STEM DISCOVERY WORKSHOP

FACILITATION GUIDE

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IDAHO STEM ACTION CENTER

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STEM DISCOVERY WORKSHOP

INTRODUCTION

I. Introduction: STEM Discovery Workshop

Workshop Overview

The one-day STEM Discovery Workshop introduces a comprehensive framework for developing high-quality, hands-on STEM learning activities for students that support classroom, school and district learning goals. Designed for teams of educators at any grade level (K-12), the workshop provides opportunities for both individual skill-building and meaningful dialogue within the teaching staff. During the workshop, educator teams collaborate to develop a hands-on STEM learning activity they could implement in the classroom. This is accomplished through a gamified, multi-step process (the “Learning Design Process”) that uses Design Thinking to strike a balance between engaging learners, delivering required content and staying within the educator’s capacity. This workshop is primarily geared toward teachers and support staff who teach STEM-related content OR who teach a traditionally non-STEM subject but have an interest or expectation to integrate STEM in their classroom activities.

Objectives

In this one day STEM Discovery Workshop, participants will:

- Identify and understand key elements of an effective STEM learning experience
- Build skills in facilitating STEM learning activities and developing original STEM projects
- Explore pathways for integrating STEM within existing teaching goals, including within “non-STEM” disciplines
- Collaborate with colleagues to develop a hands-on, learner-centered STEM activity they can implement in the classroom
- Redefine their relationship with STEM

II. Key Elements of Learner Centered STEM

In Module A, participants are introduced to the following key elements of a valuable, learner-centered STEM learning experience. These elements are derived from commonalities between a variety of STEM and PBL frameworks, as well as the approaches used by model STEM programs in Idaho and across the country. We introduce these elements in the first module in order to set expectations for both the core STEM projects teams will develop during the workshop, and the kinds of STEM learning experiences we hope to see them offering to their students moving forward.

When introducing the Key Elements to workshop participants, the information below does not have to be repeated verbatim. Use these notes as a reference while explaining these concepts to participants in your own words.

*Invites Learners to Make Decisions and Solve Problems: Learners are encouraged to take an active role in their own learning process by considering a goal or challenge before them and making a decision about the best way to get there. Learners' abilities and comfort with this process develop over time, so it is up to the educator to set appropriate benchmarks that challenge the learner without overwhelming them.

*Interdisciplinary, By Design: Sometimes referred to as "Integrated STEM," this is the idea that STEM should not be treated as a separate subject, or set of subjects, but something that can be integrated across the curriculum through projects that are interdisciplinary from the outset. Projects in a "non-STEM" subject such as English can apply concepts, practices and skill sets derived from science, technology, engineering and math, or preferably, a combination of these fields. True interdisciplinary projects have a central problem or question that is fundamentally interdisciplinary and can be connected to grade-level content from multiple subjects; i.e. a project where high school students examine the molecular properties of plastics to contextualize the problem of plastic pollution; versus a chemistry lab where students are asked to perform basic arithmetic.

*Develops Learner Competency with Relevant Tools & Technology: Hands-on STEM projects are used as a vehicle to introduce learners to the tools and technologies they will encounter in their personal and working life, as well as build confidence with learning new things as the pace of new technology development continues to accelerate. Projects that utilize "low-tech" items, or tools that have been around for a long time (e.g. a drill, duct tape), can still build confidence and competency in technology provided their use in this context is relatively novel to learners and the learners are engaged in how the tool enhances the final product or acquisition of knowledge.

*Connects Content to Real-World Applications: A STEM project should help learners to to understand the real-life context that makes the given content relevant to learn in the first place. "Real-world" is often assumed to mean connected to a career in STEM, and while exposing

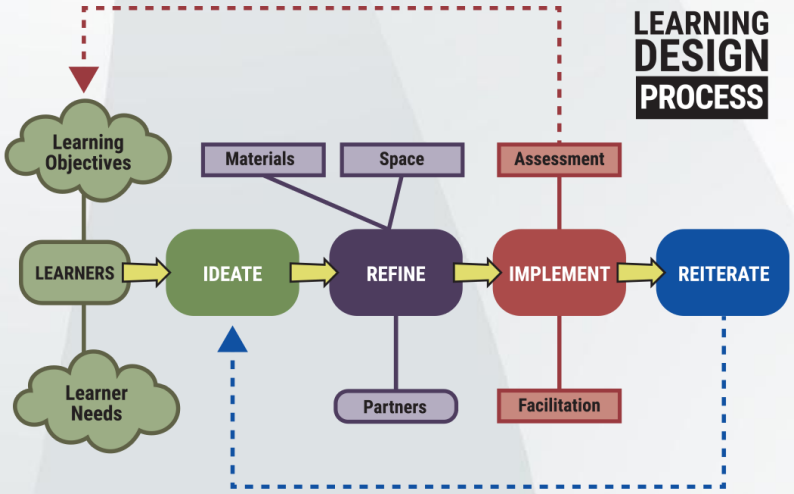
students to previously unknown career pathways in STEM is never a bad outcome, there is also great value to be derived from projects that don't specifically relate to the workforce at all, but engage with the critical questions of our time, or on a smaller scale, the everyday issues in the community or the lives of students themselves.

*Provides Opportunities for Learners to Communicate About Their Work: STEM projects are recognized for building skills in creativity, communication and collaboration, but only if learners are provided the opportunity to do so. Projects that require learners to solve problems with their peers, document their process over time, tell the story of their work or explain a concept using communication technology elevate the learning experience and more closely resemble the demands of the world outside the classroom.

III. Learning Design Process

What is the Learning Design Process?

The Learning Design Process or (LDP) is a framework for how to critically think through designing an engaging, hands-on learning experience for a given group of learners. The LDP as taught in this workshop involves working through four distinct phases, IDEATE, REFINE, IMPLEMENT & REITERATE, to develop a classroom-ready core project.



What is the Core Project?

The Core Project is a project curriculum that teams of participating teachers develop to use with their students. The project should incorporate several learning objectives and is intended to take place over multiple days or class periods. *See Section IV, p. 9 for an example.*

The core project should meet the following criteria:

- Original: Allows participants to present existing content in novel ways
- STEM-Focused: Incorporates the *Key Elements of Learner-Centered STEM* from Section II
- Feasible: Can be realistically implemented in participants' teaching environment

How are the Game Board & Card Deck used to teach the LDP?

The game board is a visual model that allows educators to track their progress through the phases of the LDP. Prompts on the game board guide participants in developing their core project at each phase.

The card deck is a set of 72 cards which also correspond to the four phases of the LDP. Within each phase, there are subsets of cards that support activities completed by participants during different workshop modules.

IDEATE PHASE CARDS (17)

The IDEATE phase answers the question: "How might we engage our learners in a hands-on project that meets specific learning goals?"

Subsets of cards:

- LEARNERS (4) - Used in **Module 2** to identify a target group of learners
- LEARNER NEEDS (4) - Used in **Module 2** as a reference for determining 4-6 learner needs
- SUBJECT (8) - Used in **Module 3** to identify initial content area(s) for the core project

REFINE PHASE CARDS (43)

The REFINE phase answers the question: "How might we refine our project idea to be feasible within our teaching/learning context?"

Subsets of cards:

- MATERIALS (33) - Used in **Module 5** to encourage creativity in the core project design given the constraint of limited resources
- PARTNER PITCH (9) - ***Two-day workshop only*** **-** Used to enhance learning outcomes & increase access to resources through the introduction of a community partner(s)

IMPLEMENT PHASE CARDS (6)

The IMPLEMENT phase answers the question: "How might we best support and measure learner progress while the project is taking place?"

Subset of cards:

- FACILITATION (5) - Used in **Module 6** to anticipate areas where learners may struggle during the core project and brainstorm responsive facilitation strategies

REITERATE PHASE CARDS (6)

The REITERATE phase answers the question: "How might we adjust our project plan to better serve the needs of both learner and educator?"

Subset of cards:

- POINT OF VIEW (5) - Used in **Module 7** to analyze the core project design from a variety of critical perspectives, and reiterate accordingly

IV. Core Project Example (For Facilitators)

Simple Machines Exploration & Design Challenge

Each module in the workshop is designed to support participants in developing their core project. To help participants see how these concepts play out from beginning to end, a consistent example is used throughout the workshop. The project is outlined below, along with developments that are introduced at each step.

Module 1: Making STEM Matter

Introductory content -- no direct applications for Core Project

Module 2: Learner Needs

Learner Group: Third Grade Students in Traditional Classroom Setting

Empathy Map - Data Points

- Said:
  - "So and so said my idea is stupid and won't work"
  - "I need help" - Often expressed vaguely, without specifying what the actual problem is or what kind of help is needed
  - "What are we supposed to do?"- after instructions have been given
- Did:
  - Students look out the window while I talk
  - Students begin to rock their chairs, fidget or get out of their seats if I present for more than a minute
  - Certain students aren't participating during group work
- Thought:
  - *This sucks* - Based on the sour look on students' faces after being told the scope of the project
  - *I already know what I'm going to do* - Based on students losing focus when given additional instructions/constraints on developing their idea
  - *My ideas don't matter* - Based on students checking out of the conversation upon receiving critical feedback
- Felt:
  - *Overwhelmed* - Based on students freezing when released to start working on the project
  - *Proud* - Based on excitement/enthusiasm to tell a teacher or volunteer about something they have made
  - *Embarrassed / Uncomfortable* - Based on tentative hand-raising, speaking quietly,

trailing off or freezing when called upon to answer a question aloud

Extrapolating Data Points From Learner Needs

Data Points:
1) Said: "So and so said my idea is stupid and won't work"
2) Felt: Embarrassed / Uncomfortable

Extrapolation >> Students expect or fear rejection of their ideas so they don't feel comfortable expressing themselves in front of their peers

Identified Learner Needs: Judgment-free environment; Positive Reinforcement

Data Points:
1) Said: "What are we supposed to do again?"
2) Did: Students look out the window while I talk
3) Did: Students begin to rock their chairs, fidget or get out of their seats if I present for more than a minute

Extrapolation >> Students don't retain information well during long periods of presenting with no activity

Identified Learner Need: Frequent change of activity

Data Points:
1) Said: "I need help"
2) Felt: Overwhelmed

Extrapolation >> Students lack skills in breaking down a problem into smaller, achievable steps. They may be more accustomed to having their learning micro-managed

Identified Learner Needs: Confidence Development; Independence Development

Module 3: Learning Objectives

Subject Selected: Science

Topic Ideas (for 3rd Grade Science):
- Weather
- Gravity
- Electromagnetic Fields
- Simple & Compound Machines

- Recycling

Learning Objectives:

- Content-Based: Students understand that a simple machine is a mechanical device that changes the magnitude or direction of a force, therefore making it easier to do work. (PS1-3-1)
- Content-Based: Students apply their knowledge of forces and motion to create mechanisms that move in a predictable fashion. (PS1-3-1 & 2)
- STEM-Based: Students work in teams to create a design and tell the story of their project. (Inspiration = Learning Dimensions → Social & Emotional Engagement → Working in teams, Documenting/Sharing ideas with others)
- STEM-Based: Students practice a process for how they can bring original ideas to life, from thought, to sketch, to model. (Inspiration = Framework for Maker-Centered Learning → Envision, Make and draw plans)

Sample Brainstormed Project Ideas:

- Simple machine scavenger hunt
- Construction site field trip
- Build simple machines
- Build bicycles for stuffed animal friends (compound machines)
- Build toys

In discussion, the example group takes elements from multiple ideas and decides to have students design and build models of playground equipment that integrate simple machines. Before completing the playground project, students will explore and build models of simple machines at stations around the room, building fluency with the same materials they will eventually use to create their playground models. The class will also take a "field trip" to their own playground to look for simple machines. Activities will be completed in small segments over a few days.

Module 4: Tower of Cups

Team Building break -- no direct applications for Core Project

Module 5: Materials & Further Brainstorming

At this stage, groups are beginning to further refine their idea in order to determine what materials they might need. The example group has decided that prior to beginning design work on their model playgrounds, students will first visit each of six stations to build machines in their simplest form. Afterward, the class will reflect on how these simple machines can be combined with each other or other elements to create something more complex, such as play equipment.

Materials Budget:

- All Free Materials: Pencils, Rulers, Markers, Scissors, Box Cutters, Paper
- Equipment (Wooden Blocks Set) = $2
- Cardboard = $1
- Yarn = $1
- Pipe Cleaners = $1
- Masking Tape = $1
- Straws = $1
- Construction Paper = $1

The example group is challenged to figure out how to provide adequate building materials to accurately represent simple machines and keep students engaged while staying within budget. The initial materials list is cut down by considering which materials perform similar functions and how materials can be used in novel ways.

For example, craft sticks are proposed, but eliminated because scrap cardboard can be cut into a similar shape that is just as stable. The group initially plans to have students create screws by rolling and shaping aluminum foil, then realizes that the cheaper pipe cleaners can be used instead -- plus they double as a colorful and versatile building material for the playground. A pencil inside a straw is used as an alternative to a plastic spool for creating pulleys and axles. The block set is selected as a foundational building material and the different shaped pieces can be used to model several different machine types.

Module 6: Facilitation

Struggle Example #1: The first group of students at each station may experience difficulty figuring out how to build the given machine out of the materials provided without an example. At the same time, students probably won't get much out of the experience if they simply copy an example or the work of a classmate who previously visited the station.

Opportunity: We won't give students a direct example made out of the consumables they are working with. Instead we will provide a real-life example of that machine that they can examine and touch (e.g. a stapler for the lever station). In addition to prevent students from simply copying other students' work, students will stay at their same tables, keeping their projects with them, while the objects get rotated.

Struggle Example #2: Students get overwhelmed and say they can't think of any ideas or don't know what playground equipment to build.

Opportunity: Start with a creative exercise -- give students the option to draw or write a description of the coolest playground ever. Approach students struggling with this exercise and ask them to share with you directly a favorite memory they have of a playground or what their favorite thing at the playground is and why.

Full Example Project Outline:

Part 1 - Opener (15 minutes): Students placed in small groups with two sets of simple machine flash cards -- images on one, definitions on the other -- and try to figure out as a group which go with which. Class discussion follows where the teacher formally introduces simple machine types and examples.

Part 2 - Tinker Stations (30 minutes): Students placed in six groups. Each group gets 5 minutes to explore each machine type. Every table has a set of consumables needed to build all six machines. Teacher places real-life examples of each machine at one of the tables. During the five minutes, students should look closely at the examples and attempt to build something that mimics its properties. When done building students will take a picture with the iPad, upload to Seesaw and label in the picture where they think the forces are when the machine performs work, as well as whether or not they think the force is a push or a pull. (We will have started studying forces before this.) This will be done in pairs. After five minutes is up, students pass machines to the next table.

Part 3 - Compound Machines & Scavenger Hunt (30 minutes): Teacher will introduce the concept of combining machines with each other or other things to change how work is performed. We will look at some example photos, videos then we will go outside and look to see what examples we can find of the simple machine types on our playground. Students will record/draw their findings on a worksheet.

Part 4 - Playground Design Project (Flexible): Students will work in small groups to build a 3D model of a playground that incorporates at least three different simple machines. Students will first write or draw their ideas on paper. They are encouraged to add color, themes or other decorative elements. They are also welcome (encouraged!) to invent entirely new forms of playground equipment they think would be cool. When they are finished, they have to give a live or video “tour” of their model, highlighting its best features and explaining how they used simple machines in its construction.

Module 7: Project Finalization

Reiteration Examples:

Learner Advocate Role: Notes that 5 minutes might not be enough time for students to process what they are building and be ready to move on the next thing. → Group decides to make station time 10 minutes long, with the caveat that if there isn’t enough class time, it’s ok if not every student gets to build every machine.

Curriculum Specialist: Proposes making the playground project longer to incorporate cross-curricular and social-emotional learning goals. Group decides to add an optional extension where students reiterate their playground design to be more accessible to children

with disabilities (and what extra opportunities simple machines might introduce). Students can practice research skills looking for examples of adaptations at other playgrounds and learn about the history of the Americans with Disabilities Act and what it means for their own school community.

V. Sample Agenda: One-Day STEM Discovery Workshop 8:00am - 3:30pm

8:00am - 8:30am	Registration, Breakfast & Opener Activities
8:30am - 9:30am	Module 1: Making STEM Matter
9:30am - 10:30am	Module 2: Learner Needs
10:30am - 10:40am	BREAK
10:40am - 12:00pm	Module 3: Learning Objectives
12:00pm - 12:30pm	LUNCH*
12:30pm - 12:50pm	Module 4: Tower of Cups
12:50pm - 1:20pm	Module 5: Materials & Further Brainstorming
1:20pm - 2:20pm	Module 6: Facilitation
2:20pm - 3:10pm	Module 7: Project Finalization
3:10pm - 3:30pm	Conclusions & Next Steps

*length of lunch to be mutually determined by Facilitator Team & Host Site

VI. Pre-Workshop / Registration Process

30 Minutes
Handouts O
Registration Packet - *See: List of Documents for Registration Packet, p. 18*

Fifteen to thirty minutes should be reserved at the beginning of the day for participants to register, grab breakfast, find their seats, connect with colleagues and complete an opener activity. Hosts can decide in conjunction with Facilitators when they want to advertise the start of the workshop versus open the doors for registration; however, you should make sure the advertised start time is at least 10 minutes before the start of the first module so that people who arrive "right on time" still have a chance to get settled and complete the opener.

Materials:

- Easel Paper (2 sheets total)
- Large permanent marker
- Masking Tape
- Dot Stickers (2 per participant)
- 4x6" Index Cards (2 per participant)
- Opener Activity Cards - Handout O (1 per table)
- Team Table Tents
- Registration Materials

Prep - Group Surveys:

Opener Activity #1 asks participants to respond to two group survey prompts. These prompts should be displayed on the wall using easel paper so that participants can post their responses and see where they fall in relation to their colleagues.

1. You will need 2 sheets of easel paper. At the top of each page, using a large marker or sharpie, write one of the following titles:
    - Comfort Implementing STEM in the Classroom: Where Do I Fall?
    - Confidence I Can "Figure It Out" When Faced With an Unfamiliar Problem: Where Do I Fall?
2. Use masking tape or a thick marker to make a vertical straight line down the center of each paper, beginning just below the title and continuing to ~an inch above the bottom of the page.
3. Make hash marks to the left of each line at the top, middle and bottom
4. On the "Comfort with STEM" spectrum, label:
    - Top: "STEM IS my comfort zone"
    - Middle: "Ok, but it doesn't come naturally"

    - Bottom: “Totally out of my comfort zone”
5. On the “Figure it out” spectrum, label:
    - Top: “That’s me, I’m the person who figures stuff out!”
    - Middle: “I can “figure it out” if I need to.”
    - Bottom: “I feel totally lost without directions”.
6. Place one sticker on each chart to represent what you think is the middle of the road for your colleagues at your own organization/school. (This helps remove the intimidation for participants of having to be first.)
7. Be mindful when hanging that someone shorter will still be able to reach the top

Set-Up - Registration Table:

- Registration Table should be pre-set with:
    - Participant name tags
    - Participant folders, sorted and labeled with table numbers, pre-filled with materials from Registration Packet
    - Participant sign-in sheet
    - STEM AC goodies
    - Host goodies (optional)
- Ideally, one facilitator and one representative from the host site should be seated at the registration table to greet people as they arrive and give instructions

Set-Up - Workshop Table:

- Place workshop table tents
- Place one set of laminated Opener Activity Cards (Handout O) at the center of each table
    - Opener #1: Where Do I Fall?
    - Opener #2: Assets & Needs
- Place 5 sets of (2) dot stickers on each table, or enough sets for each participant assigned to the table
- Place 5 index cards with “Need” printed/written on them at each table (one per participant)
- Place 5 index cards with “Asset” printed/written on them at each table (one per participant)
- Place a roll of masking tape and pair of scissors at center of each table (for Module A)

Registration Process:

1. Greet participant and ask their name
2. Mark off participant on sign-in sheet and identify table number & color
3. Give participant a folder that corresponds to table and verbally confirm table number and color

4. Explain that there are a couple of short activities for them to complete during breakfast. They will find instructions for these on their table.
5. State the time that content delivery will officially begin and explain they have until that time to get settled, grab breakfast, complete the activities and chat with colleagues. Note the location of breakfast.
6. Five minutes before the official start of instruction, a facilitator should circulate and remind participants to complete the opener activities if they haven't already.

If all participants are registered, settled and opener activities are completed, the facilitator may choose to start instruction early

List of Documents for Registration Packet

List of all documents to be included in Participant Folders passed out at registration

Host Sites and/or Facilitators may choose to include additional items if they wish

Site Agenda - *See the Fillable Agenda in Workshop Materials, p. 70*
Handout B - Core Project Example
Handout C - Learning Dimensions
Handout D - Agency by Design Framework
Handout E - Themes / Bugs
Handout F - Makey Makey Setup

STEM DISCOVERY WORKSHOP

MODULES

Module 1: Making STEM Matter

60 Minutes
Slides
Handouts A

In this introductory module, participants explore key elements of a quality, learner-centered STEM experience through a series of team and whole group exercises. We have found in facilitating these workshops over the years that most educators show up with a preexisting awareness of the benefits of STEM education and its connections to workforce development. What is less understood are the mechanisms through which STEM achieves those benefits, or the qualities that distinguish a STEM activity that is meaningful and learner-centered. This module sets the stage for the day by first inviting participants to introduce themselves and their needs and assets in relation to STEM education. Participants then practice adapting hypothetical classroom activities to deliver a better learning experience.

After this activity, participants should be able to:

- Recognize shared needs and assets for STEM education in their immediate professional community
- Understand the concept of Learner-Centered STEM
- Identify key elements that characterize Learner-Centered STEM Education
- Recognize opportunities to adapt existing activities to be more learner-centered

Materials:

- Need and Asset cards from Opener Activity
- Scissors (1 per table)
- Rolls of Masking Tape (1 per table)
- Measuring tape
- Easel Paper (2 sheets total)
- Marker
- Laminated Key Elements Scenario Cards - Handout A (1 per table)

Preparation:

- See prep for Pre-Workshop

Set-Up:

- Tape, scissors and index cards should already be on tables from start of workshop
- Label a piece of easel paper “What Makes a Valuable STEM Learning Experience?” and post it on a wall where it can be easily seen by participants and written on by a Facilitator. (Second piece of easel paper for backup)

Process:

Intro (10 minutes)

1. Host should officially kick off the workshop, welcome the group, and introduce the facilitators. They should also make any housekeeping announcements (bathroom locations, etc.) and, if they wish, say a few words about their intentions for the workshop.
2. Facilitators introduce themselves. [Note: Add your personal information to the Facilitator Bio slide.]
3. Present background information about the workshop:
    a. This project is the next iteration of a STEM AC project called the Rural Community STEM Engagement Project.
    b. This project was created to provide localized, community-focused professional development to educators in small rural communities across Idaho who typically find it difficult to travel to mainstream PD events or struggle to connect with the content.
    c. However, we realized in implementing this project that an intensive, community-focused approach where educators were able to learn, plan, and problem solve alongside their colleagues -- and really have the conversations they didn't normally get to have -- was something that could be valuable to educators everywhere, in communities big and small.
    d. The creators of the program adapted the approach and activities from the two-day Rural STEM workshop into a one-day STEM PD intensive that could meet the needs of schools and school teachers in this rapidly changing educational landscape.
    e. Feel free to add anything here about your own thoughts on the workshop and how the experience as a facilitator has led you to reflect on your own work as an educator -- words of encouragement, special things to focus on, etc.
4. Explain Workshop Objectives - *See Workshop Introduction in Section I, p. 4*
5. Briefly go over agenda for the day

Group Introductions & Team Building (20 minutes)

6. Go around the room. Each person states their name, role and then shares what they wrote down on their need and asset card (Need first, Asset second). Facilitators may occasionally give brief verbal feedback to show active listening, but in general this process should move quickly.
7. *Say:* Now that we've gotten to know a little more about each other, we're going to kick things off with a little STEM challenge. We are going to be using the same index cards where you wrote your Needs and Assets, so have those handy please. Clear a space in the center of your table.
8. Explain to teams that they will have 5 minutes to build a tower at the center of their table. Rules:

   a. Use only the index cards and the masking tape provided. You can use the scissors to cut but cannot incorporate them in your tower.
   b. Goal is to build the tallest tower possible
   c. You can manipulate or alter the index cards any way you like to make them optimal for building.
9. Set a timer for five minutes and circulate the room during building to clarify any questions teams may have. Call time when five minutes is up.
10. Measure the height of each tower and declare a "winner." (Option to have a prize here if there are give-away items available). As you measure, point out how different teams used the exact same materials in different ways.
11. Have teams clear their tables and dispose of unwanted materials.

Group Discussion: Key Elements of Learner-Centered STEM (15 minutes)

12. *Say:* For the remainder of this module, we're going to be thinking about this question of: What makes a truly valuable STEM learning experience? What are its key elements? So starting with this quick engineering challenge we did, what are some things that made that a valuable learning experience, and what more broadly do we think a STEM activity or project needs to have in order to be effective?
13. Take answers from the group for 2-3 minutes. Second facilitator should capture key concepts on the easel paper.
14. Transition into presenting the Key Elements of Learner-Centered STEM [*See Section II, p. 5*]
   a. *Say:* There are a lot of different research-based frameworks for STEM education, and we've put together a list of the key elements these frameworks tend to have in common. You'll notice a lot of similarities between this list and the items that we were just talking about.
   b. Define Learner-Centered STEM. This workshop focuses on using STEM as a vehicle for learner-centered experiences.
   c. Display Key Elements and explain that we will be working on designing a STEM project that incorporates all of these (to some degree)
15. You'll now walk the group through an example of how a traditional classroom activity can be improved by incorporating these elements.
   a. Display the Physical/Chemical Reactions scenario and read aloud. Ask the group if they can think of ways to improve the effectiveness of this activity, bearing in mind the Key Elements that were just discussed.
   b. After a couple minutes of discussion, display the reimagined scenario. Highlight items in the new version that explicitly relate to the Key Elements, as well as items that tie back to what participants suggested in discussion.

Team Exercise: Key Elements Scenario Cards (15 minutes)

16. Participants will now repeat this exercise in their teams with a new scenario. Distribute Scenario Cards to teams (Handout A). Each team receives the same scenario.

17. Allow discussion for 5-7 minutes depending on time, then go around the room and ask each team to share one or two ideas they had for improving the activity. Synthesize and provide your own feedback. Suggest the following if not introduced in conversation:
    a. Having students choose their own monuments/landmarks to research to allow for more self-directed learning (Make Decisions)
    b. Having students choose a historic event or person and design their own monument to honor that moment in history. Could be connected to how real monument designs are commissioned. (Make Decisions & Problem Solve, Real-World Connections)
    c. Participants may suggest the possibility of students using 3D modeling software to model monuments. While well-intentioned, it should be pointed out that students of this age (nor most adults) do not have the 3D modeling skills to model the majority of existing monuments beyond importing other people's work (which does not allow for much skillbuilding). This can then be used to introduce a discussion around what would be an appropriate 3D modeling project, such as students designing their own monuments or creating a 3D printed map depicting the locations of monuments using symbols. (Tools & Technology)
    d. Having students create a green-screen video in which they give a report about their monument in front of an image of their monument. This would be better as a pair or team project. (Tools & Technology, Opportunity to Communicate)
    e. Making intentional math connections by having students graph monuments by scale or age (do they notice any trends?), comparing their own height to the monument's, estimating how long it would take to get there by foot, bike, car, etc. (Interdisciplinary)
    f. Assign the entire class a particular event from recent history (past ~30 years) and invite them to pitch their prototypes to members of the community that have a personal connection to that event, then reiterate based on feedback. (Real World Connections, Problem Solve, Opportunity to Communicate)
18. *Say:* Our goal for you today is to apply this same standard to the STEM projects you'll be developing as a team. (Transition to the next module where this process is introduced.)

Facilitator Tips:

- If participants are having trouble responding to the group scenario, prompt them with questions about the key elements one at a time, i.e. "How could new tools or technology be incorporated into this project? Do you see any ways to introduce more opportunities for students to problem solve?" Etc. If more help is needed, tease an idea to get them started.
- You are encouraged to bring your own expertise with different tools and technologies into the analysis of the monument scenario and share your own ideas about how you might adapt this project beyond what is suggested here
- Be mindful that participants don't get the message that every classroom activity they do should be on par with the ideas being discussed. The intention of this module is to define something to strive for, while acknowledging that, especially at first, this might be

something that is fully realized for a few special projects each year. Over time, an educator can build up a repertoire of effective STEM projects

Resources for Facilitators:

The following resources provide helpful background on understanding and articulating the "Key Elements" of Learner-Centered STEM we've identified here. They are also useful resources to share with curious educators who are interested in delving further into these topics

- Agency by Design, The Framework for Maker-Centered Learning
- Makerspace for Education, The Mechanisms of a Makerspace (click on each of the links for Constructionism, Makerspace, Design Thinking and Media Literacy)
- Makerspace for Education, Seymour Papert's Big Ideas
- Exploratorium, Learning Dimensions of Making and Tinkering
- Battelle for Kids, Framework for 21st Century Learning
- youcubed, Mathematical Mindset Teaching Guide, Teaching Video and Additional Resources
- Science and Engineering Practices in the NGSS

Module 2: Learner Needs

60 Minutes
Slides
Handouts B

In this module, participants use evidence derived from observations to identify the latent learning needs of a chosen group of learners. Participants are first introduced to the Learning Design Process and the card game that will guide them in using this process to create their team's core project -- a STEM project incorporating the Key Elements discussed in the previous module. Teams will define a target learner group for their project and use an Empathy Mapping exercise to identify insights they can translate into specific learner needs. Finally, groups will reflect on how to design their project so as to best meet the identified needs.

After this activity, participants should be able to:

- Take observations of their learners in the learning environment and turn them into insights about those learners' needs
- Strategize around adapting a given activity to better meet learner needs
- Target 3-5 learner needs to address in their core project

Materials:

- LDP Game boards (1 per table)
- LDP Card Deck (1 per table)
- Empathy Map - (1 per table)
- Wet Erase Pens (2 per table) - to be used with Gameboard
- Core Project Example, For Participants - Handout B
- Optional - Tissues or Rag to erase mistakes

Preparation:

- Place a colored dot sticker on each card tuck case and game board to correspond with the team colors on table tents.This is used to speed up distribution of game materials in future modules.
- Ensure Empathy Maps & Game Board have been wiped down from any previous use.

Set-Up:

- Distribute to each table:
    - Card deck corresponding to their table's color
    - Game board corresponding to their table's color
    - 2 wet erase pens
- Retain Empathy maps and dry erase pens for later in the module

Process:

Intro to LDP and Game (10 minutes)

1. Introduce the Learning Design Process [*See Section III, p. 7*] and the four phases: Ideate, Refine, Implement and Reiterate
    a. *Say:* Our objective for this one-day workshop is to work as a team at your table to follow this process and create an engaging, hands-on, well-thought-out STEM project that you could actually go back to your classroom or learning space and use.
2. *Say:* For this workshop, we've created a few items to help guide you in this process, which are the deck of cards and game board you see before you.
3. Have participants unfold their game boards..
    a. *Say:* You should notice this looks very similar to the Learning Design Process we just presented. We'll be using this game board to track the development of our core project by filling out specific sections as we learn about them during the workshop.
    b. Note that the surface of the game board is writable. Participants should use wet erase markers with the game board (as opposed to dry) so it doesn't smudge.
4. Have participants open the deck of cards. Explain how the different colored cards correspond to the phases of the Learning Design Process: Green = IDEATE, Purple = REFINE, Red = IMPLEMENT, Blue = REITERATE.
    a. Note how the first card in each set is an informational card that includes an overarching prompt to guide thinking throughout that phase.
    b. *Say:* We're starting with the Ideate Phase, which asks us: "How might we engage our learners in a hands-on project that meets specific learning goals?"
    c. Explain that within the Ideate Phase, there are three subsets of cards -- labeled "Learners," "Learner Needs" and "Subject," respectively. Have groups grab the set of 4 Learner Cards and set the other cards aside.

Learner Selection (10 minutes)

5. *Say:* Our journey begins with our learners. As educators, it is often our students that drive us to be better teachers. When we follow the Learning Design Process we can see that prior to setting off with an amazing idea, we first need to consider who it is we're designing for (gesture to Learners bubble on slide) and let their needs (gesture to Needs bubble) and our objectives (Learning Objectives bubble) inform the type of project we create.
6. Explain to participants that they will now have a few minutes to discuss in their teams which of the four broad learner groups on the cards they would like to design their core project for. Participants should already be seated with other educators who serve

roughly the same age group as them. Once they have selected a broad Learner Group, they may choose to narrow their focus further, by selecting a specific grade level (e.g. 6th grade), or learning population (6th grade SPED).
    a. Encourage teams to define a learner group that will result in an applicable project for all participants at the table. (Remember that the goal is to create something they can actually implement in their classrooms later.)
7. Set a timer for 5 minutes and allow the groups to discuss. Circulate and provide support as necessary. Check in after 3 minutes. If everyone is done, you can move on; otherwise give a 2-minute warning and help stragglers come to a consensus
8. Direct teams to place their learner cards on the game board.
    a. *Say:* While you're all working on your own core project, we'll be working through the same process with an example up here. In this case, we've chosen 3rd grade students as our learners.

Group Activity: Empathy Map (15 minutes)

9. *Say:* Now that we've identified who our learners are, our next step is to contextualize them. We know that when 30 students walk into our classroom they are NOT nameless, faceless "3rd Grade Students," as in our example, but individuals, each with their own set of needs. As educators and learners ourselves, we can recognize that not everyone's needs are the same when it comes to having a successful outcome during a learning experience. Therefore, part of our job is to empathize with our learners with the goal of getting to know them on a deeper level and uncovering any latent needs that may prevent them from completing parts of the project. Once we identify these needs, we can find ways to address those needs when designing our core project.
10. Direct participants to follow along as you work through the Empathy Map quadrants with the example Learners (3rd grade students). Display examples on slides for each section. Participants may follow along with the Core Project Example in their folders. (Handout B)
    a. Quadrant - Say: Things we have heard learners say during a learning activity
    b. Quadrant - Do: Things we have observed learners do during a learning activity
11. *Say:* The next two quadrants can be slightly more challenging, as they ask us to read between the lines of what our learners say and do. We look for body language, tone of voice, engagement level and other cues to help us conjecture what our learners might be thinking or feeling. This is an important part of the process as it helps paint a fuller picture of who our learners are. But it also comes with the caveat of checking our assumptions. While assumptions can give us a helpful starting place, they can also mislead us, so it's important to ask ourselves periodically during this process if we are acting on an assumption, and if so, to be critical of it.
12. Give groups ~10 minutes to work together to complete the quadrants on their empathy map, based on their own experiences with the chosen group of learners.

Identify Learner Needs (15 minutes)

13. *Say:* For the next step in our process we're going to ask you to identify 3-5 specific needs of your learner group, based on the information in your empathy map. In other words, you should be able to point to evidence of each need you've identified among the data points on your map.
    a. Walk through the example of needs identification on the slides. For each example, present the data point(s), the insight that can be extrapolated from this data and the need that it suggests. (*Refer to the Core Project Example in Section IV, p. 9*)
14. Participants will now have 10 minutes in their groups to identify 3-5 needs for their chosen learners.
    a. Introduce the four green "Learner Needs" cards in the game deck and say that these are examples of needs they could use; however they are free to come up with their own.
    b. Acknowledge that there may be a lot more than 5 needs that are supported by the data. Advise groups to choose needs most strongly supported by data that could also be feasibly addressed within the context of their core project.

Reflection & Application (10 minutes)

15. Once groups have identified Learner Needs, spend the remaining part of the module discussing how one might respond to these needs in project design. Begin by presenting examples that correspond to the needs identified in the previous section:
    a. Judgment-free environment / Positive Reinforcement:
        i. Establishing a culture from day one that "no answer is a dumb answer."
        ii. Frequently visiting group work and encouraging participation from everyone, keying in on the silent group members and giving them "shine" for their ideas.
        iii. Providing a model/language for students to give feedback and build on an idea rather than rejecting it outright
    b. Frequent Change of activity:
        i. Understanding the attention span of your learners and splitting large projects into smaller bite-size pieces.
        ii. Changing the "types" of activities to allow for different students to shine throughout the course of the project.
    c. Independence & Confidence Development: I need to find the sweet spot in challenging my students to independently problem solve without totally floundering. I can find an age-appropriate model of the engineering design process and define an ask for each of the steps. The next time we do a project like this, I'll give them more freedom. I can also include a short art activity or game before we start this lesson, so that my students are already in a mindset where they are used to having more creative control.

16. If time, allow groups to discuss for a few minutes how they might incorporate the identified Learner Needs into project design.
    a. *Say*: These needs should be an ongoing consideration as you continue to develop your project idea.

Facilitator Tips:

- Different participant groups may be faster/slower at different tasks within this module. Keep an eye on time and feel free to push ahead during sections where teams work quickly to leave more time for sections where they may struggle.
- Push teams to have a well-populated empathy map (as opposed to doing the bare minimum) as this will make subsequent steps much easier
- If participants complete all parts of the process relatively quicker, any remaining time can be devoted to the reflection period at the end, when teams consider ways to incorporate the identified needs in activity design
- The Learner Group selected early in the module should be reflective of the reality in which participants engage with students; be mindful of groups attempting to choose a hyper-specific learner group that they are actually unable to target exclusively. For example, if a group wants to develop an activity targeting low-income teens, ask questions about where they would be implementing this activity and why they could confidently assert that low-income teens would be the primary audience. If they can't provide this context (for example, if they would be implementing this project in a classroom with a mixed-income demographic), a better approach may be to keep the learner group broad, but make sure the needs of low-income students within that population are acknowledged within the empathy map and needs identification process.
- Part of the challenge of meeting learner needs is figuring out how to meet disparate needs of learners within the same leaner group. Encourage groups to acknowledge differences as well as similarities among their learners using the empathy map. This may lead them to realize that a concrete "need" is scalability, adaptability, personalization, etc.

Resources for Facilitators:

- Idaho STEM AC, VIDEO - Principles of Learning Design 1.2: Learner Needs
- Interaction Design Foundation, "Empathy Map - Why and How to Use It" + free downloadable template

Module 3: Learning Objectives

90 Minutes
Slides
Handouts C & D

In this module, teams write learning objectives for their Core Project that are then used as a basis for brainstorming a particular project idea. The module begins by randomly selecting a STEM subject from the LDP Deck, then brainstorming potential topic areas. After deciding on a topic, teams are guided through a process of identifying both content-based Learning Objectives, which are specifically tied to curriculum, and STEM-based Learning Objectives, that seek to introduce additional benefits of STEM learning such as technical knowledge and 21st century skills.

After this activity, participants should be able to:

- Write an effective learning objective
- Distinguish between learning objectives that are tied to curriculum and those that serve tangential learning goals such as social-emotional and 21st century skill development (and recognize the value of each)
- Understand how learning objectives can be used to intentionally integrate STEM learning into content-driven activities
- Finalize 3-4 learning objectives for the Core Project

Materials:

- LDP Game boards (1 per table)
- LDP Card Deck (1 per table)
- Wet Erase Pens (2 per table) - to be used with Gameboard
- Core Project Example, For Participants - Handout B
- Post-it note Pads (1 per person)
- Current Idaho Content Standards for science, math & CS and/or host school's science & math curriculum -- at the discretion of the hosting school. Can be digital.
- Printed Learning Dimensions and Framework for Maker-Centered Learning Handouts - Handouts C & D (1 per person)

Preparation:

- N/A

Set-Up:

- LDP Game boards, deck & wet erase pens should be on tables from the last module
- Pass out one pad of post-it notes to each person. Preferably give a different color pad to each person at a given table.

Process:

Subject Selection (10 minutes)

1. *Say*: In this module, we're going to determine what our Core Projects are going to be about, and from there decide on more specific Learning Objectives that can guide us toward a hands-on, student-centered experience.
2. Give teams instructions to draw their Subject Cards:
    a. Find the 8 light green colored SUBJECT cards within the IDEATE deck
    b. Separate out the Science, Computer Science, Engineering and Computer Science cards.
    c. Shuffle these four cards. Have someone on the team draw one card at random.
    d. *Say*: This is the primary subject around which you will develop your Core Project. This is the element of chance in this game.
3. Option to select a secondary subject:
    a. *Say*: When we talk about STEM projects, we like to encourage interdisciplinary learning. So you are welcome to select a second subject for integration in your project today.
    b. For the secondary subject, teams may choose any of the 8 Subject cards, not just the 4 that were pre-separated.
    c. Reasons teams might want to select a second subject include:
        i. You pulled something that is not in your core curriculum, like Engineering, and you want to find a way to incorporate that in something you have to teach.
        ii. Several of your team members are experts in, or really enjoy another subject
        iii. You want to enhance your students' learning experiences by introducing concepts in an interdisciplinary context
        iv. You want to create something today that is applicable to as many of your teammates' classrooms as possible
    d. *Say*: I will give you 3 minutes to decide if you want to integrate another subject in your Project. If you're not sure right now, you can always bring in another subject later.
4. Have teams place their chosen Subject cards in the corresponding space on the game board and put the rest of the cards back in the box.

Topic Brainstorm & Selection (18 minutes)

5. Introduce the idea of the Brain Dump:
    a. 3-5 minutes of silent, individual brainstorming work to get all your ideas out on paper

   b. Write "good" ideas as well as those you're not so sure of -- we are dumping EVERYTHING to get to the good stuff
   c. You might spend the first minute or so just sitting there, thinking. This is normal.
   d. It's critical that this be an individual activity because it ensures that everyone gets a chance to put their ideas out there, instead of one person monopolizing. It's a good strategy to use with your students as well.
   e. Every idea, or piece of an idea or thought that you have, gets its own post-it note. This is so that the group can physically move and manipulate ideas later during discussion.
   f. After you write a post-it, stick it down on the table in front of you and move on to the next idea. Quantity > Quality
6. Start a timer for 5 minutes while participants brain dump. *Prompt:* What possible topics or combinations of topics within your chosen subject area(s) could you explore with a hands-on project?
7. Call time. Participants will now have 10 minutes to discuss ideas as a group and identify a topic and the beginnings of an activity idea.
   a. *Say*: To kick off this discussion, each person should read each one of their post-it notes out loud. As you do this, you can start to group similar ideas together, or set aside ideas the team isn't interested in pursuing further.
   b. *Say*: We're going to leave each of you with one pad of post-its so that you can add new ideas that come up. Second Facilitator should circulate and collect all but one pad of post-its from each table.
   c. The goal at the end of the 10 minutes is for each team to have identified a topic or topics that will be explored within the Core Project, not to figure out what the actual project will be. (Groups may start to discuss actual project ideas once a topic is identified, if time remains.)

Identify Content-Based Learning Objectives (20 minutes)

8. *Say:* Now that we have a topic identified, your team is going to spend some time figuring out - what are your school's learning goals associated with that topic? And this is going to form the basis for what we call "content-based" learning objectives. Before we do that though, let's briefly review what Learning Objectives are.
   a. Learning Objectives describe what a learner should know, understand or be able to do at the end of a given learning activity
   b. Learning Objectives should be:
      i. Outcomes-Focused: They describe the results of the activity, not what students will be doing during the activity.
      ii. Student-Centered: The student is the subject of the sentence, e.g. "Students can recognize Newton's second law at play in everyday situations."

iii. Specific: They describe a particular outcome for the student in relation to the subject matter.
iv. Measurable: You should be able to tell from a student's behavior or work that the objective has been achieved.

c. *Say*: As you can see on your game board, we want you to come up with 3-4 Learning Objectives for your Core Project. [Share slide with example Learning Objectives.] We want these to include 1-2 "content-based" learning objectives and 1-2 "STEM" learning objectives. These are not necessarily mutually exclusive ideas, but represent different ways of arriving at the objective.
   i. (What we mean when we say) Content-based = Tied directly to objectives embedded within the school curriculum and/or state standards
   ii. (What we mean when we say) STEM-based = Tap into the additional benefits associated with STEM learning, e.g. resilience, job readiness, 21st century skills, etc.

9. Distribute either copies of school-specific curriculum or up-to-date Idaho content standards for math/science.
   a. Whether standards or district curriculum is used is at the discretion of the hosting school
   b. Alternatively, links can be provided where participants can access these resources digitally.
10. Teams will now have 10-12 minutes to work on identifying 1 or 2 content-based objectives for the core project. Show how the example content-based objectives connect to 3rd grade physical science standards for Forces & Interactions.
    a. Teams that selected more than one subject should include a content-based objective for *each* subject.
    b. Teams may choose to use the objective as written in the reference document or tweak slightly to meet the context. In either case, it should meet the previously specified criteria for a Learning Objective.
11. Teams should record their finalized content-based Learning Objectives in the corresponding cloud on the Game board.

Identify STEM-Based Learning Objectives (22 minutes)

12. *Say*: For this next section, we're going to focus on the aspects of STEM learning that might not be explicitly part of the curriculum but are still very critical to 21st century education. But we're actually going to take this a step further and integrate those aspects into the Core Project, as Learning Objectives.
13. *Say:* To help you with this task, we are going to take a look at a couple of frameworks for what is known as "maker-centered learning." This is a learning style popularized in museums and libraries and makerspaces that focuses on hands-on, creative or engineering or design-oriented experiences that people have increasingly sought to bring into the classroom because of its potential benefits for STEM and 21st century learning.

And these frameworks are each an attempt to take that style and give it structure so that it can be used in a classroom setting.

14. Introduce the Learning Dimensions of Making and Tinkering. Direct participants' attention to the corresponding handout in their folders (Handout C).
    a. Developed through a partnership between the Tinkering Studio at the Exploratorium Museum in San Francisco and the Lighthouse Community Charter School in Oakland, CA
    b. Attempt to document how skills students were developing in maker programs during out-of-school time were making students stronger in the classroom
    c. Each Dimension is an area of potential growth for students and the items listed below are behaviors that indicate this growth
15. Introduce the second framework, the Agency by Design Framework for Maker-Centered Learning. Direct participants' attention to the corresponding handout in their folders (Handout D).
    a. Developed through a multi-year research project by the Harvard Graduate School of Education
    b. Focuses on how "to help young people and adults feel empowered to build and shape their worlds"
    c. Includes three "Maker Capacities" that students can develop and apply to objects, systems, structures, etc. Each Capacity has associated "Learning moves" that indicate students are developing this capacity.
16. Teams will now have 15 minutes to review both frameworks, and use them as a jumping-off point for creating 1-2 STEM-based learning objectives for the Core Project. During this time, teams should:
    a. Read through each Framework as a team
    b. Discuss how these Frameworks are similar to and different from the work that is traditionally done in the classroom setting
    c. Identify which of the Indicators (Learning Dimensions) or Learning Moves (Framework for Maker-Centered Learning) feel most important for their chosen group of learners
    d. Identify Indicators and/or Learning Moves that could be potentially integrated as a Learning Objective in the Core Project
17. *Say*: By the end of the 15 minutes, you should have 1 or 2 STEM-based Learning Objectives added to your game board. You can choose to base them off one framework, both frameworks or some combination. They don't have to match exactly; this is just a starting point.
    a. Show example STEM-based objectives and how they connect to the Indicators/Making Moves

Project Brainstorm and Work Time (20 minutes)

18. Bring the group back together.

19. *Say:* You will spend the remaining time in this module brainstorming a specific idea for your Core Project, that both meets the Learner Needs you articulated in the last model and the Learning Objectives you defined in this one. We will kick things off with another Brain Dump.
20. Remind participants of the instructions for Brain Dump.
21. Set a timer for 4 minutes. Tell participants that they can go right into discussing ideas as a group after time is called.
22. After 4 minutes, call time and allow teams to continue work on their project.
23. Two minutes prior to the end of the module, bring the group back together and ask them to record a summary of their idea in the green IDEATE box on the LDP game board.

Facilitator Tips:

- In the initial Topics brainstorming, participants may want to skip ahead to coming up with activities. Remind participants that even though it may feel strange, the purpose of the exercise is to start with what you want/need to teach first and then begin to explore how to teach that topic in a hands-on way.
- As participants work on crafting their Objectives, circulate and check in with each team to ensure their objectives meet the criteria and offer suggestions (if necessary) for how they could be made more outcomes-focused, student-centered, specific and/or measurable. This ensures groups are ready to move on when time is called.

Resources for Facilitators:

- Idaho STEM AC, VIDEO - Principles of Learning Design 1.4: Learning Objectives
- Agency by Design, The Framework for Maker-Centered Learning
- Exploratorium, Learning Dimensions of Making and Tinkering
- University of Waterloo Centre for Teaching Excellence, "Writing Intended Learning Outcomes"

Module 4: Tower of Cups

20 Minutes
Slides
No Handouts

In this team building activity, participants build a simple six-cup pyramid, but using an apparatus that requires them to move as one. Each team member has control of a 24" length of string, the end of which is tied to a single rubber band in the center. Participants move and stack the cups by collaboratively manipulating the rubber band with the strings. The cups are labeled to represent the different layers of a successful foundation for STEM learning -- individual, organization and greater community. The first team to successfully build their pyramid receives a selected STEM tool as a prize. Following the activity, facilitators guide the group in reflecting on the experience and, in particular, its implications for their collaboration on STEM activities moving forward. This activity is strategically scheduled immediately after lunch to help raise the energy level in the room before diving into afternoon activities.

After this activity, participants should be able to:

- Reflect on their own collaboration and problem solving skills
- Gain insight into their colleagues' communication styles and behavior under pressure
- Identify applicable strategies for implementing collaborative STEM projects at their school/organization
- Approach afternoon activities with a renewed energy and collaborative spirit

Materials:

- 50' ft. string or baker's twine
- Scissors
- 6 solo cups per table - 3 red, 2 blue, 1 yellow (can substitute other colors so long as there are three, divided as specified)
- Sharpies (1 per table)
- Rubber bands (1 per table)
- Large Sheet of Paper (1 per table)
- Team set of STEM tools as a prize:
    - The tool should match whatever is taught during Module 6: Facilitation

Preparation:

- Cut a 24" length of string for each participant
- Sort cups into sets of (3) red cups, (2) blue cups and (1) yellow cup each. Into each stack, place: a sharpie, rubber band, and enough string for each person at the table.

Set-Up:

- Have each team place a large sheet of paper at the center of their table
- Distribute a set of cups, rubber band, sharpie and string to each table
- Display prizes at the front of the room
- Be prepared to have someone take photographs during this activity

Process:

Intro (5 minutes)

1. As participants are cleaning up from lunch, ask them to clear their tables as much as possible, push in their chairs and make sure the area around them is generally free of clutter.
2. Explain they will be participating in a team building activity and the winning team will receive a prize.
3. Ask teams to separate their cups by color and verify they have 3, 2 and 1 of each.
4. *Say*: When we are working to create better STEM learning opportunities for our students, that work is really happening on three different levels. It starts with you, the individual, and what changes you can make in your classroom or learning space. To represent this, I would like you to take your sharpie and write the word 'Me' on the single yellow solo cup.
5. *Say*: However, we know that there's only so much we can do on our own. In order to take our STEM learning to the next level, we need our organization behind us -- our colleagues, our administrators, our support staff. To represent this, I would like you to label your two blue cups 'My School.'" (substitute "My District" or "My Organization" depending on the audience.)
6. *Say*: And finally, we know that when the organization is strong, it can be made much stronger by the support of the community -- our parents, our families, our industry partners and out-of-school organizations. Please take each of your red cups and label them "My Community."
7. Have teams arrange their cups around the edge of their large sheet of paper, right side up. Meanwhile, invite teams to construct their rubber band apparatus. Explain that they need to tie each piece of string onto the rubber band. Teams should make sure the strings are securely fastened and do their best to evenly distribute them around the rubber band. There should be one string tied for each person on the team.
8. Explain the Goal and Rules of the challenge. Before explaining, ask participants to please refrain from picking up their string or talking amongst themselves until the activity has started officially.
    - Your team has to build a pyramid of cups in the center of your table. The red cups will form the base of the pyramid; the blue will form the second layer; and the yellow will go on top.
    - Each member of your team should grab hold of the end of one of the pieces of string. Your team will move the cups by using the pieces of string to adjust the tension in the rubber band. Position the rubber band around the cup to pick it up.

- You must hold the piece of string at the very end. You may only hold the string with one hand. You must hold onto your string the entire time. (Switching hands if you're tired is fine.) If we see you holding the string with two hands or in the middle, we'll give you a warning. If we see it again, we'll put one of your cups on the floor as a penalty.
- At no point during the activity can you touch a cup with your hand, foot, mouth or any other part of your body. This includes preventing a cup from falling to the floor. If a cup does fall to the floor, work together to pick it up and get it back where it needs to be.
- No practicing or manipulation of cups before the game begins.

9. Gesture to the prizes on display and remind participants what they are competing for. First team to finish their pyramid wins. (The cups must be right side up and in correct color order)

Building (5-7 minutes)

10. Call Ready, Set, Go!
11. As teams build, circulate to make sure rules are followed, give warnings, and -- if necessary -- give a penalty by placing a cup on the floor.
12. Distribute prizes to the winning team. Remind recipients that prizes are intended to be used in the educational context, not taken home by the individual -- though they are certainly welcome to take it home to learn and practice with it! (If any team member does not see a meaningful use of the prize item in their learning space, they are welcome to donate it to another educator/organization present.) If time allows and participants remain enthusiastic, allow all teams the chance to finish if they wish.

Reflection (5-7 minutes)

13. Have a group discussion about the activity, using the prompts in the Slides. As the Facilitator, you should guide the discussion to elicit the most relevant and valuable insights. This may mean you skip or don't get to certain discussion prompts, or craft an entirely new question based on a behavior pattern you observed in the moment. In general, encourage participants to reflect on their own actions and feelings, rather than critiquing or casting blame on teammates.

Facilitator Tips:

- Make teams as even as possible. Past participants in this exercise generally report it is easier to maneuver the rubber band with five people than four; even though an additional "cook in the kitchen" may confer a slight disadvantage.
- Participants with limited mobility can be exempt from maneuvering a string and serve as an observer and coach for their teammates. During reflection, members of this team can be invited to share how having a designated coach impacted their team's performance,

despite a possible disadvantage of having less people to maneuver the rubber band. (Typically, teams who choose a leader have more success during this exercise.)

- If you need to make the exercise easier for the entire group (e.g. if the room is very crowded and difficult to move around or you have less time than you planned, etc.), you can have teams start with their cups already flipped upside-down.
- Variations of this game allow for people to pass strings between themselves in order to flip cups. The rules as stated here do not allow this as participants must keep their hand on their string the entire time. Participants will have to maneuver around each other instead.

Resources for Facilitators:

- Activity Example Video

Module 5: Materials & Further Brainstorming

30 Minutes
Slides
Handouts E

In this module, participants explore how material choices impact the learning that happens within a given activity or project. This module begins with a facilitator-led discussion of the factors influencing material choice, including age group, budget, storage capacity and the time and skill needed to maintain a particular tool. This is followed by a creative activity that encourages participants to think about how to use everyday materials—specifically the materials in the LDP card deck—in novel ways. Remaining time in the module is spent revisiting the material cards in relation to the core project, and beginning to identify items on which to spend the allotted $8 project budget.

After this activity, participants should be able to:

- Recognize that material selection and preparation is a key area within the Learning Design Process where Learner Needs should be applied
- In selecting materials for a project, balance educator objectives and needs of the learner with time, space and budgetary concerns
- Identify developmentally appropriate materials and/or equipment to use during the core project that enhance learning outcomes and encourage learner growth

Materials:

- LDP Game Boards (1 per table)
- LDP Card Deck (1 per table)
- Wet Erase Pens (2 per table)
- Core Project Example, For Participants - Handout B
- Scrap Paper (5+ sheets per table)
- Themes/Bugs sheet - Handout E

Preparation:

- none

Set-Up:

- Distribute to each table:
    - Card deck corresponding to their table's color
    - Game board corresponding to their table's color
    - 2 wet erase pens
    - Several sheets of scratch paper

Process:

Introduction to Material Choices (5 minutes)

1. Open the module with a brief discussion about choice of materials, and how this can impact the learning experience
    a. *Say*: Like our overall idea, material choices should be informed by both our identified Learner Needs and our Learning Objectives. In other words, we should be selecting materials that both meet our learners' needs, while enhancing our own objectives for the lesson or activity.
2. Highlight four key considerations. Invite additional comments from participants as time allows.
    a. **Presentation:** How are the given materials presented or introduced to learners?
        i. Example (Materials): If your Learning Objective is to build students abilities to develop and execute an original design:
            1. You might choose to set out a variety of consumable materials for students to choose from, rather than giving each learner a predetermined set of materials
        ii. Example (Tools/Equipment): Consider that the first time you introduce a new piece of equipment will shape how students treat it from then on. If introducing something sharp, have students gently touch the point or blade and feel how sharp it is. If using hot glue, designate an area and model how it should be picked up or set down.
    b. **Type:** What is the skill or developmental level needed to use the tools and materials provided?
        i. Example: Young children (PK-2nd grade), as well as older learners with fine motor challenges, need materials appropriate for learners with limited fine motor skills:
            1. Alligator clips instead of a soldering iron to make electrical connections
            2. Tape dispenser with a serrated edge built-in instead of duct tape that needs to be torn
    c. **Accessibility/Price:** Can you afford and successfully source the material at scale? If not, is there a work-around that actually enhances the learning experience?
        i. Example: Maybe your activity calls for squares of flat wood, but you can't afford the wood and you don't have access to a saw. So instead, you invite students to source a viable substitute -- cardboard from the school's recycling bin -- and cut it to size themselves, developing their resourcefulness and their skills with measurement tools.
    d. **Hi-Tech Equipment:** Expensive, large or hi-tech equipment carry their own special considerations, such as:

i. Accessibility: Where does the equipment physically live? How will you manage getting students access to the equipment to complete their project? Do you have enough for your students to work with?
ii. Knowledge / Skills / Maintenance: Who knows how to use or fix it? What procedures will you build into your project to reduce the likelihood of a student damaging the equipment?
iii. Process driven or product driven: Is the use of the equipment meeting a need/objective or is it merely a means to an end?
    1. Example: Students who are normally disengaged in math class are invited to explore the concept of volume by modeling and 3D printing measurement tools, meeting their needs for real-world applications and hands-on learning.

3. *Say*: When you start to think about materials for your core project, we'll want you to have these considerations in the back of your mind.

Group Activity: Materials, Themes & Bugs (10 minutes)

4. *Say*: We're going to do a quick creative brainstorming exercise.
5. Have each table pick TWO numbers between 1 and 25. Write it down. Second Facilitator should pass out one Themes/Bugs Sheet (Handout E) to each table.
    a. The numbers chosen indicate a row on the handout. The first number picked corresponds to the row of the "Theme" they must use, and the second number corresponds to the "Bug."
6. Have groups take out the purple Refine "Material" cards from the deck.
    a. Set aside the "Equipment" and "Any Item" cards, and shuffle the rest.
    b. Draw four Material cards and place them face up in the center of the table so everyone can see.
7. *Say*: Your job is to come up with a solution or idea that addresses your Bug, using your Materials, that relates to your Theme.
    a. Share example on Slides.
8. Individuals have 3 minutes to sketch their idea on scratch paper.
9. Participants then have 3 more minutes to share their ideas with others at their table.

Core Project Work Time (15 minutes)

10. *Say*: For the remainder of the time, your team will work on choosing Materials for your Core Project and further refining your project idea.
    a. These materials are things students need to complete the project, NOT items you would need to prep something for the project.
11. Explain Material choices from the Example Core Project. (*Refer to the Core Project Example in Section IV, p. 9*)
12. Explain the Constraints:

a. Budget: You have $8 to spend. If you choose to use the "Any Item" card, your facilitator will determine the value of the proposed material.
b. Knowledge: If you are interested in incorporating equipment that no one on your team knows how to use, you should research and/or consult with facilitators or others in the room to ensure your plan is realistic
c. OPTIONAL (if host site has a makerspace/STEM lab): You can use any one item from the makerspace or lab for FREE, but:
    i. You must justify how introducing this item enhances learning outcomes
    ii. You must use the item in an ORIGINAL way, rather than using existing curriculum or built-in activities

13. *Say*: As you discuss Materials, you will be developing a clearer picture of your project overall. You can use the Refine section on your game board, as well as any scratch paper, to jot down new details that you come up with.
14. Teams have remaining time in the module to work on their Core Project.
    a. Display slide summarizing four key considerations for choosing Materials.

Facilitator Tips:

- Time is short for this module so be mindful of extra chatter when doing the MBT activity as it can often elicit the giggles between tablemates. Solution: it's best to set a timer and alert the room to ensure you stay on task
- Set prices for "Any Item" materials according to the real-life values of those items; for example, googly eyes might be $1, whereas wooden dowels might be $2, and Velcro, $3.
- If conversation runs long during the Refining of teams core project idea, simply adjust time constraints in other modules.

Resources for Facilitators:

- Digital Promise version of Materials, Themes, Bugs

Module 6: Facilitation

60 Minutes
Slides
Handouts F

In this module, participants experience a Facilitated Learning approach while becoming familiar with a new STEM tool. Facilitators model language, behavior and overall activity structure that allows for learners to independently problem solve and make decisions in the learning process. Participants then consider how they might apply these concepts to their own Core Project. The module as written offers an introduction to the Makey Makey, which was chosen for its versatility and educational applications for ages 8 to adult. However, another STEM tool could be substituted (e.g. if working with an early elementary cohort), so long as the activity provides a similar opportunity for participants to experience productive struggle and reflect on how this could be translated in the classroom.

After this activity, participants should be able to:

- Understand the basic operation of the Makey Makey (or a comparable STEM tool) and identify opportunities to incorporate it in the classroom
- Recognize how Facilitated Learning strategies can enable student growth and deeper understanding of the learning content
- Anticipate places where learners might struggle within a given activity and empathize with those learners
- Brainstorm strategies to ensure the struggle remains productive and positive for the learner

Materials:

- Makey Makeys (1 per table + 1 additional for presenter) (use the Makey Makeys that were giveaways)
- Laptops or Chromebooks (1 per table)
- Laminated Makey Makey set-up instruction sheets - Handout F
- LDP Game Boards (1 per table)
- LDP Card Deck (1 per table)
- Wet Erase Pens (2 per table)
- Core Project Example, For Participants - Handout B
- Participant notebooks/scratch paper
- Sheet of Easel Paper or Whiteboard
- Play-Doh Tubs (5-6 total)
- Popsicle Sticks
- Stack of Plastic Cups (leftover from Tower of Cups)

- Pitcher of Water
- Jumbo Paper Clips
- Craft Foam Scraps
- Other miscellaneous craft supplies available on site (including both conductive and non-conductive materials)

Preparation:

- To save time during the activity, a laptop for each group should be plugged in, turned on, connected to Wifi and pre-opened to the Scratch Piano in a web browser. Double check that the volume on each laptop is turned up to an audible level. Laptops should be placed at each table, but in sleep mode so that participants can focus on the initial content being presented.
- The presentation laptop (the one hooked up to the projector) should also be prepped in this way. This is so the whole room can see and hear the piano being played when the volunteer is invited up for the demonstration. Make sure the podium is large enough, or introduce a secondary surface, so that a Makey Makey can be connected to the presentation laptop.

Set-Up:

- Distribute pre-set laptops (see above) and one Makey Makey (still in box) to each table
- Connect a Makey Makey to the presentation laptop at the front of the room and test to make sure it works with Scratch Piano. Do not connect the alligator clips to anything.
- Place craft supplies in bins or spread out on tables in a central location where participants will be able to access them during the activity
- Have teams consolidate LDP game board, deck and wet erase pens and place on table or nearby surface so they are out of the way

Process:

Introduction to Makey Makey (7 minutes)

1. *Say*: We are now moving into the next phase of the Learning Design Process, where we consider what our project will actually look like in practice, and more specifically how we will facilitate a successful learning experience for our students. We're going to be working through a sample activity, and use that as a tool for reflecting on effective facilitation.
2. Move into a brief (2-3 minute) discussion about circuits. Invite participants to share what they know about simple circuits. Capture insights on a sheet of easel paper or whiteboard. Direct the conversation to elicit the following insights:
    a. Within a circuit, electricity flows in a circle, from the positive terminal of the power source to the negative or "ground" terminal. We can add items to this circular path (like lights!) to make something useful happen.
    b. Electricity can only flow through certain materials (including people)

   c. If the circuit is broken, the electricity cannot flow
3. *Say:* We're going to be working with a device today called the Makey Makey which applies the concepts we just discussed.
4. Introduce the basic parts of the Makey Makey
   a. 1 motherboard, which acts as a input/output device between the real world and the computer
   b. 1 Usb cord to connect to the computer
   c. 7 Alligator clips to connect the motherboard with real life objects
5. *Say:* When the Makey Makey is connected to the computer, a simple circuit can be made by touching one of the ports on the motherboard with one hand and touching ground with the other. (In this case, our power source is the computer itself, as mediated by the motherboard.)
   a. Invite a volunteer to come up and play the piano on the presentation laptop by touching the alligator clips. (Note: show how they need to hold or touch ground while they play)
   b. *Say:* The other thing that is happening here, in addition to the circuit being completed, is that we are connected to a simple, block-based program called Scratch. And someone has written a program in Scratch to make piano sounds when the arrow keys and the space bar on the computer are pressed. When you're touching the Makey Makey, it is simulating the pressing of the keys and that's why we're able to make music with it.
6. Introduce the Exercise:
   a. *Say:* Makey Makey is described as an invention kit because it allows for everyday objects to be hooked up to the computer in creative ways. But you'll notice we don't have any objects connected in our set-up here. So your challenge as a group is to set up your Makey Makey and connect it to Scratch piano like this, but you then have to figure out how you can play the piano without touching the alligator clips or the motherboard directly.
   b. Point out the set-up instructions in their folders as a reference and the supply table they can use for their connected objects

Group Challenge: Connecting Everyday Objects (15 minutes)

7. Groups will now work together to connect objects to their Makey Makey. The goal is for them to discover on their own that only conductive objects will work with the device, as well as which of the provided materials are in fact conductive.
   a. Facilitators should monitor the activity of groups closely during this exercise.
8. If groups are struggling, facilitators can engage the group in a dialogue to help get them closer to to the answer (without directly instructing them), for example:
   a. *Groups are struggling with basic set-up.* Remind groups to check for mechanical as well as technical issues (sometimes something just isn't plugged in very well). You can also encourage participants to get up and take a look at the example set-up or another group's and compare it to their own.

   b. *Groups are set up but confused about the next step.* Try prompting → "You're trying to figure out what objects you can connect to the Makey Makey and still have it work. Why don't you grab some objects from the table and start experimenting?"
   c. *Groups have a conductive object connected but are forgetting to touch ground.* Try prompting → "Is your circuit complete?" "Try it without the item again. What changed?"
   d. *Groups have a conductive object connected but the connection is unreliable, e.g. the alligator clip is barely making contact with the object.* Try prompting them to compare that touchpoint to a connection that is working better.
9. Alternatively, groups may figure out the challenge very quickly. Here are some ways you can push them to go further. Note that even if all groups finish the initial challenge very quickly, the full allotted time should still be taken for this exercise as this will be a chance to model how new opportunities for learning can be spontaneously created through this type of instructional approach.
   a. Challenge them to make every single one of their touchpoints a different type of object. This may require them to branch out to objects on their own person or from around the room.
   b. Challenge them to make a "wearable" ground so that they can have their second hand free to play chords.
   c. Make a rule that one person has to hold ground while someone else plays the piano (allowing the discovery that the electrical pathway can flow through more than one person).
   d. Most Advanced: Show them how to click the Remix button in Scratch and see if they can figure out how to change their piano notes to animal sounds.

Discussion: Productive Struggle (8 minutes)

10. Bring the group back together for a discussion.
    a. *Say:* We intentionally set up this exercise to provide you all the opportunity to experience productive struggle -- times where you encountered an initial challenge or frustration, but were able to overcome it with support from the facilitator or your peers. Does anyone want to share a moment like that they experienced during this exercise?
11. After a couple examples are shared, next ask: "Did you notice us as facilitators doing anything to ensure those experiences of struggle stayed productive, as opposed to purely frustrating?"
12. Continue discussing for a few more minutes. The goal is to arrive at the understanding that the role of the facilitator in education is to allow students to experience a push-pull of struggle and success, with the goal of gradually raising the threshold of how much struggle they can tolerate -- while also bearing in mind that this threshold may look different every day and won't always advance in a linear fashion.

Core Project Work Time: Facilitation & Productive Struggle (30 minutes)

13. Explain that we will now apply this concept of productive struggle to the core project.
14. Have participants pull the six red IMPLEMENT cards from the game deck and set the other cards aside.
15. *Say:* At this point in the planning process, we are moving into thinking about what this activity is going to look like moment to moment as we facilitate it with students. For the next 25 minutes, your team will be working on developing an outline for your project. As you do so, you will also be using the prompts on the IMPLEMENT cards to identify possible areas of struggle for your students.
16. Walk through the example outline provided in the Slides, highlighting areas where the example team identifies an area of potential struggle and reframes it as an opportunity for richer learning.
    a. You may note in this section that the proposed solution to "Struggle Example #1" includes incorporating real-life examples of simple machines, which are technically additional materials. Now that participants have done the work of brainstorming under constraints, you may allow teams to bring in materials that they know they already have access to in their classrooms, *if* it can help improve learning outcomes.
17. Give teams remaining time in the module to a) work on a project outline, and b) identify 2-3 areas where students might struggle in their project. Teams should discuss how they might respond to those scenarios and adjust their project outline accordingly.
    a. Explain that teams can use the "Things to Say" and "Things to Do" cards in the Implement deck as a starting place for brainstorming responses. (These cards are examples only and not something the team has to use.)
    b. Teams should capture the highlights of their outline in the Implement box on the gameboard, and their struggle scenarios in the Facilitation box.
    c. As there is limited space on the actual game board, teams should be encouraged to take more detailed notes about the project outline on scratch paper or in a personal notebook, so they have this info for both the presentation and after the workshop is over.
18. Give teams a 5-minute warning and remind them to fill in the relevant sections of their game boards if they haven't already.

Facilitator Tips:

- If an alternative STEM tool is chosen, work with your co-facilitator to ensure the planned activity offers opportunities for productive struggle and reflection on the experience
- Facilitators should feel free to adjust the level of challenge for the initial exercise up or down to provide a productive learning experience for participants. The goal of the module is to demonstrate a teaching approach; specific content delivered about the Makey Makey is secondary and should be tailored to fit the experience of the educators in the room

- Ensure that sufficient time is left for participants to have at least 25 minutes of work time at the end of the module. This may mean groups do not get to “finish” their challenge. This emphasis on “process over product” is something you may discuss with participants as a strategy they can employ with their own STEM activities.
- Be open to feedback from participants that may come up in discussion about areas where you as the facilitator fell short at providing a productive struggle experience. This models how continuous self-reflection and adjustment, particularly when working with a new group of learners, is part of being a good facilitator.

Resources for Facilitators:

- Makey Makey “First Time Set Up!” Full Guide
- Sparkfun “What is a Circuit?”
- Trevor Mackenzie and Rebecca Bathurst-Hunt: Helpful Infographics on Inquiry-Based Learning
- Inquiry Through Provocación sample lesson structure
- Many of the Suggested Resources from Module A will also be helpful for this module

Module 7: Project Finalization

50 Minutes
Slides
No Handouts

In this module, participants will finalize their core projects, present them to the group and finish the workshop with a curriculum they can take back to their classrooms and use. A reiteration exercise at the beginning of the module invites participants to evaluate their project through a variety of different lenses, each focusing on a different aspect of the project's success. Teams are then invited to present their project outlines and receive feedback from the facilitators and their peers. Participants will also identify action steps they can take to bring the project to life in their classrooms going forward.

After this activity, participants should be able to:

- Examine project ideas through a variety of different lenses to maximize project success
- Draw inspiration from a range of high-quality, hands-on curriculum ideas developed and presented by their peers
- Incorporate peer and facilitator feedback to improve project ideas
- Identify at least one action step that will help them to implement their project in the classroom

Materials:

- LDP Game Boards (1 per table)
- LDP Card Deck (1 per table)
- Wet Erase Pens (2 per table)
- Core Project Example, For Participants - Handout B

Preparation:

- n/a

Set-Up:

- n/a

Process:

Group Activity: Reiterate the Core Project (15 min)

1. *Say:* Before you present your ideas to your peers today, we're going to do one last exercise to help identify some possible last-minute tweaks to improve your overall

project. We call this reiteration. In reality, this is a process we encourage you to go through several times, both before and after the first time you facilitate this in a classroom.

2. Have teams separate out the five blue REITERATE cards from the LDP Card Deck, and give the following instructions:
    a. Shuffle & randomly deal one card to each person at the table. Note: If there are only 4 people at the table, remove the Team Manager card.
    b. Silently read your card to yourself. This is the perspective or role you will be assuming in team discussion.
3. Set a timer for 10 minutes.
4. Prompt: Have a discussion with your teammates about your core project. Your job is to evaluate and propose adjustments to the project from the Point of View described on your card.
5. After 10 minutes bring the group back together. Invite them to shed their assigned perspectives and decide as a team which changes (if any) that came up in discussion they would like to incorporate in their final project idea. Give teams a few more minutes to write down these changes before transitioning into the presentation portion.

Group Presentation & Reflection (35 Minutes)

6. Give each group a few minutes to prepare their thoughts for a brief (<5 minutes) presentation on their core project that includes the following:
    a. Learners & Subject
    b. One sentence overview of Project
    c. Learner Needs that were intentionally incorporated in the project
    d. Content and STEM-based Learning Objectives
    e. ONE example of a material choice that was made to meet a Need or support an Objective
    f. Brief outline of project
    g. ONE example of a potential struggle and how it was reframed as a learning opportunity
    h. ONE example an insight from the reiteration discussion that was incorporated in the final project idea
7. Each team member should then share ONE action step they would personally need to take in order to take the core project from paper to the classroom.
8. After each group finishes, provide feedback as time allows, including one or two comments from peers. Possible questions to consider when giving feedback include:
    a. Does the project include the Key Elements of Learner-Centered STEM introduced in the first module?
    b. Is the project achievable? (i.e., do you have the staff, expertise, resources, etc. to complete the project)
    c. Does the project meet the learning objectives?

d. Are there possible extensions to the project that you see, or opportunities for crossover to another subject area?
e. Are the given action steps concrete and achievable?

Facilitator Tips:

- When describing the presentation assignment, emphasize that the goal is not to simply list everything off the game board but rather to focus on specific places where the process followed during the workshop resulted in key insights or ideas
- Take notes during each presentation with specific questions and feedback so that you are ready to provide that information as soon as the presentation ends. Some facilitator teams may find it helpful to divvy up feedback responsibilities, e.g. one person focuses on project content, while the other focuses on action steps.
- Opening up for peer feedback is contingent on the size of the group as well as the overall energy in the room. If there are a lot of teams, you may wish to limit peer comments to 1 or 2 per presentation. Air on the side of keeping things positive and keeping things moving.
- If there are 6+ teams, it is recommended that presentations are given back to back, without stopping for reflection. Take notes during each presentation and then present synthesized feedback to the entire group at the end, opening it up for group discussion as time allows.

Conclusions and Next Steps

20 Minutes
Slides
No Handouts

Participants complete a post-workshop survey, discuss follow-up resources and ask any last questions they may have.

Materials:

- Extra device or two for participants to complete online survey

Process:

1. Conclude the workshop by thanking participants and highlighting any insights you've learned about the group and their STEM journey. Suggest teams take photos of their game board and notes prior to cleaning up.
2. Participants complete workshop survey
3. TBD Resources, Follow-Up Meetings, Funding

STEM DISCOVERY WORKSHOP

HANDOUTS

Opener Activity #1: Where Do I Fall?

Grab a pair of dot stickers. Use each sticker to indicate where you fall on the spectrum:

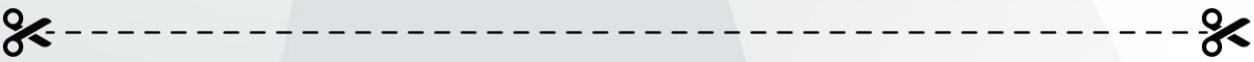
- Comfort implementing STEM in the classroom
- Confidence I can "figure it out" when faced with an unfamiliar problem

Opener Activity #2: Assets & Needs

A theme of this workshop is leveraging your organization's unique assets to meet your collective needs in STEM education. Take a moment to reflect on your individual strengths as an educator. What is one strength, or asset, that you have that might be valuable for creating new educational opportunities for your students? Write this down on one of the "Asset" index cards on your table. Next, consider the information, skills, resources or support you might not have access to yet. What is one concrete need you have in regards to STEM education? Write this down on a "Need" index card. Hold on to your "Asset" and "Need" cards -- we will share them during Introductions.

Scenario: For an end-of-the-year social studies project, a fifth grade teacher assigns each student a U.S. monument to research and present to the class. The teacher wants to incorporate STEM in the project so she has each student build a model of their monument using popsicle sticks and cardboard, then paint it to look like the real thing. The students showcase their completed model in their presentation to the class.

*How can this project be adapted to better incorporate the Key Elements of Learner-Centered STEM? Invites learners to make and solve problems * Interdisciplinary by design * Develops competency with relevant tools and technology * Connects to real-world applications * Provides opportunities for learners to communicate about their work*



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*How can this project be adapted to better incorporate the Key Elements of Learner-Centered STEM? Invites learners to make and solve problems * Interdisciplinary by design * Develops competency with relevant tools and technology * Connects to real-world applications * Provides opportunities for learners to communicate about their work*

LEARNING DESIGN PROCESS

STEM Discovery Workshop: Core Project Example

This handout outlines an example Core Project developed using the same process we will follow in the STEM Discovery workshop. Use this information as a reference as you work through the phases of developing your own team's project.

Module 2 - Learner Needs

Learner Group: Third Grade Students in Traditional Classroom Setting

Empathy Map - Data Points

- **Said:**
  - "So and so said my idea is stupid and won't work"
  - "I need help" - Often expressed vaguely, without specifying what the actual problem is or what kind of help is needed
  - "What are we supposed to do?"- after instructions have been given
- **Did:**
  - Students look out the window while I talk
  - Students begin to rock their chairs, fidget or get out of their seats if I present for more than a minute
  - Certain students aren't participating during group work
- **Thought:**
  - *This sucks* - Based on the sour look on students' faces after being told the scope of the project
  - *I already know what I'm going to do* - Based on students losing focus when given additional instructions/constraints on developing their idea
  - *My ideas don't matter* - Based on students checking out of the conversation upon receiving critical feedback
- **Felt:**
  - *Overwhelmed* - Based on students freezing when released to start working on the project
  - *Proud* - Based on excitement/enthusiasm to tell a teacher or volunteer about something they have made
  - *Embarrassed / Uncomfortable* - Based on tentative hand-raising, speaking quietly, trailing off or freezing when called upon to answer a question aloud

Data Points >> Learner Needs

Data Points:

1) Said: "So and so said my idea is stupid and won't work"
2) Felt: Embarrassed / Uncomfortable

Extrapolation >> Students expect or fear rejection of their ideas so they don't feel comfortable expressing themselves in front of their peers

Identified Learner Needs: Judgment-free environment; Positive Reinforcement

Data Points:

1) Said: "What are we supposed to do again?"
2) Did: Students look out the window while I talk
3) Did: Students begin to rock their chairs, fidget or get out of their seats if I present for more than a minute

Extrapolation >> Students don't retain information well during long periods of presenting with no activity

Identified Learner Need: Frequent change of activity

Data Points:

1) Said: "I need help"
2) Felt: Overwhelmed

Extrapolation >> Students lack skills in breaking down a task or problem into smaller, achievable steps. They may be more accustomed to having their learning micro-managed

Identified Learner Needs: Confidence Development; Independence Development

LEARNING DESIGN PROCESS

Module 3 - Learning Objectives

Subject Selected: Science

Topic Ideas (for 3rd Grade Science):

- Weather
- Gravity
- Electromagnetic Fields
- Simple & Compound Machines
- Recycling

Learning Objectives:

- Content-Based: Students understand that a simple machine is a mechanical device that changes the magnitude or direction of a force, therefore making it easier to do work. (*PS1-3-1*)
- Content-Based: Students apply their knowledge of forces and motion to create mechanisms that move in a predictable fashion. (*PS1-3-1 & 2*)
- STEM-Based: Students work in teams to create a design and tell the story of their project. (*Inspiration = Learning Dimensions → Social & Emotional Engagement → Working in teams, Documenting/Sharing ideas with others)*
- STEM-Based: Students practice a process for how they can bring original ideas to life, from thought, to sketch, to model. (*Inspiration = Framework for Maker-Centered Learning → Envision, Make and draw plans*)

Sample Brainstormed Project Ideas:

- Simple machine scavenger hunt
- Construction site field trip
- Build simple machines
- Build bicycles for stuffed animal friends (compound machines)
- Build toys

In discussion, the example group takes elements from multiple ideas and decides to have students design and build models of playground equipment that integrate simple machines. Before completing the playground project, students will explore and build models of simple machines at stations around the room, building fluency with the same materials they will eventually use to create their playground models. The class will also take a "field trip" to their own playground to look for simple machines. Activities will be completed in small segments over a few days.

LEARNING DESIGN PROCESS

Module 5 - Materials & Further Brainstorming

At this stage, groups are beginning to further refine their idea in order to determine what materials they might need. The example group has decided that prior to beginning design work on their model playgrounds, students will first visit each of six stations to build machines in their simplest form. Afterward, the class will reflect on how these simple machines can be combined with each other or other elements to create something more complex, such as play equipment.

Materials Budget:

- All Free Materials: Pencils, Rulers, Markers, Scissors, Box Cutters, Paper
- Equipment (Wooden Blocks Set) = $2
- Cardboard = $1
- Yarn = $1
- Pipe Cleaners = $1
- Masking Tape = $1
- Straws = $1
- Construction Paper = $1

The example group is challenged to figure out how to provide adequate building materials to accurately represent simple machines and keep students engaged while staying within budget. The initial materials list is cut down by considering which materials perform similar functions and how materials can be used in novel ways.

For example, craft sticks are proposed, but eliminated because scrap cardboard can be cut into a similar shape that is just as stable. The group initially plans to have students create screws by rolling and shaping aluminum foil, then realizes that the cheaper pipe cleaners can be used instead -- plus they double as a colorful and versatile building material for the playground. A pencil inside a straw is used as an alternative to a plastic spool for creating pulleys and axles. The block set is selected as a foundational building material and the different shaped pieces can be used to model several different machine types.

Module 6 - Facilitation

Struggle Example #1: The first group of students at each station may experience difficulty figuring out how to build the given machine out of the materials provided without an example. At the same time, students probably won't get much out of the experience if they simply copy an example *or* the work of a classmate who previously visited the station.

Opportunity: We won't give students a direct example made out of the consumables they are working with. Instead we will provide a real-life example of that machine that they can examine and touch (e.g. a stapler for the lever station). In addition to prevent students from simply copying other students' work, students will stay at their same tables, keeping their projects with them, while the *objects* get rotated.

Struggle Example #2: Students get overwhelmed and say they can't think of any ideas or don't know what playground equipment to build.

Opportunity: Start with a creative exercise -- give students the option to draw or write a description of the coolest playground ever. Approach students struggling with this exercise and ask them to share with you directly a favorite memory they have of a playground or what their favorite thing at the playground is and why.

Full Example Project Outline:

Part 1 - Opener (15 minutes): Students placed in small groups with two sets of simple machine flash cards -- images on one, definitions on the other -- and try to figure out as a group which go with which. Class discussion follows where the teacher formally introduces simple machine types and examples.

Part 2 - Tinker Stations (30 minutes): Students placed in six groups. Each group gets 5 minutes to explore each machine type. Every table has a set of consumables needed to build all six machines. Teacher places real-life examples of each machine at one of the tables. During the five minutes, students should look closely at the examples and attempt to build something that mimics its properties. When done building students will take a picture with the iPad, upload to Seesaw and label in the picture where they think the forces are when the machine performs work, as well as whether or not they think the force is a push or a pull. (We will have started studying forces before this.) This will be done in pairs. After five minutes is up, students pass machines to the next table.

Part 3 - Compound Machines & Scavenger Hunt (30 minutes): Teacher will introduce the concept of combining machines with each other or other things to change how work is performed. We will look at some example photos, videos then we will go outside and look to

see what examples we can find of the simple machine types on our playground. Students will record/draw their findings on a worksheet.

Part 4 - Playground Design Project (Flexible): Students will work in small groups to build a 3D model of a playground that incorporates at least three different simple machines. Students will first write or draw their ideas on paper. They are encouraged to add color, themes or other decorative elements. They are also welcome (encouraged!) to invent entirely new forms of playground equipment they think would be cool. When they are finished, they have to give a live or video "tour" of their model, highlighting its best features and explaining how they used simple machines in its construction.

LEARNING DESIGN PROCESS

Module 7 - Project Finalization

Reiteration Examples:

Learner Advocate Role: Notes that 5 minutes might not be enough time for students to process what they are building and be ready to move on the next thing. → Group decides to make station time 10 minutes long, with the caveat that if there isn't enough class time, it's ok if not every student gets to build every machine.

Curriculum Specialist: Proposes making the playground project longer to incorporate cross-curricular and social-emotional learning goals. Group decides to add an optional extension where students reiterate their playground design to be more accessible to children with disabilities (and what extra opportunities simple machines might introduce). Students can practice research skills looking for examples of adaptations at other playgrounds and learn about the history of the Americans with Disabilities Act and what it means for their own school community.

LEARNING DIMENSIONS
of Making and Tinkering

Valuable learning experiences can be gained through making and tinkering.

Use this framework to notice, support, document, and reflect on how your tinkering environment, activities, and facilitation may have supported or impeded such outcomes.

Initiative & Intentionality

- Actively participating
- Setting one's own goals
- Taking intellectual & creative risks
- Adjusting goals based on physical feedback and evidence

Problem Solving & Critical Thinking

- Troubleshooting through iterations
- Dissecting the problem components
- Seeking ideas, tools, and materials to solve the problem
- Developing work-arounds

Conceptual Understanding

- Making observations and asking questions
- Testing tentative ideas
- Constructing explanations
- Applying solutions to new problems

Creativity & Self-Expression

- Playfully exploring
- Responding aesthetically to materials and phenomena
- Connecting projects to personal interests and experiences
- Using materials in novel ways

Social & Emotional Engagement

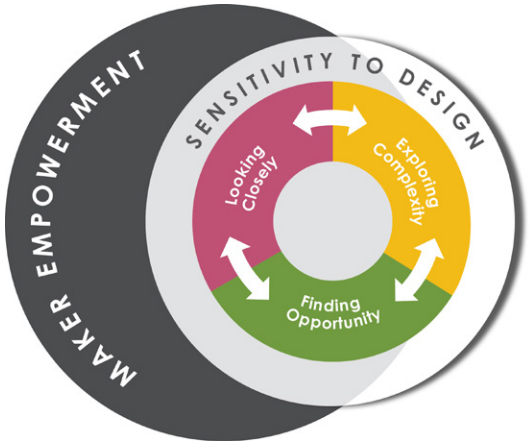
- Working in teams
- Teaching and helping one another
- Expressing pride and ownership
- Documenting / sharing ideas with others

exploratorium • the tinkering studio • RESEARCH + PRACTICE COLLABORATORY

The Agency *by* Design Framework

A key goal of maker-centered learning is to help young people and adults feel empowered to build and shape their worlds. Acquiring this sense of maker empowerment is strongly supported by learning to notice and engage with the designed dimension of one's physical and conceptual environment—in other words, by having a sensitivity to design.

Maker Empowerment:
A sensitivity to the designed dimension of objects and systems, along with the inclination and capacity to shape one's world through building, tinkering, re/designing, or hacking.



Sensitivity to Design:
Learning to notice and engage with one's physical and conceptual environment by looking closely and reflecting on the design of objects and systems, exploring the complexity of design, and finding opportunity to make objects and systems more effective, more efficient, more ethical, or more beautiful.

Sensitivity to design develops when young people and adults have opportunities to: look closely and reflect on the design of objects and systems, explore the complexity of design, and understand themselves as designers of their worlds. Accordingly, the Agency *by* Design framework describes three interrelated capacities that help learners develop a sensitivity to design: Looking Closely, Exploring Complexity, and Finding Opportunity. For each of these capacities, there is a set of observable "moves" — or indicators — that learners and educators can use to help design maker-centered learning experiences, and to support, observe, document, and assess maker-centered learning. They apply to individual as well as collaborative learning.

Making Moves

Learning moves that support a sensitivity to design

LOOKING CLOSELY: *Using any and all of the senses to examine objects and systems in order to notice their intricacies, nuances, and details. By looking closely, one may begin to see the complexities inherent in objects and systems.*

- *Notice everything*—Cast a wide net to capture all that you can observe.
- *Revisit*—Look/listen/touch again, and see if you can find something new.
- *Use categories*—Look for different kinds of features or components.
- *Juxtapose*—Look at things side by side; compare, observe relationships.
- *Physically change perspectives*—Look from high, low, far away, close up.

EXPLORING COMPLEXITY: *Investigating the interactions between the various parts and people associated with objects and systems, including the range of values, motivations, and priorities held by the individuals who engage with particular objects and systems.*

- *Explore inner workings*—Explore how things, ideas and systems work—what are their parts and interactions?
- *Explore points of view*—Consider and take different perspectives: What different ways can you look at this?
- *Probe your own perspective*—Examine your own assumptions and beliefs.
- *Look back and forward*—Explore the histories and possible futures: How did this come to be? Where might it be going?
- *Tinker to explore*—Take things apart, put things together, play around with how things work.

FINDING OPPORTUNITY: *Building on close observations and explorations of complexity to see the potential for building, tinkering, re/designing, or hacking objects and systems.*

- *Envision*—Imagine what could be invented, or how things could be changed.
- *Reframe*—Rethink, refocus, or re-define a problem, opportunity, or procedure; hack or repurpose how things work.
- *Source resources*—Be proactive and creative about finding information, advice, and instruction.
- *Prototype and test*—Make models and run tests; try things out to see what works.
- *Make (and draw) plans*—Identify steps; sketch what things could look like and how they could work; illustrate ideas & processes.

#	THEMES	BUGS
1	Vehicles of the Future	Getting cut off while driving
2	Extreme Sports	Bad restaurant food
3	Holiday Disasters	Stinky socks
4	Elementary School Playground	Dog poop on the sidewalk
5	Monsters	Leaving lint in the lint catcher
6	Magical Creatures	Stuck in traffic
7	Farm Animals	Potholes
8	Habitats	Forgetting your password
9	Outer Space	Snoring
10	Summer Fun	When frames on the wall are crooked
11	Hide and Seek	Drawers that are left open
12	Dance Party	Adapters that take up more than one
13	Family Camping Trip	Rabbits eating vegetables in your
14	Candy Village	Car door won't stay open on its own
15	The Coolest Library Ever	Forgetting your keys
16	Superhero	Windows won't latch
17	Jewelry	Dust on ceiling fan
18	Flower	Running toilets
19	A New Invention	Losing the back of your earring
20	Childhood Toy	Bothersome perfume/cologne smell
21	Theme Park	Gum under desk
22	Food	Always running late
23	Kindness	Loud distracting noise
24	Ocean	Students clicking pens
25	Zoo	No toilet paper

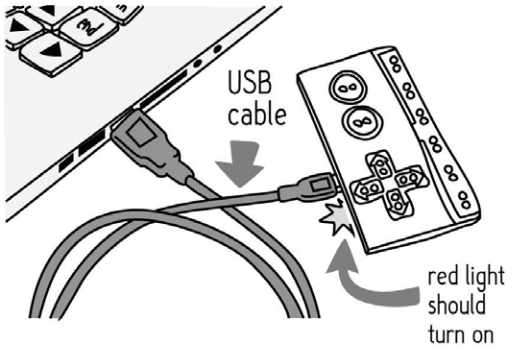
Getting Started with

more info at makeymakey.com

Makey Makey® & SCRATCH

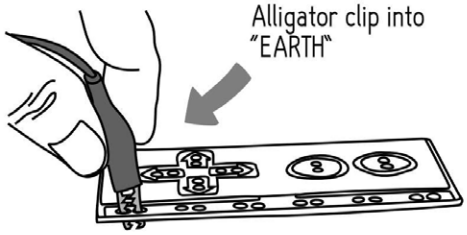
Part II: Setting up MaKey MaKey

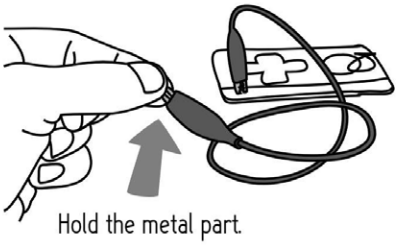
1. Plug board into computer

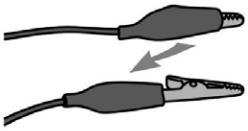


2. Close any pop-ups

3. Connect yourself to EARTH

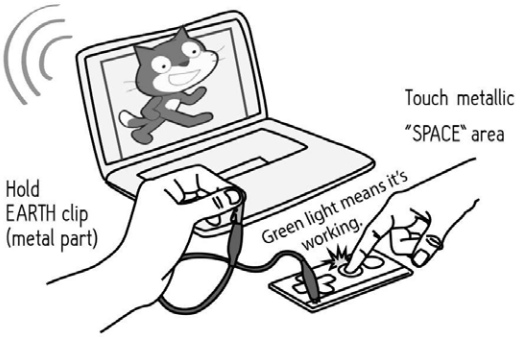






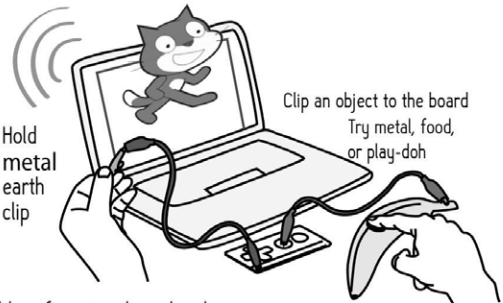
(Tip: Removing cover makes clip easier to hold)

4. Try it with Scratch



Your computer should think "space bar" was pressed. If not, try pressing more firmly or licking your finger.

5. Connect everyday objects



Add craft materials and make a musical instrument out of anything!

Touch object to complete a circuit

STEM DISCOVERY WORKSHOP

WORKSHOP MATERIALS

LEARNING DESIGN PROCESS

One-Day STEM Discovery Workshop

Registration, Breakfast & Opener Activities

Module 1: Making STEM Matter

Module 2: Learner Needs

BREAK

Module 3: Learning Objectives

LUNCH*

Module 4: Tower of Cups

Module 5: Materials & Further Brainstorming

Module 6: Facilitation

Module 7: Project Finalization

Conclusions & Next Steps

Length of lunch to be mutually determined by Facilitator Team & Host Site

IDAHO STEM ACTION CENTER

FOLD

TEAM

IDAHO STEM ACTION CENTER

STEM DISCOVERY

Explore • Discover • Imagine • Engage

FOLD

TEAM

IDAHO STEM ACTION CENTER

STEM DISCOVERY

Explore • Discover • Imagine • Engage

FOLD

TAPE

CUT

FOLD

TAPE

Use Avery Label 8163 to print out name tags for facilitators and participants.

Use Avery Label 8163 to print out name tags for facilitators and participants.