and perhaps a follow-up interview later. Others might make good mentors who can provide more intensive support with multiple contacts. Work with teams to identify potential mentors and/or advisors who could help provide advice and offer feedback on their work. The following are just a few ideas about experts students might wish to reach out to, depending on the challenge and solution they are working on.

- Local teachers and university professors
- STEM entrepreneurs
- Business leaders or professionals in relevant STEM fields
- Experts from STEM-related institutions, such as museums, science centers, zoos, extension offices, and professional associations
- Government employees working in STEM fields
- Teachers or leaders from local STEM camps or other extracurricular programs

Students are more likely to secure a mentor or advisor with whom they have a personal connection. Encourage students to think about who they may already know, including:

- Neighbors, adult family members, parents' friends or coworkers
- Community members
- Individuals that the instructor has identified and possibly reached out to in advance

2. Once potential experts have been identified, teams should consider how the experts might offer assistance. Suggest that teams consider the following questions.

- At what point(s) in the process will you seek feedback or advice?
- What kind of feedback will you solicit?
- How will you communicate with advisors outside of your classroom?

Teams should include answers to these questions in the "Expert Advice" portion of Deliverable 1.

3. Once a team has specific goals and a general timeline for requesting advice, the Communications Director or another team member should reach out to potential experts via email or phone. Keeping in mind their answers to the previous questions, students can use the following outline to draft an interview or mentorship request.

- Introduce yourself.
- Explain the purpose of your email or call.
- Outline your interview or mentorship goals. These may vary depending upon the expert.
- Offer the options of interviewing the expert in person, by phone, or by email.
- Provide a timeline in which you would like the expert to respond.
- Thank the expert for their time and consideration.

Feedback Opportunity: Before students contact experts, review the drafts of their requests for accuracy and completeness.

4. Prepare teams for the possibility that some experts may not reply to their requests or may regretfully decline. Experts tend to be busy. Teams should consider sending requests to several experts with the hope of positive responses from one or more.

5. As potential advisors or mentors respond, the Communications Director and/or Project Manager should add their names and the dates/times of feedback to the project plan or calendar.

Teams should include details about any advisors or mentors and the role(s) they will play in the "Expert Advice" section of Deliverable 1.

Deliverable 1

Using the Deliverable 1 template (Appendix C), outline the following in one page or less.

- **Team Dynamics:** Describe each member's key strengths related to the project (e.g., skills, expertise, or knowledge) and your plan to work collaboratively during the challenge.
- **Expert Advice:** Explain how you will engage a mentor and/or STEM experts throughout the process.

Terms and Concepts

- ***challenge* or *innovation challenge***: a fixed period of time during which individuals or teams compete to design creative solutions to a real-world problem

Additional Resources

Design Thinking

The GSA Innovation Process is based on an approach called *design thinking.* The process is outlined throughout Lessons 1 to 5.

- 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 Helpful 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/

Lesson 1 Hyperlink Index

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

Expert Talk: Katy Kasmai on High-Impact Teams: Katy Kasmai, founder of Team Exponent and an engineering project manager at Google, discusses characteristics of successful teams. https://vimeo.com/183361239/ccb2af95ff

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. Helpful 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.