STEAM

Toolkit and User Guide

21ST CCLC NTAC
National Technical Assistance Center

For out-of-school time and summer learning programs

Contents

STEAM Toolkit User Guide

The STEAM Toolkit consists of this user guide and the 26 tools described and included herein. The tools were developed for 21st Century Community Learning Centers (21st CCLC) programs, but any out-of-school time (OST) program can use them.

How to Access the Tools

The tools are available on the 21st CCLC National Technical Assistance Center (NTAC) website in the STEAM Toolkit, which you can download as a zip file. The zip file includes (1) a PDF version of the user guide and toolkit and (2) a Microsoft Word version of each tool for easy customization.

What's In This Guide

- The full set of tools and ways to use them
- Tips and strategies for using the STEAM approach to support learning and learning recovery in OST programs

Ways to Use the Tools

To support professional development:

- Read the tools to increase your understanding of a topic or strategy.
- Note ideas you'd like to put into practice or learn more about.
- Use the tools during staff training sessions as discussion starters or in small-group activities such as think-pair-share.

To help your program implement or improve a practice:

- Use the tools to assess and reflect on what you already know and do — and what you need to know and do — to implement or improve a practice.
- Use them during a planning or strategy session to inform decisions about how to adjust current practices or implement new ones.
- Share bite-size ideas from the tools in emails, text messages, or staff meetings to help program staff implement a new strategy or practice.
- Customize the tools to include information, examples, or guidance specific to your program.

To engage and inspire stakeholders:

- Share a tool (or ideas from a tool) with school-day staff, community leaders, partners, volunteers, families, or students to help them understand a program initiative or to inspire them to get involved.
- Share excerpts or ideas in your newsletter and in emails, social media posts, and other communications with stakeholders.

Get Resources for Your Out-of-School Time Program

Check the 21st CCLC NTAC website for professional learning opportunities and resources on this and other topics. To stay updated as new content is added:

❑ Subscribe to our newsletter. ❑ Follow us on social media.

How to Customize a Tool

You may customize the Microsoft Word version of any tool to meet your needs.

Tips for customizing tools:

- If you plan to print multiple copies for distribution, you may print the tool in black and white to avoid the cost of color printing.
- If you delete or replace any of the text or graphics, you may need to adjust the formatting or page breaks.
- If you add or revise content, please replace the text box at the end with the following statement:

  Note: Parts of this document are based on information in the STEAM Toolkit, a resource developed by the Nita M. Lowey 21st Century Community Learning Centers (21st CCLC) National Technical Assistance Center (NTAC). The toolkit is in the public domain and is available at 21stcclcntac.org.

Keep reading to learn why and how to make STEAM part of your out-of-school time program. Go to page 6 to see the tool titles and descriptions.

STEAM and Its Importance to Student Success

STEAM is an approach to learning that uses science, technology, engineering, the arts, and mathematics as access points for guiding student inquiry, dialogue, and critical thinking. STEAM projects and activities may include some or all of the five STEAM disciplines.

“Scientific thinking and understanding are essential for ***all people*** navigating the world, not just for scientists and other science, technology, engineering, and mathematics (STEM) professionals. They enable people to address complex challenges in local communities and at a global scale, more readily access economic opportunity, and rein in life-threatening problems such as those wrought by a global pandemic. In this way, knowledge of science and the practice of scientific thinking are essential components of a fully functioning democracy. Science is also crucial for the future STEM workforce and the pursuit of living wage jobs” (National Academies of Sciences, Engineering, and Medicine, 2021, p. 7). Also, there’s a growing recognition that the arts can play an important role in career preparation. For example, an article in the *Journal of Microbiology & Biology Education* (Segarro et al., 2018) describes how the arts can be used to train well-rounded, creative scientists. Creativity is an important part of problem solving.

STEAM = STEM + the Arts

Adding the arts in a meaningful way (for example, inviting students to create a video, mural, or infographic to share the results of a citizen science project) helps students develop 21st century skills like creativity and communication. Connecting analytic and creative thinking is essential to solving problems. It’s also a powerful way to engage students who might otherwise see science, technology, engineering, and math as “boring” or “not for them.”

Four Characteristics of STEAM

Creative	Interdisciplinary	Experiential	Inquiry Based
Tackles a real-world challenge or creates something that has value or meaning.	Includes content and skills from more than one field of knowledge.	Provides opportunities for active exploration (for example, through a makerspace).	Includes questioning, observation, experimentation, problem solving, and reflection.

Tips for Out-of-School Time Programs

The National Research Council (2015) identified three desirable characteristics of productive OST programs. They should:

- Engage young people **intellectually, emotionally, and socially**.
- Respond to young people's **interests, experiences, and cultural practices**.
- **Connect STEM learning** in out-of-school, school, home, and other settings.

The authors of a national study of afterschool STEM programming (Allen et al., 2019) recommend, based on their research, that OST programs:

- Provide opportunities for **hands-on activities** that promote active engagement.
- Provide **role models** to encourage identity and belonging.
- **Allow youth to make decisions** around the steps in an activity.
- Encourage **thoughtful questions** and **demonstrate relevance of learning** to everyday life.

To facilitate academic and social learning, motivation, and engagement across academic areas, Denise Huang and colleagues (2010) recommend that programs make learning fun and:

- Offer **diverse activities**.
- Connect to **real-world** and **relevant** examples.
- Incorporate **field trips, student performances, and exhibitions**.

The following insights about developing high-quality programs in the STEAM disciplines come from the Afterschool Training Toolkit (a product of the National Center for Quality Afterschool) and the U.S. Department of Education's STEM Initiatives.

Science

- Investigate science through inquiry.
- Explore science through projects and problems.
- Integrate science with other subject areas.
- Engage families and communities in science.
- Tutor to enhance science skills.

Why STEAM in 21st CCLC Programs?

"Because OST programs serve significant populations of young people who are underrepresented in STEM, they may be able to reduce the opportunity gap for these youth and help to enhance youth learning and engagement." *Clark et al., Afterschool Matters Spring 2021*

Technology

- Facilitate learning, communication, creativity, and self-expression.
- Promote student-centered activities where the students become involved in determining the course of their own learning.
- Motivate and engage students in real-world activities that are authentic and relevant.
- Promote opportunities for communication and collaboration in project-based and inquiry-based activities.
- Support activities that promote problem-solving and higher-order thinking skills.
- Support different learning preferences.
- Be safe, operational, and accessible to all.

Engineering

- Provide creative, hands-on experiences that invite students to learn about the design process by exploring materials, thereby harnessing children's love of play.
- Connect students with local scientists and engineers who can help them understand what engineers do and how their work affects people's lives. Virtually or in person, they can demonstrate real-world engineering and design principles, answer questions, and talk about careers that involve engineering.
- Use readily available resources like the Exploratorium's engineering and making and tinkering activity ideas, NASA's engineering design challenges for middle school students, and the National Science Foundation resource collection.

The Arts

Consider these questions as you think about ways to integrate the arts:

- Who are our students? What are they like? What are they interested in?
- What do we want to accomplish?
- What resources and materials do we need?
- What resources do we have in our community?
- How can we collaborate or partner with local organizations to teach the arts?
- How can we develop academic skills while addressing art-based goals?
- How can we ensure students' safety in arts activities?
- What kinds of short- or long-term outcomes do we want?
- How will we measure those outcomes?
- How do we provide for professional development to enhance teaching in the arts?

Mathematics

- Encourage problem solving.
- Develop and support "math talk."
- Emphasize working together.

> See the 21st CCLC NTAC **Math Toolkit** for additional information, tools, and resources on math and math anxiety.

General Strategies

The U.S. Department of Education's guide to supporting learning acceleration suggests the following strategies for providing high-quality OST learning experiences to support students' social, emotional, and academic needs. These strategies are especially helpful for supporting learning recovery for students who've fallen behind and aren't meeting grade-level standards:

- **Align OST programs academically** with the school curriculum so OST educators can build on material and skills students are already learning.
- **Adapt instruction to individual and small group needs.** OST groups of more than 20 students per staff member are shown to be less effective.
- **Provide high-quality, engaging learning experiences** that provide academic support and access to enrichment activities that develop students' social and emotional well-being and leadership skills.
- **Target student recruitment and retention efforts** to ensure that students with the most need for additional support have adequate opportunity to participate in OST programs.
- **Assess program performance** regularly, using disaggregated results to improve or adjust the program as needed.
- **Partner with community-based organizations and local intermediary organizations** to increase access to high-quality OST opportunities. Partnerships create opportunities for community engagement and may provide additional enrichment opportunities for students. Partnerships also expand the opportunity for students to interact with organization staff who may be more racially, culturally, and linguistically diverse.
- **Support students with disabilities** by providing services that can help accelerate learning. Students' Individualized Education Programs (IEPs) and Section 504 plans can provide OST program staff with helpful information about meeting individual student needs.

Learning Recovery: Acceleration vs. Remediation

Learning acceleration is a learning recovery strategy to get students on grade level by providing just-in-time foundational support connected to the grade-level content they're learning. Research cited by the U.S. Department of Education shows that learning acceleration is an important strategy for advancing equity and that students who experienced acceleration struggled less and learned more than students who started at the same point but experienced **remediation** (repeating lessons or practicing skills they didn't master during previous grades) instead.

Want to Know More About Learning Recovery?

The 21st CCLC **NTAC Learning Recovery Toolkit** includes a **Learning Recovery Research and Practice Brief** that contains additional information about learning recovery and a bibliography with links to research and resources.

Tool Titles and Descriptions

The STEAM Toolkit includes the following tools. Use this annotated list to identify the tools you need.

- The list is organized into three categories: (1) Learn, (2) Plan and Implement, and (3) Assess and Reflect.
- Each tool described below is included in this document.
- If you want to use or distribute a tool "as is," you may print the pages for that tool.
- If you want to customize a tool, visit the 21st CCLC NTAC website and download the STEAM Toolkit zip file, which includes a Microsoft Word version of each tool.

Learn

Learning Recovery Tip Sheet — This tip sheet provides strategies OST programs can use to support learning recovery for students who aren't meeting grade-level standards in math, science, or other content areas.

Next Generation Science Standards at a Glance — This tool will help educators address important concepts and skills in science education across three dimensions: science and engineering practices, crosscutting concepts, and disciplinary core ideas.

STEAM at a Glance — This quick reference sheet includes a diagram and key terms and concepts about the STEAM approach to learning and teaching.

Plan and Implement

Activity Center Planner — This tool includes considerations and ideas for K-12 activity centers, plus a planning template and an observation checklist.

Creating a Scientist's Notebook — Use this tool to create a format for students to collect data and make observations during a science project.

Design Thinking Framework: Project Planning Template — Use this tool to plan how you'll guide students through the design thinking process during project work.

Design Thinking Task Tracker for Students — Students use this planning template to keep track of steps during the design thinking process.

Everyday STEAM Strategies — Use this tool to choose strategies that fit your schedule, time, resources, and students as you integrate STEAM learning into program activities.

Four Characteristics of STEAM: Planning Worksheet — Use this worksheet to plan a STEAM project or activity that's creative, interdisciplinary, experiential, and inquiry based.

Guiding Questions for Project-Based Learning — This tool provides question stems that promote student thinking at all six levels of Bloom's Taxonomy: remember, understand, apply, analyze, evaluate, and create.

Informal Assessments of Student Learning — Use this tool's strategies to informally assess student learning during science (and other) activities.

Integrating Project-Based Learning Into Program Activities — This overview of project-based learning strategies helps with brainstorming ways to implement this hands-on approach into program activities.

Investigating Issues in Your Community — This checklist can help students identify ways to research and investigate community issues, challenges, and needs as they embark on a STEAM, civic learning, citizen science, service-learning, or entrepreneurial project.

Makerspace Checklist for Home and Virtual Learning — Use this checklist to plan and implement virtual and home-based project activities that are engaging and effective.

Science and Mathematics Vocabulary Builder — Use this checklist of key terms and guiding questions to help your staff build students' science and math vocabulary during various program activities, including homework time.

Science Interest Survey: All Grades — Select the age-appropriate survey version to gather student voice data about areas of science students want to explore.

Selecting Student Roles for Group Work — Use this graphic organizer during projects that include group work to help you decide on group number, size, and composition — and whether to assign student groups and roles or let them choose.

STEAM Activity Example — This example activity combines all five STEAM disciplines and uses the design thinking process to address a real-world problem.

STEAM Careers: Myth Busting — Use these questions and insights to get students and staff talking about STEAM careers so you can bust myths and break down barriers that could hold students back.

Student Portfolio Planning and Review Checklist — Use these ideas to plan for incorporating portfolios into an activity or project, and for providing feedback to students.

The Five Whys Questioning Technique — Use this tool as a worksheet to document the process and conclusions of the Five Whys questioning technique.

Assess and Reflect

Project Assessment and Reflection: Planning Worksheet — Program staff (and students) can use this worksheet to decide what tools to use (e.g., rubrics, surveys, journals) to assess and reflect on learning during project work.

Science Skills Rubric — This rubric provides a ready-to-use example and a customizable template to effectively measure students' ability to make observations, plan and execute investigations, and collect and analyze data.

Scientific Inquiry Skills Checklist — This checklist describes scientific inquiry skills, offers tips on integrating them into activities, and provides individual student and class checklists to measure skill mastery.

STEAM Approach: Staff Self-Check — Use this self-check to gauge staff's individual and collective knowledge and strengths in using the STEAM approach. Findings can inform professional development.

Student Self-Monitoring Checklist for Project Work — Students can identify areas of personal strength and areas for growth as they reflect on thoughts, feelings, and behaviors before, during, and after project work.

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Activity Center Planner

What to do: Use the planning considerations, activity center ideas, and checklist in this tool to help you plan interesting, age-appropriate activity centers in your out-of-school time program.

Why it matters: Activity centers are a quick and comfortable way to ease staff and students into learning opportunities. Well-planned activity centers engage students in hands-on, independent exploration, collaborative experiences, and learning targeted to specific objectives.

Planning Considerations

Space: A "center" can be as simple as a table or area where students can work on activities they choose by selecting from shoeboxes filled with activity-specific materials.

Materials: The materials needed will vary by activity. Start with free or low-cost materials that are easily available. As you add centers, you may decide to purchase some materials and ask businesses, organizations, and community members to donate materials as needed.

Time: Decide when centers will be available. On certain days, or daily at set times? During homework time for those who finish early or need a break?

Student engagement: Students can help develop ideas, organize materials, and manage centers.

Purpose, objectives, and expectations: Specify learning objectives in the planning stage. Make the purpose, objectives, and expectations clear. Include rules and procedures about behavior, safety, and clean-up.

Variety: Build a repertoire of activities for students to choose from. Experiment with making several different activities available at the same time.

Assessment: Watch centers in use. Note whether children are engaged, distracted, or bored. Talk to students to gauge outcomes. Discuss findings with staff, and revise activity centers as needed.

Activity Center Ideas for Various Grade Levels

Time: Calendars to customize, daily and weekly schedules with dates and times, clocks and watches to play with and take apart, appointment books (K-3)

Money: Penny jar, pennies, play money, menus, catalogs, store items (K-3); balancing a checkbook and budgeting (Grade 5 and up)

Measuring: Measuring cups, measuring spoons, containers of different sizes, scale, sand, pebbles, liquids to measure (K-3); designing a garden or room (Grade 4 and up)

Sorting: Buttons or beads in a variety of colors, sizes, and shapes for sorting, estimating, and counting (K-2)

Building, construction: Blocks, Legos, paper cups, cardboard, straws, and twist-ties to construct two- and three-dimensional shapes (K-4); straws, tape, scissors, papers, graph paper, and paint with instructions for completing different challenges (Grades 3-6); plywood, wood scraps, tools, and electronics equipment (Grade 6 and up)

Puzzles: Various types of two- and three-dimensional puzzles, with increasing complexity (K-12)

Shapes: Posters with shapes, crayons, pencils, construction paper, graph paper, different sizes of triangles, squares, rectangles, and circles; two- and three-dimensional shapes and objects to trace, draw, cut out, and play with (K-3)

Patterns and rhythms: Rhythm instruments to beat out patterns, paper for students to write beat patterns in symbols for others to follow (e.g., a = short tap, b = long tap) (Grades 2-4)

Experiments and building kits: Use downloaded instructions and gather materials for experiments and make them available regularly. Include kits for things like building sun dials, paper airplanes, and boats, and mixing paint colors (Grades 2-6)

Activity Center Planner

Description/theme of center ______________________________

Focus areas (check all that apply)

____ Science ____ Technology ____ Engineering ____ the Arts ____ Mathematics

____ Other (specify): ______________________________

Learning objectives/purpose ______________________________

____

Number of users at one time ____

Primarily for ___ Individual work ___ Pairs ___ Small groups ___ Any

Instructions ___ Clearly written

___ Needs verbal explanation or demonstration

___ Users can explain to each other

Availability ___ Always ___ Days/times ______________________

___ Homework ___ By request

Supervision ___ None, general only ___ Periodic check

___ Demonstrations and explanations needed

___ Active supervision required

Extensions and support

_____ Additional resources _____ Expertise _____ Specialized support

Supplies needed

Instruction sheet ____

Materials, tools, equipment ____

____

Activity Center Observation Checklist

Use this checklist to record observations and suggestions.

_____ The center is actively used by all or most students

_____ Most students can follow the written activity instructions

_____ Students seem to enjoy the activities offered

_____ Objectives are being met

_____ Materials or supplies need to be updated or replenished

- For the center in general? Specify: ____
- For certain activities? Specify: ____

_____ Positive outcomes are achieved

_____ Possible improvements (Specify: ____)

_____ Possible changes or extensions (Specify: ___________________________________)

Additional ideas or comments:

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Creating a Scientist's Notebook

What to do: Select a format (e.g., spiral notebook, composition book, lined paper, digital file) for students to use when recording their questions, observations, findings, and ideas during a science project. Consider the prompts suggested in the grid below or write your own to encourage young scientists to wonder and reflect. If you like, use the blank template at the end of this tool to create a grid for students to use.

Why it matters: Scientists record data and observations to help them analyze and reflect on what they see during a scientific exploration. The skill of gathering and organizing information is useful in many areas of work and life.

Tip: Reviewing students' notebooks is a wonderful way to do an informal assessment!

Before the Project

Name/Topic of Project: NASA GLOBE Observer Clouds
What question is the project trying to answer or explore? How do clouds affect Earth's atmosphere?
How will you help try to answer the question? I'll go outside and look at clouds. I'll look at how much of the sky is covered by clouds, the shape of the clouds, and the color of the sky. I'll talk about my observations with others in my group, and we'll report our data to the scientists who lead this citizen science project.
Background research notes: • Clouds are made of tiny water drops or ice crystals. They form from water in the sky. • Clouds are important for many reasons. They make shade to keep us cool during the day. They reflect heat at night to make the ground warmer. They make rain and snow. • There are different kinds of clouds. Cirrus clouds look thin and wispy. Cumulus clouds are big and fluffy. Stratus clouds look like sheets that cover the sky. • Scientists categorize clouds by locations and shape. Clouds can be high in the sky, low, or in the middle. • We practiced using the cloud cover estimation tool from a website. It showed us pictures of clouds in the sky and we had to estimate what percentage of the sky was covered. It doesn't have to be exact because the project uses ranges, like 25-50 percent, but you want to try to get close. It was a little tricky at first, but Ms. Johnson helped us. It's kind of like when we learned about fractions. You imagine the entire picture is the whole and then you have to figure out what part of the whole the clouds are. Like if the picture of the sky is half covered by clouds, that's 1/2, or 50 percent. By the end, I got really good at it!

During the Project

Data collection/observation notes:

- 07/24/2023: I went outside with my class at 11:15 this morning. The sky was really blue. We saw a lot of cumulus clouds. They look kind of like cotton balls. We reported that the sky was 40 percent covered by clouds. Ms. Johnson took pictures on her phone and sent them on the app.
- 07/25/2023: We went back outside after lunch. It was 12:30. It's another hot summer day. The sky was blue and we saw cumulus clouds covering 30 percent of the sky.
- 07/26/2023: It was raining today, so we didn't go outside. But we did look out the windows to see if we could see any clouds. The sky looked totally grey. Ms. Johnson said they were probably nimbostratus clouds. I guess I have more kinds of clouds to learn about! Since we couldn't go outside, we looked at some pictures online instead.
- 07/27/2023: The rain is gone! We could go outside again today. The sky was blue and I saw big, fluffy cumulus clouds. After observing for a while, we decided they were covering about 45 percent of the sky because it seemed like a little less than half.
- 07/28/2023: It's Friday and we got to go outside again! I love summer camp. I saw cirrus clouds when we went out this morning. Cirrus clouds look cool because they're wispy and kind of curly. We estimated that they were covering 20 percent of the sky.

After the Project

What did you like about the topic/project?

I really liked getting to go outside and look at clouds. It was fun when we got to lie down in the grass and look up at the sky. Sometimes the clouds looked like things, like one time I thought a cloud looked like a dog. I liked getting to have class discussions to decide what type of clouds they were and how much of the sky they covered. It's also cool that we helped scientists by putting our data in the app.

What did you find challenging about the topic/project?

I didn't always know what type of clouds they were. I guess there are a lot of kinds. At first, I thought there were just cumulus, stratus, and cirrus, but then Ms. Johnson taught us about other kinds, like nimbostratus.

Describe one thing you learned.

Clouds are important. I never really thought about them much before, but now I know that they are important to our planet because they make rain and snow, make shade that helps keep us cool when it's hot like it is now in summer, and reflect heat to make the ground warmer at night. I also learned that there are lots of different kinds of clouds and it's important to observe the shape and location to tell what kind they are.

What questions do you still have about the project/topic?

- What are all the types of clouds and what do they do?
- How are clouds made?
- Why are clouds white?
- How much do clouds weigh? How do they stay in the sky instead of falling?

Before the Project

Name/Topic of Project:
What question is the project trying to answer?
How will you help try to answer the question?
Background research notes:

During the Project

Data collection/observation notes:

After the Project

What did you like about the topic/project?
What did you find challenging about the topic/project?
Describe one thing you learned.
What questions do you still have about the project/topic?

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Design Thinking Framework: Project Planning Template

What to do: Use the information on the first two pages and the template on the third page to plan how you'll guide students through the design thinking process during project work.

Why it matters: The design thinking process helps students develops problem-solving skills and creativity. Careful planning and facilitation ensures that you don't miss important steps or go off track.

Design Thinking Action Steps

Step	Facilitator Actions	Student Actions
Empathize Research users' needs.	• Introduce the topic and help students connect it to personal experiences. • Explain "market research" as the first step in design thinking. • Give students access to data collection tools and processes.	• Identify one or more problems or issues related to the topic. • Research the problem or issue by doing online, in-person, and library research. • Research users' needs by reviewing available information and collecting data on users' needs.
Define State users' needs.	• Ask open-ended questions. • Guide students to use the "five whys" technique to identify the root cause of the problem. • Provide feedback as students develop a clear needs statement.	• Analyze and synthesize information collected in the Empathize step. • Use the "five whys" questioning technique to identify the root cause of the problem. • Write a clear needs statement. • Make sure the needs statement is based on data, not on assumptions or biases.
Ideate Brainstorm possible solutions.	• Guide students as they analyze and synthesize the information they collected on users' needs. • Guide students through solutions to the root problem	• Use the root problem and needs statement developed in the Define step to brainstorm possible solutions. • Conduct additional research if needed.
Prototype Create solutions.	• Provide initial feedback on feasibility of prototype(s). • Provide materials. • Monitor progress, ask guiding questions, and provide support.	• Identify which solution you'll develop. • Draw and design the prototype. • Determine and collect needed materials. • Build the prototype.

Step	Facilitator Actions	Student Actions
Test, Refine, Repeat Try out solutions.	• Help set testing parameters and safety measures. • Monitor testing, ask guiding questions, and provide support. • Guide students to continue refining their solution if testing reveals a design flaw. • Provide feedback and encouragement.	• Describe the testing parameters and safety measures. • Outline the steps for testing. • Decide on the measures of success. • Determine the data to be collected. • Run tests. • Record observations and results. • Collaborate to decide if refinements are needed and, if so, what to try next.

The greatest sign of success for a teacher is to be able to say "The children are now working as if I did not exist."

— Maria Montessori

Design Thinking Action Steps

Step	Facilitator Actions	Student Actions
Empathize Research users' needs.		
Define State users' needs.		
Ideate Brainstorm possible solutions.		
Prototype Create solutions.		
Test, Refine, Repeat Try out solutions.		

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Design Thinking Task Tracker for Students

What to do: Use this form to track progress on project tasks during the design thinking process.

Why it matters: Using tools like this can help you plan and complete tasks on time.

Name: ______________________ **Project:** ______________________

Step	Tasks	Due Date	Date Completed
Empathize Research users' needs.	•		
	•		
	•		
	•		
Define State users' needs.	•		
	•		
	•		
	•		
Ideate Brainstorm possible solutions.	•		
	•		
	•		
	•		
Prototype Create solutions.	•		
	•		
	•		
	•		

Step	Tasks	Due Date	Date Completed
Test, Refine, Repeat Try out solutions.	•		
	•		
	•		
	•		

To invent, you need a good imagination and a pile of junk.

— Thomas Edison

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Everyday STEAM Strategies

What to do: Use the rating scale in the last three columns of this table to identify which strategies fit your available time, effort, and resources. Then use your choices to increase STEAM opportunities for students.

Why it matters: The hands-on and creative aspects of STEAM appeal to students, and STEAM learning teaches problem-solving and critical thinking, fosters curiosity, and guides students toward innovation. Gradually increasing the intensity of activities will help to build staff skills and maintain student engagement.

	Readily Doable	Somewhat Complex	Challenging
Increase STEAM Exposure Through Everyday Activities			
Provide simple materials like blocks, boxes, measuring spoons, cups, graph paper, construction paper, scissors, shapes, and puzzles.			
Set up activity centers for explorations with varied materials or structured activity kits.			
Use STEAM vocabulary regularly.			
Ask questions to probe for explanations and reasons.			
Talk to school-day teachers about STEAM activities and content.			
Provide measuring materials like scales, rulers, tape measures, and thermometers, along with activity ideas and instructions.			
Provide materials like clocks, calendars, maps, charts, graphs, and word games related to weather, times, and seasons.			
Provide construction materials like straws, toothpicks, sticks, tape measures, paper, tape, glue, and string, and create challenges for building and making.			
Schedule regular guessing games and mental puzzles.			
Create a “snack committee” to calculate quantities and create nutrition reports, taste surveys, budgets, and so on.			
Create a program of field trips to outdoor sites.			
Create a program of guest presenters on STEAM-related jobs.			
Schedule visits to libraries, museums, and science centers.			
Make copies of textbooks and reading materials available.			

	Readily Doable	Somewhat Complex	Challenging
Supplement library and computer use with STEAM-related books, magazines, and websites.			
Other:			
Connect STEAM With School-Day Content			
Contact school-day teachers in subject areas like science, math, technology, and the arts.			
Get copies of standards or school goals for STEAM content.			
Work with staff to pinpoint standards to target in the program.			
Review program activities and projects for ways to include STEAM objectives based on state or district academic standards.			
Provide school-day teachers with evidence of students' STEAM activities in your out-of-school time program.			
Ask teachers to recommend websites, projects, materials, and resources.			
Include program staff in STEAM professional development provided by schools.			
Get lists of key vocabulary words, concepts, and questions to incorporate.			
Target oral vocabulary development for all, with particular attention to English learners.			
Obtain curriculum, textbooks, and other reading and reference materials used in schools.			
Let school-day teachers know that STEAM homework projects can be supported in your program.			
Attend school-sponsored STEAM events, such as science fairs, and invite school-day teachers to your STEAM presentations and events.			
Observe what children are working on for STEAM homework, look for opportunities to discuss STEAM ideas with students, and ask for explanations and thoughts.			
Other:			

Ways to Build STEAM Into Program Routines and Activities

Here are some ideas to consider:

- During snack time, have student committees present weather and news reports (including vocabulary, measurement, data presentations, and explanations), conduct surveys, and manage distributions and menus.
- During homework time, students can do hands-on projects to supplement classroom learning, or homework time can begin with mental math contests, puzzles, or guessing games. Homework is also a good time for vocabulary expansion and questioning.
- Physical education can include sports stats, outdoor explorations, counting, and measurement.
- Enrichment time is wide open for a range of exciting options.

Jot down your ideas here:

Snack time	
Homework time	
Physical education	
Enrichment time	
Other	

You can plan to have STEAM activity centers available every day, with one day set aside for more in-depth projects or club time. Or, you may have dedicated STEAM activity or project time two or more times per week. The key is to map out times and maximize opportunities to bring in STEAM. Jot down your ideas here and see the next page for a sample activity schedule.

Monday	Tuesday	Wednesday	Thursday	Friday

	Snack	Homework Time (for students who finish early)	Enrichment (1-2 times per week)	Enrichment (3+ times per week; longer term)	Physical Activity
Theme: Cooking/Food	**Activity:** Do taste-test surveys and reports on preferences. **Skill:** Make, read, and use graphs, charts, and diagrams.	**Activity:** The snack committee meets to develop surveys, budget, and snack menus. **Skill:** Listen and collaborate respectfully and effectively.	**Activity:** Map local food establishments with student reviews and nutrition information. **Skill:** Use coordinates to show locations on a map or graph.	**Activity:** Plan and work in school garden; work with lunch staff to create healthy snacks. **Skill:** Explain plant life cycles and development.	**Activity:** Calculate calories burned and needed. **Skill:** Add, subtract, multiply, and divide whole numbers, decimals, and fractions.
Theme: Weather/Seasons/Climate	**Activity:** Do daily weather reports with predictions and recommendations for activities and clothing. **Skill:** Describe and explain seasons and weather patterns.	**Activity:** Activity center with make-your-own seasonal calendars. **Skill:** Describe and explain seasons and weather patterns.	**Activity:** Map each student's ideal living environment (e.g., features, climate, weather patterns). **Skill:** Explain the concept of "ecosystem" and the relationship of living things and the environment.	**Activity:** Use Google Earth, Maps, and Sky to explore, research, and report on climate change. **Skill:** Understand environmental change over time and through fast, catastrophic change.	**Activity:** Create charts of activities for different types of weather, based on student surveys and preference rankings. **Skill:** Make, read, and use graphs, charts, and diagrams.

	Snack	Homework Time (for students who finish early)	Enrichment (1-2 times per week)	Enrichment (3+ times per week; longer term)	Physical Activity
Theme: Building/Engineering	**Activity:** Numbers, measurement, and spatial puzzles and guessing games (e.g., How far from A to B? How many M&M's in the jar?). **Skill:** Calculate mentally, on paper, and with calculators.	**Activity:** Activity center with mazes, puzzles, Sudoku, construction materials (sticks, paper, cardboard, glue, scissors, twine). **Skill:** Use the process of experimentation to solve problems.	**Activity:** Redesign the afterschool space or do design-build challenges (e.g., tallest tower, strongest bridge, best parachute, farthest-flying paper airplane). Draw designs to scale. **Skill:** Use innovation to modify an existing product or structure.	**Activity:** Learn about, plan for, and compete in local robotics, building, design, or Lego competitions. **Skill:** Solve complex problems in teams.	**Activity:** Design and build a race, skateboard, aerobic, or obstacle course; hold competitions. **Skill:** Design, test, and build a system or process to meet desired needs within realistic constraints.

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Four Characteristics of STEAM: Planning Worksheet

What to do: Use this template to help you plan STEAM projects and activities that are creative, interdisciplinary, experiential, and inquiry based.

Why it matters: When you unleash the full power of STEAM, you give students opportunities to build interests and skills that can support success at school and in future careers.

Characteristics (Include all four)	**Students will have opportunities to…** (Include at least two for each characteristic)
Creative Tackles a real-world challenge or creates something that has value or meaning	☐ Identify a problem no one has thought of before. ☐ Create a new solution to a known problem. ☐ Explore multiple solutions. ☐ Think of new ways to use materials or technologies. ☐ See themselves as creators, inventors, and solution generators. ☐ Discover or develop knowledge, skills, and talents. ☐ Other: ___________________________ **Notes/ideas:**
Interdisciplinary Includes content and skills from more than one field of knowledge	☐ Explore one or more of the STEAM disciplines in depth. ☐ Make new connections between STEAM disciplines. ☐ See how school-day subjects connect to real-world issues. ☐ Learn about people, past and present, who've used STEAM knowledge and skills to create something meaningful and useful. ☐ See how people in different careers use knowledge and skills from multiple disciplines. ☐ Other: ___________________________ **Notes/ideas:**

Characteristics (Include all four)	**Students will have opportunities to…** (Include at least two for each characteristic)
Experiential Provides opportunities for active exploration (for example, through a makerspace)	◻ Make choices and decisions. ◻ Try new ideas, strategies, materials, roles, and processes. ◻ Contribute to a team effort. ◻ Develop knowledge and skills through hands-on, minds-on activities. ◻ Reflect on what they do, think, and feel during and after activities. ◻ Other: ____________________ **Notes/ideas:**
Inquiry Based Follows the design thinking process (empathize, define, ideate, prototype, test)	◻ Ask questions, and learn to ask better questions. ◻ Explore and try potential solutions. ◻ Develop a sense of curiosity and wonder. ◻ Explore how scientists, artists, and inventors from different disciplines build on each other's ideas to make discoveries and create new things. ◻ Other: ____________________ **Notes/ideas:**

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Guiding Questions for Project-Based Learning

What to do: Review the information on this page about Bloom's Taxonomy. Use the question stems on the next page to develop guiding questions to use during project-based learning.

Why it matters: Guiding questions that prompt students to think at increasingly higher levels develops their thinking skills.

Bloom's Taxonomy is a widely used framework for distinguishing between different kinds of thinking or cognition. Originally developed in 1956, it was revised in 2001 and is still used by teachers at all grade levels. The framework is useful for planning activities and questions that help students apply various types of thinking. The taxonomy (or classification system) identifies six levels of cognitive processes (thinking), with each level building on the previous levels. The six levels are Remember, Understand, Apply, Analyze, Evaluate, and Create. See the table below for a definition of each level and "action words" that describe what students do when they use that level of thinking.

The Six Levels of Thinking in Bloom's Taxonomy

Remember	Understand	Apply	Analyze	Evaluate	Create
Recall facts and basic concepts: *Define* *Duplicate* *List* *Memorize* *Repeat* *State*	***Explain ideas or concepts:*** *Classify* *Describe* *Discuss* *Explain* *Locate* *Report* *Select* *Translate*	***Use information in new situations:*** *Execute* *Implement* *Solve* *Demonstrate* *Interpret*	***Draw connections among ideas:*** *Differentiate* *Organize* *Relate* *Compare* *Contrast* *Distinguish* *Examine* *Experiment* *Question* *Test*	***Justify a stand or decision:*** *Appraise* *Argue* *Defend* *Judge* *Select* *Support* *Value* *Critique* *Weigh*	***Produce new or original work:*** *Design* *Assemble* *Construct* *Conjecture* *Develop* *Formulate* *Author* *Investigate*

Source: Armstrong, P. (2010). *Bloom's Taxonomy.* Vanderbilt University Center for Teaching. https://cft.vanderbilt.edu/guides-sub-pages/blooms-taxonomy

	Remember	Understand	Apply	Analyze	Evaluate	Create
Guiding Questions	What happened after...? How many...? Who was it that...? Can you name the...? Describe what happened at...? Who spoke to...? Can you tell why...? What's the meaning of...? What is...? Which is true or false...?	Can you write in your own words...? Can you write a brief outline of...? What could have happened next? Who do you think...? What was the main idea of...? Who was the key character in...? Can you distinguish between...? What differences exist between...? Can you give an example of what you mean by...? Can you provide a definition for...?	Do you know another instance where...? Could this have happened in...? Can you group by characteristics such as...? What factors would you change if...? Can you apply the method used to some experience of your own? What questions would you ask of...? From the information given, can you develop instructions for...? Would this information be useful if ...?	If...happened, what might the ending have been? How was this similar to...? What was the underlying theme of...? What do you see as other possible outcomes? Why did...changes occur? Can you compare your...with that presented in...? Can you explain what must have happened when...? How is...similar to ...? What are some of the problems of...?	Is there a better solution to...? Judge the value of.... Can you defend your position on...? Do you think...is a good or a bad thing? How would you have handled...? What changes to...would you recommend? Do you believe…? Are you a...person? How would you feel if...? How effective are...? What do you think about...?	Can you design a...to...? Why not compose a song about...? Can you see a possible solution to...? If you had access to all resources, how would you deal with...? Why don't you devise your own way to deal with...? What would happen if...? How many ways can you...? Can you create new and unusual uses for...? Can you develop a proposal that would...?

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Informal Assessments of Student Learning

What to do: Review and try various ways to assess student learning during science (or other) activities. If you feel uncertain about how to implement an approach, ask your school-day partners to provide a quick demonstration or example.

Why it matters: Out-of-school time is about having fun while learning. Using approaches other than formal quizzes or tests to assess learning creates a relaxed experience. You may find that these options lead to discussions or questions that deepen student interest and learning.

Asking Questions

Assessing student learning can be as simple as checking in with students and asking questions during activities. Questions are at the heart of the scientific process, and they're an essential part of learning in general. Consider using prompts like these:

- What do you see/hear/smell/taste/feel?
- What do the data tell you?
- How do you know that?
- How does that connect to the question we're trying to answer/explore?
- What are you learning?
- Is this interesting to you?
- What will you do next? How? Why?
- Should we consider collecting additional kinds of data? If so, tell me more.
- How do you think this will help scientists or others address the question or issue we're exploring?

Class Discussions

Similar to checking in with individual students (or groups of students) during an activity, engaging in class discussions is a great way to gauge students' understanding and promote engagement. It can also help students develop speaking and presentation skills. During a science activity, consider using prompts related to the following topics:

- Students' attitudes about science (e.g., anyone can be a citizen scientist, the importance of science to society, science as a collaborative process, recognizing the many unanswered questions in science, the value of curiosity in driving science)
- Students' development of scientific process skills (e.g., experiences with making observations, asking questions, carrying out investigations, analyzing and interpreting data, constructing explanations, communicating findings)
- Students' understandings related to specific projects (e.g., what they like, what they find challenging, next steps, questions they have, initial findings, explanations)

Observation Rubrics

Observing students during activities can help you assess their learning and development of skills, and a rubric can help you define and score the elements you're interested in. These elements may be related to students' attitudes about science or another area, their development of skills, or other learning goals. There are many ways to create observation tools; see below for a simple example of a rubric that focuses on science.

<table>
<tr><th rowspan="2">Skill, Knowledge, or Attitude</th><th colspan="3">Ability Level</th><th rowspan="2">Score</th><th rowspan="2">Notes</th></tr>
<tr><th>1 – Beginning</th><th>2 – Developing</th><th>3 – Exemplary</th></tr>
<tr><td>Understanding that anyone can be a scientist and scientists don't have all the answers.</td><td>• Gets easily frustrated by not knowing something and views it as a failure.
• Doubts their abilities as a scientist and feels they have nothing worthwhile to contribute to scientific research.</td><td>• Gets frustrated by not knowing something, but demonstrates curiosity and persistence.
• Acts excited to contribute to scientific research, but is not fully confident in their ability to do so.</td><td>• Gets excited by not knowing something and views it as an opportunity to explore unanswered questions.
• Feels empowered by contributing to real scientific research.</td><td></td><td></td></tr>
<tr><td>Making observations.</td><td>• Requires significant guidance and prompting to make observations.
• Observations aren't always relevant to the question or project.
• Requires step-by-step guidance or prompting to discuss, draw, or record observations.</td><td>• Requires some guidance and prompting to make observations.
• Requires some guidance to determine whether observations are relevant to the question or project.
• Requires some guidance or prompting to discuss, draw, or record observations.</td><td>• Focuses attention on senses, using tools to extend as appropriate.
• Makes observations that are relevant to the question or project with minimal guidance or prompting
• Discusses, draws, or records observations.</td><td></td><td></td></tr>
</table>

Scientist's (or Expert's) Notebook

Every scientist needs somewhere to record their burning questions, fascinating findings, and brilliant ideas. Have students document their progress throughout a project, either in a notebook or an electronic file. This supports their learning and also gives you a way to assess their learning.

Culminating Event/Activity

Communicating your findings and reflecting on what you learned are critical parts of the scientific and learning processes, and holding an end-of-project celebration or activity can be a fun opportunity for students to communicate and reflect. Consider these ideas:

- **Presenting findings.** Being able to explain their findings to an audience is an important skill for students to develop. The audience may be other students in the program or the school, or it may include families, school leaders, community members, the city council, a local environmental organization, and others). You can explain the expectations to students and create an observation rubric based on the elements you want to assess (e.g., being able to tell why the project is important and relevant, describing and/or demonstrating how they collected data, and making connections to community or global issues).
- **Writing to a scientist.** Collaboration and communication are critical science skills. After completing a citizen science project, for example, you can have students write to the researchers who led the project you participated in. Depending on the project, you may be able to use the contact information provided, or you can look up contact information on the organization's website. Students can write letters or send emails. Provide prompts for the content to include, such as a description of students' experiences with the project, what they enjoyed about it, challenges they faced, questions they have, and recommendations for improving or expanding the project. Although a response is not guaranteed, the scientists working on the project will likely love to hear from your students and may write back!
- **Recruiting more citizen scientists to join the project.** Professional scientists use the citizen science approach because they can learn more by having many people collecting data. Your students may want to recruit their peers. This could involve giving presentations, writing letters, or creating advertisements. For example, students might create posters about the project, why they liked it, what they learned, and how others can join. Feature student products on your program or school website and in spaces such as hallways, the cafeteria, entryway, or other high-visibility areas. You can help build enthusiasm for science — and communicate that we can accomplish more together!

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Integrating Project-Based Learning Into Program Activities

What to do: Review the six project-based learning strategies described below, and think of ways you might use them. Consider activities where students need to actively engage with a topic and with the community — for example, STEAM, citizen science, service learning, social entrepreneurship, and civic education.

Why it matters: When students lead the learning and staff members facilitate, students gain 21st century skills such as critical thinking, teamwork, communication, creativity, and leadership. These skills help prepare students for future education and career opportunities.

Project-Based Learning Strategy	Description	How to Implement This Strategy
Capture student voice and choice.	Invite active student decision-making throughout the project.	*Example activity:* Use a student interest survey to gather input on topics students want to learn about. Activity:
Follow a well-established sequence.	Projects follow a sequence of planning, active inquiry, and opportunities for students to share and reflect on what they've learned.	*Example activity:* Introduce the scientific process — make observations, ask questions, form hypotheses, make predictions, carry out projects/investigations, collect data, analyze and interpret data to construct explanations, and communicate findings. Activity:
Focus on high-interest topics and questions.	Students might choose to explore questions about themselves, their communities, and their world.	*Example activity:* Engage in a class discussion about topics that are important to students and explore projects related to them (e.g., water quality in the community). Activity:
Emphasize active learning.	Students learn by doing and have hands-on opportunities to explore the topic or answer the driving question.	*Example activity:* Provide opportunities to use authentic tools and methods (e.g., using an air quality monitor). Activity:
End the project with a product and/or culminating event.	Students display or share their project, data, solution, or invention for others to see.	*Example activity:* Students may create a presentation (with visual, auditory, and/or written elements) to explain their findings to relevant stakeholder groups (e.g., school leaders, town board, a local environmental organization). Activity:

Project-Based Learning Strategy	Description	How to Implement This Strategy
Include reflection.	Provide opportunities for students to reflect on how working on a project helps them develop academic and 21st century skills.	*Example activity:* Provide prompts that encourage students to reflect on their work and learning in a project or scientist's notebook. Activity:

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Investigating Issues in Your Community

What to do: Give this checklist to students as they begin a STEAM, civic learning, citizen science, service-learning, or entrepreneurial project. Explain any terms that aren't familiar.

Why it matters: Capturing information through a variety of methods and sources can help students make a strong start and can help facilitators ensure that the project stays on track.

Directions: Use this checklist to identify ways to research and investigate community issues, challenges, and needs. It will also help you think about the best ways to report your findings.

Research Methods

Check the research methods you'll use for the project. Write notes in the spaces provided.

- ☐ Interviews ______________________
- ☐ Focus groups ______________________
- ☐ Surveys ______________________
- ☐ Observations ______________________
- ☐ Texts (newspapers, blogs, books) ________
- ☐ Other documents ______________________
- ☐ Videos ______________________
- ☐ City records ______________________
- ☐ Demographic data ______________________
- ☐ Google Maps ______________________
- ☐ Podcasts ______________________
- ☐ Other ______________________

Planning Check! Are the research methods:

- ✓ Appropriate for what you need to find out?
- ✓ Doable in the amount of time you have?
- ✓ Using quality information and sources?
- ✓ Mindful of contradictory information?
- ✓ Interesting and sustainable?

Analyzing Data and Reporting Findings

Check the best ways to report your findings for the project.

- ☐ Charts and graphs ______________________
- ☐ Written report ______________________
- ☐ PowerPoint presentation ______________
- ☐ Verbal summary ______________________
- ☐ Visual displays (photographs, videos) ______________________
- ☐ Published writing (newspaper, blogs, books) ______________________
- ☐ Other ______________________

Planning Check! Do the findings:

- ✓ Shed light on the root(s) of the problem?
- ✓ Lead to a possible solution?
- ✓ Reveal feasible ways for people to get involved?
- ✓ Suggest potential community partners?

Materials or Resources Needed

Check the items needed for the project.

- ☐ Computers, cameras, video cameras, etc. ____________________
- ☐ Access to information (e.g., from people, databases, records) ____________________
- ☐ Internet access ____________________
- ☐ Microphones/equipment for interviews ____________________
- ☐ Safety supplies such as gloves, hard hats, etc. ____________________
- ☐ People (e.g., interpreters, guides, experts) ____________________
- ☐ Office supplies ____________________

Planning Check! Are materials needed to:

- ✓ Guide you when making a project plan?
- ✓ Carry out the project work?
- ✓ Help you document, report, and share what you learn?
- ✓ Establish agreements with others?
- ✓ Conduct a showcase event at the end of the project?
- ✓ Reflect or review?

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Learning Recovery Tip Sheet

What to do: Review this tip sheet and the U.S. Department of Education's guide on learning acceleration for strategies to help you provide quality out-of-school time (OST) learning experiences. See the **Learning Recovery Toolkit** on the 21st CCLC NTAC website for practical tools to support students' academic and social-emotional learning recovery in OST settings.

Why it matters: These strategies are especially helpful for supporting learning recovery for students who've fallen behind and aren't meeting grade-level standards.

To Support Learning Recovery in Your OST Program…

Ask This

- What are they learning at school?
- Are these the students who need it most?
- What training do staff need?
- What do the data say?
- What's working well?
- What do we need to change?

Do This

- Connect activities to student needs and interests.
- Offer choices.
- Support students with disabilities.
- Celebrate successes.
- Align with the school day.
- Support learning at home.
- Encourage curiosity and creativity.
- Engage community partners.

Learning Recovery: Acceleration vs. Remediation

Learning acceleration is a learning recovery strategy to get students on grade level by providing just-in-time foundational support connected to the grade-level content they're learning. Research shows that learning acceleration is an important strategy for advancing equity and that students who experienced acceleration struggled less and learned more than students who started at the same point but experienced **remediation** (repeating lessons or practicing skills they didn't master during previous grades) instead.

Check the 21st CCLC NTAC website for professional learning opportunities, tools, and resources on learning and learning recovery — including the **Learning Recovery Research and Practice Brief**.

Use the space below to record your ideas, insights, and questions about ways to support students' academic and social-emotional recovery.

Success is the sum of small efforts, repeated day in and day out.

— Robert Collier

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Makerspace Checklist for Home and Virtual Learning

What to do: Use this checklist to plan and implement strategies that support virtual and home-based project activities that are engaging and effective.

Why it matters: Virtual activities can help you connect with students and families when you can't meet in person or at times convenient to them. Also, you can use virtual learning during in-person activities and events — for example, to build digital literacy skills, teach software programs, and research community resources.

Student Engagement Strategies

- ☐ Invite community members to a virtual meeting with students so they can survey them.
- ☐ Invite a community expert to join a virtual meeting where students can ask questions.
- ☐ Watch videos to get students ready and excited for the activity.
- ☐ Give students reusable "science bags" filled with items they can use for a makerspace.
- ☐ Host a virtual classroom with specific activities each week.
- ☐ Other: ____________________

Family Engagement Strategies

- ☐ Get families informed, excited, and on board.
  - Invite families to a virtual or in-person orientation session to explain the STEAM approach.
  - Send home emails or flyers with information about STEAM, including tips on how families can create a makerspace at home with common materials they already have.
- ☐ Provide families with an orientation.
  - Explain the STEAM or other learning approach and how it can benefit students.
  - Preview the activities and materials you plan to use.
  - Explain what a makerspace is and how to create one at home. Describe the resources you'll provide and provide a list of household items the family can add.
  - Answer family members' questions.
  - Record the virtual orientation for those who can't attend the live session.
- ☐ Encourage ongoing participation.
  - Offer at-home project ideas and resources.
  - Invite families to contribute their knowledge and ideas.
  - Offer training for family members willing to help facilitate virtual project activities.
  - Invite families to virtual events where students showcase their projects and creations.
- ☐ Other: ____________________

Create a Virtual Makerspace

- ☐ Explore the use of virtual tools.
  - Consider online software tools designed for making, animation, and the arts, like JavaScript or graphic design software. Many free tools are available online. If you can't locate a free version of a tool you want for your virtual makerspace, check with the school and local organizations to see if they can help.
  - If you decide to purchase a virtual tool for your makerspace, and it's within your budget, (a) check to see if there's a discount for educators, (b) make sure the purchase or license permits multiple users, and (c) make sure it's compatible with the laptop, tablet, or other device where the tool will be downloaded and used. *Before you make a purchase, you might check with the school or district technology specialist for guidance on these matters, as well as any security requirements.*
- ☐ Other: ____

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Next Generation Science Standards at a Glance

What to do: Use this overview of the Next Generation Science Standards to help you design activities that address important science concepts and skills. Consult school-day teachers to identify which ones your students need to master. For more about the standards, visit http://www.nextgenscience.org.

Why it matters: Activities that address the three dimensions described below can help students learn content, the scientific approach, and universal ideas at the same time, which reflects how science is practiced in the real world.

Dimension 1: Science and Engineering Practices

Science and engineering practices are behaviors that scientists use to investigate the natural world and engineers use to design solutions to problems. These practices demand both knowledge and skills. Examples include:

- Asking questions and defining problems
- Developing and using models
- Planning and carrying out investigations
- Analyzing and interpreting data
- Using mathematics and computational thinking
- Constructing explanations and designing solutions
- Engaging in argument from evidence
- Obtaining, evaluating, and communicating information

Dimension 2: Crosscutting Concepts

Crosscutting concepts are universal ideas that students will encounter across various scientific fields of study such as geology, biology, astronomy, and engineering. Here are examples:

- Patterns, similarity, and diversity
- Cause and effect
- Scale, proportion, and quantity
- Systems and system models
- Energy and matter
- Structure and function
- Stability and change

Research is formalized curiosity.
It is poking and prying with a purpose.

— Zora Neale Hurston

Dimension 3: Disciplinary Core Ideas

Core ideas in the four domains listed below help to focus curriculum, instruction, and assessment on the most important aspects of science. The ideas help to organize concepts, provide tools for understanding or investigating ideas, relate to societal or personal concerns, and can be taught and learned at increasing levels of depth and sophistication over multiple grades. They include:

Physical Sciences Core Ideas

- Matter and its interactions
- Motion and stability
- Energy
- Waves and their applications

Life Sciences Core Ideas

- From molecules to organisms
- Ecosystems
- Heredity
- Biological evolution

Earth and Space Sciences Core Ideas

- Earth’s place in the universe
- Earth’s systems
- Earth and human activity

Engineering, Technology, and Applications of Science Core Ideas

- Engineering design
- Links among engineering, technology, science, and society

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Project Assessment and Reflection: Planning Worksheet

What to do: Use this worksheet to plan what tools you'll use. Depending on student ages, you might include students in making decisions about which ones to use.

Why it matters: Informal assessments give you — and your students — insights into how their knowledge and skills are developing. Reflecting before, during, and after a project helps students deepen their understanding of the content and provide a sense of accomplishment.

Assess the Learning

Assessment Tool	When I'll Use It	How I'll Use It	Preparation Required
Games			
Journals			
Portfolios			
Rubrics			
Surveys			
Other:			

Reflect on the Learning

Reflection Tool	When I'll Use It	How I'll Use It	Preparation Required
Blogging			
Creative project			
Draw the big idea			
Letters to leaders			
Mapping			
Postcard takeaway			
Other:			

Fun Fact

Famous scientists, writers, artists, and inventors who kept notebooks or journals include Charles Darwin, Marie Curie, Frida Kahlo, Leonardo da Vinci, Thomas Edison, and Alice Walker.

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Science and Mathematics Vocabulary Builder

What to do: Use this tip sheet to remind you of ways you can help students become comfortable and familiar with words related to math and science. You can customize this tool to match your students' ages and needs. Consider asking their school-day math and science teachers to send you a list of vocabulary terms students need to know. Also, you can use this tool during activity observations to "catch" staff and students using the processes, questions, and vocabulary terms listed below.

Why it matters: All students can benefit from explicit instruction and repeated exposure to the language of mathematics and science. It's especially helpful for English learners. Often, they can pick up on conversational English on the playground, but they may have limited opportunities to learn and use academic language.

Talking Science

Tip: Use science-related vocabulary and questions in all activities, not just during science activities or homework time.

Scientific Process	Guiding Questions	Related Vocabulary	Activity	Staff use		Student use		Notes
				Y	N	Y	N	
Questioning and hypothesizing Forming questions and coming up with possible explanations or answers (hypotheses).	• Why is that? • How does it work? or How does it happen? • What might happen if…? • What might you see?	Curious Hypothesis Inquire Inquiry Question Theory Wonder	**Example:** Take a walk in the woods or in a park to explore plant life.					

Scientific Process	Guiding Questions	Related Vocabulary	Activity	Staff use		Student use		Notes
				Y	N	Y	N	
Observation Using the senses to gather information.	• What do you see, hear, smell, or taste? How does it feel when you touch it? • What's going on? How do you know? • Does this seem like anything else you know about?	Describe Experiment Observation Observe Senses **Tip:** Include observation tools like microscopes and telescopes. **Tip:** Include terms related to the metric and U.S. customary measurement systems as appropriate.	**Example:** Notice and talk about different plants and seeds.					
Classification Ordering and grouping data based on observations.	• Which are the same, similar or different? • How are they similar or different?	Characteristics Classification Classify Differ Different Features Group Same Similar Sort	**Example:** Collect samples of different seeds and leaves. Group them by characteristics (e.g., size, shape, color, texture, where they were found).					

Scientific Process	Guiding Questions	Related Vocabulary	Activity	Staff use		Student use		Notes
				Y	N	Y	N	
Recording and communicating Explaining and presenting to others.	• How do you describe this? What did you do? How did that happen? • What were you looking for?	Explain Justify Justification Reason Reasoning Report	**Example:** Ask students to explain what they found, where, and why they grouped the seeds and leaves the way they did.					
Using data (e.g., numbers and measurement) to represent and explain.	• How many? • How often? How much? • How long did it take? • When? • How big? What shapes? • How many different…?	Area Calculate Circumference Count Data Diameter Length Quantity Represent Width	**Example:** How many types of seeds and leaves? How many of each? Which are the most common?					

Scientific Process	Guiding Questions	Related Vocabulary	Activity	Staff use		Student use		Notes
				Y	N	Y	N	
Form conclusions, question further, predict, and revise hypotheses.	• What did you find out? • What do you wonder about? What else do you want to know? • Is there another explanation? • What do you think will happen if…	Conclude Conclusion Explain Explanation Findings Predict Prediction Revise Revision	**Example:** Which seeds grow into which plants and leaves? Who eats these seeds and leaves? Do people eat seeds and leaves? What makes a seed or leaf edible or not? For whom?					

Talking Mathematics

Tip: Use math-related vocabulary and questions in all activities, not just during math activities or homework time.

During…	Ask and talk about…	Related Vocabulary	Staff use		Student use		Notes
			Y	N	Y	N	
Snack time	• How many will you need? • How many more? About how many? Estimate. Approximately how much? • How many extra are there? • Count these out by twos. • What percentage is sugar?	Add/Addition Approximate/Approximately Divide Estimate Less than/More than Minus/Take away Multiply/Times Percent/Percentage Plus Subtract/Subtraction					
Forming teams, playing games, music, art	• Divide into groups of two (or five, or three) • Count off by twos, or odds and evens, or A's and B's • How many points? How many more? What's the total? • What's the rhythm? Tap it out. • What proportion of which color? What's the pattern?	Divide Odd, even Pattern Proportion Represent Shapes Total					
Dismissal, schedules, events	• What time will that happen? Later or earlier? Before or after? In how long (minutes, hours, days, weeks)?	Location and position words Measurement words Time vocabulary					

During…	Ask and talk about…	Related Vocabulary	Staff use		Student use		Notes
			Y	N	Y	N	
General conversation, family, pets, friends, making plans	• Is he or she bigger or smaller? Older or younger? Taller or shorter? • How much will that cost? Do you have enough? Is that more or less? • How many pairs do you have? • Can you make a list? Can you put the items in order? How do you rank them? Same or different? Straight or curved? Equal or unequal? • How else can you say that?	Add/Addition Compare/Comparison Distance Divide/Division Fraction Half Measure/Measurement Minus Order/Organize Plus Prioritize Rank Subtract/Subtraction Sum/Total Whole/Part/Piece					
Going places, finding things, cleaning up, neighborhood	• Is that closer or farther? • Near or far? How far? • How long does it take? • Right or left? • Above, below, next to, between? • Where is it? How do you get there?	Directions/Compass terms Distance (measurements) Location and position terms Maps and mapping terms Relationship words					

During…	Ask and talk about…	Related Vocabulary	Staff use		Student use		Notes
			Y	N	Y	N	
Describing things, looking at things, ranking things	• What shape is that? What size? Bigger or smaller? • Which are the same; different? How are they the same or different? • Is that two-dimensional or three-dimensional?	Angle Circle Corner Cube Curved/Straight Equal/Unequal Ordinal/Cardinal Point Pyramid Rectangle Round Square Triangle **Tip:** Include measurement tools like rulers, protractors, and T-squares.					

Mathematics is the door and key to the sciences.

— Roger Bacon

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Science Interest Survey: All Grades

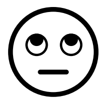
What to do: Distribute these surveys to students (selecting the age-appropriate version) to get student voice data for activity planning.

Why it matters: Responding to student interests can encourage student attendance and engagement. It also helps them feel that their voice matters.

Elementary Science Interest Survey

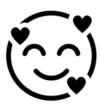
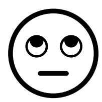
Your voice matters! Answer a few questions to tell us what kind of science project you want.

1. **I like going outside to learn.** (Circle your answer.)


Yes

Maybe

No

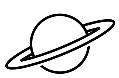
2. **I like learning on the computer.** (Circle your answer.)


Yes

Maybe

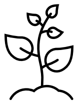
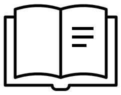
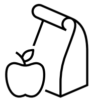
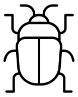
No

3. **I like to learn about…** (Circle your top three choices below.)

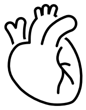
Animals

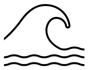
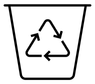
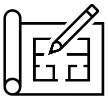
Space

Weather

Computers and technology

Gardening and growing things

History

Health and food

Bugs

Birds

Nature and outdoors

The human body

Different places in the world

Water, like streams and the ocean

Recycling and keeping our community clean

Making and building things


Middle School Science Interest Survey

Your voice matters! Answer these questions to help us decide what kind of citizen science project we should do.

1. **I like going outside to learn.** (Circle your answer.)

Strongly agree	Agree	Unsure/maybe	Disagree	Strongly disagree

2. **I like learning on the computer.** (Circle your answer.)

Strongly agree	Agree	Unsure/maybe	Disagree	Strongly disagree

3. **I like to learn about…** (Circle your top three choices below.)

Animals	Astronomy and space	Weather and climate
Computers and technology	Biology and the human body	History and culture
Health, nutrition, and medicine	Insects and pollinators	Birds and migration
Ecology and the environment	Chemistry	Geology and earth science
Ocean, water, and marine	Agriculture and plants	Geography

4. **List anything else you'd like to share about your interests and what you'd like to learn about.**

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High School Science Interest Survey

Your voice matters! Answer these questions about how you like to learn and what you like to learn about. It will help us decide which citizen science project we should do.

1. **I like learning outdoors. I want opportunities to observe nature and do hands-on, real-world activities.** (Circle your answer.)

Strongly agree	Agree	Unsure/maybe	Disagree	Strongly disagree

2. **I like using technology (e.g., computers, tablets, smartphones) to learn. I want opportunities to engage in online activities.** (Circle your answer.)

Strongly agree	Agree	Unsure/maybe	Disagree	Strongly disagree

3. **I like to learn about…** (Circle your top three choices below.)

Animals and biodiversity	Astronomy and space	Weather and climate
Computers and technology	Biology and the human body	History and archeology
Health, nutrition, and medicine	Insects and pollinators	Birds and migration
Ecology and the environment	Chemistry	Geology and earth science
Ocean, water, and marine	Agriculture and plants	Physics
Language, culture, and arts	Clean energy and sustainability	Issues affecting my community

4. **List any other topics you'd like to explore or ideas for science projects you'd like to try. If you have specific ideas for activities related to the areas you selected above, describe them here.**

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Science Skills Rubric

What to do: Share this rubric with students and review the skills they'll need to demonstrate at each ability level (novice, apprentice, and expert). You can use the third page as a template to create a rubric for any science-related project.

Why it matters: Students have more confidence and buy-in when they know the expectations for high performance. Also, rubrics like this one help activity leaders evaluate student performance consistently and provide specific feedback.

Ready-to-Use Science Skills Rubric

Skill/Knowledge	Value			Points
	Novice (1 point)	Apprentice (2 points)	Expert (3 points)	
Making observations and asking questions	• Required consistent prompting to identify observations • Described observations incompletely • Made very basic predictions	• Required some prompting to identify observations • Identified some things of interest and opportunities for investigation • Made some predictions	• Made observations without prompting • Described observations in writing • Identified things of interest or ideas for future investigation • Made predictions based on observational evidence	
Planning and doing investigations	• Required step-by-step assistance and guidance to complete tasks • Project was incomplete or late	• Required some assistance to approach and complete tasks • Completed project with some distraction	• Used a sophisticated strategy to approach and complete the tasks • Completed project on time and with minimal distraction	

Skill/Knowledge	Value			Points
	Novice (1 point)	Apprentice (2 points)	Expert (3 points)	
Collecting and analyzing data	• Collected some initial data with assistance • Data were incomplete, disorganized, or hadn't been analyzed	• Imprecise data were collected or some errors were present in collection or calculation	• Data were complete and precise • All relevant details were recorded • Demonstrated understanding of how to use data collection tools • Analysis was performed	
Developing and using scientific models	• No connections were made between investigation and larger scientific ideas	• Identified trends that were not always consistent with observations • Larger connections between ideas were not present or were incomplete	• Demonstrated understanding of key science concepts • Took clear, logical steps • Identified connections between observations and larger phenomena	
Engaging in argument from evidence and constructing explanations	• Required assistance to identify basic trends or larger concepts • Reasoning was incomplete or incorrect	• Exhibited basic reasoning skills and some understanding of larger concepts • Made basic interpretations of data • Required assistance to develop conclusions from observable evidence	• Used complex reasoning and demonstrated understanding of cause and effect • Provided clear explanations • Developed conclusions that were supported by data • Raised new questions based on findings	

Skill/Knowledge	Value			Points
	Novice (1 point)	Apprentice (2 points)	Expert (3 points)	
Sharing findings	• Required assistance to communicate information or clearly represent findings • Shared incomplete information	• Communicated basic findings using one form of expression • Shared general information with community/audience	• Communicated ideas clearly, using multiple channels or forms of expression (written, spoken, etc.) • Created innovative or interesting ways to represent information (videos, public service announcements, etc.) • Made information accessible and interesting to the intended community/audience	

Template for Customized Science Skills Rubric

Directions: Use this template to create a customized rubric based on the science process skills listed in column 1. Fill in the observable actions based on the ability levels of "novice," "apprentice," and "expert."

Skill/Knowledge	Value			Points
	Novice (1 point)	*Apprentice (2 points)*	*Expert (3 points)*	
Making observations and asking questions				
Planning and executing investigations				
Collecting and analyzing data				
Developing and using scientific models				
Engaging in argument from evidence and constructing explanations				
Sharing findings				

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Scientific Inquiry Skills Checklist

What to do: Review the list of skills on this page and select which ones to focus on during science activities. Then, use the student and class checklists that follow to assess student performance as you observe activities in progress.

Why it matters: Mastering scientific inquiry skills prepares students for success in school and throughout life. It gives them tools for exploring their world and solving problems.

Tip: You can make scientific inquiry skills part of almost any type of activity. For example, if students want to play soccer as a recreational activity, you can extend the learning into health and wellness by having them research and share the physical benefits of exercise, such as improvements in sleep patterns. Bring in math by having students collect, analyze, and graph data about the most successful angles for scoring goals or the best strategies for moving the ball down the field.

- ☐ **Making observations**
  - Focusing their senses to describe the item/experience of interest (e.g., a plant, photos of space, the area where goal shots are most successful), and using real-world tools and technologies to extend their senses (e.g., microscope, water test kit, video)
  - Making observations that are relevant to the question or project being explored
  - Discussing, drawing, or recording observations
- ☐ **Asking questions and forming hypotheses/making predictions**
  - Asking a variety of questions based on observations
  - Using background knowledge and logic to predict what they will find
  - Citing evidence from background research and/or observations to support predictions
- ☐ **Carrying out projects/investigations and collecting data**
  - Planning experiments/investigations to answer questions or following the design of an existing citizen science project
  - Following research procedures to collect accurate data
  - Organizing data (e.g., in a scientist's notebook, on a website, or in an app used for a particular citizen science project)
- ☐ **Analyzing and interpreting data to construct explanations**
  - Identifying patterns or trends in data
  - Performing appropriate calculations (e.g., frequency, mode, mean) and determining how to organize and represent data (e.g., drawing, graphing)
  - Using data to describe findings or answer a question
- ☐ **Communicating findings**
  - Discussing findings and related implications, including engaging in scientific argumentation
  - Using multiple approaches (e.g., oral, written, visual) for communicating and explaining findings to an audience
  - Expressing enthusiasm to using data to report results and being part of a community helping to advance progress in science or another arena

Individual Student Checklist

Directions: Select scientific inquiry skills you want your students to build and record indicators to look for (use the bullet points on the first page of this tool to help). As you observe students during activities, check off whether they exhibited the skill. There is also space to write comments, such as descriptions of what the student said/did to exhibit the skill or notes about their level of competency with the skill (e.g., beginning, developing, exemplary). Customize this checklist based on the number of skills you choose to include.

Student Name: ______________________________

Scientific Inquiry Skill	**Indicator(s)**	**Exhibited Skill**		**Comments**
		Yes	No	
Skill #1				
Skill #2				
Skill #3				
Skill #4				
Skill #5				
Overall		/5	/5	

Class Checklist

Directions: Select the scientific inquiry skills you want your students to build and record the indicators to look for (use the bullet points on the first page of this tool to help). As you observe students during activities, check off whether they exhibited the skill. There is also space for you to write comments, such as successes, challenges, or ideas for improvement. Customize this checklist to the number of skills and students you want to include.

Student	Skill #1	Skill #2	Skill #3	Skill #4	Skill #5	Overall
	Indicator(s):	Indicator(s)	Indicator(s)	Indicator(s)	Indicator(s)	
Student #1						/5
Student #2						/5
Student #3						/5
Student #4						/5
Student #5						/5
Student #6						/5
Student #7						/5
Student #8						/5
Student #9						/5
Student #10						/5
Student #11						/5
Student #12						/5
Student #13						/5
Student #14						/5

Comments: ____

____

____

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Selecting Student Roles for Group Work

What to do: Decide how many groups to have, the appropriate size and composition of each group, and whether to assign students to groups/roles or let them choose. This diagram shows roles often used during project work.

Why it matters: Working in groups helps students develop skills such as collaboration, communication, leadership, and more. Groups also provide opportunities to learn from and with peers in settings that resemble real-life workforce experiences.

Group Roles

Coach/Mediator
- Helps encourage the group
- Mediates when there's conflict

Materials Manager
- Identifies needed materials
- Tracks and manages resources for the project

Ambassador
- Collects questions and concerns to share with the facilitator or other groups
- May be the voice of the group

Project Coordinator
- Keeps the group on task
- May have a list of tasks to complete during the session

Timekeeper
- Keeps the group on time
- May set time limits for activities

Recorder/Scribe
- Records group ideas, decisions, and discoveries
- Reports on prior meetings

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STEAM Activity Example

What to do: Review this example activity, which combines all five STEAM disciplines — science, technology, engineering, the arts, and mathematics — to address a real-world problem. You can use this as a model for creating your projects and activities.

Why it matters: Activities like this give students a chance to experience what it's like to work on a problem together, make decisions, and make a positive difference. It also helps them see real-world uses for what they're learning in school.

Real-World Problem: The Teachers' Lounge Needs an Update

Topic: Let's Upcycle!

Students hear teachers talking about how the teachers' lounge needs new furniture, but there's no budget for it. Students have been learning about recycling and upcycling, and they wonder if that might be a way to solve the problem.

Design Thinking Step 1: Empathize

Students talk to teachers about why they're having problems with the furniture in the lounge. They take **surveys** and have one-on-one **interviews**.

Design Thinking Step 2: Define

Students find out the furniture is broken and uncomfortable. The facilitator guides students through the **"five whys" technique** to determine the root cause of the problem.

Facilitator: Why do the teachers want new furniture?

Students: Because the lounge is their place to relax, and they want to be comfortable.

Facilitator: Why is the furniture broken and uncomfortable?

Students: Because it's over 30 years old.

Facilitator: Why can't they get new furniture?

Students: Because the administration doesn't have it in the budget this year.

Facilitator: Why is it not in the budget?

Students: Because of budget cuts and "more important things" that needed funds.

Facilitator: Why are teachers not considered the most important?

Students: Because the students and their needs come first.

Students determine that the **root problem** is that teachers need a place to relax, and their needs should be considered. They need new furniture at the right price.

Design Thinking Step 3: Ideate

Students brainstorm and research solutions to overcome the problem. They talk to carpenters around the area and figure out where they can get recycled materials. They also do research on how designers have used upcycled materials. They **identify three possible solutions**:

1. Create miniature prototypes of the teachers' lounge and propose a plan to the administration.
2. Build the furniture that teachers want using upcycled and recycled materials.
3. Create a fundraiser to raise money for new furniture.

Design Thinking Step 4: Prototype

Students decide to **build a prototype** of the teachers' lounge and create 3D replicas of the furniture.

- Students decide to work in groups of two to three.
- The facilitator sets up the room with graph paper, cardboard, glue, Popsicle sticks, pipe cleaners, plastic cups, and anything else the students may need to build the replicas.
- Students start to draw ideas on the types of furniture the teachers want, and they think about the recycled materials they can use to make it life-size.
- Students begin to build replicas. The replicas will act as blueprints that included 3D mini-replicas of furniture they will build out of upcycled/recycled materials, keeping in mind that the furniture will need to fit in the teacher's lounge, and be comfortable and inviting.
- The facilitator makes sure students have enough time to dig in and think critically about what they're designing.

Design Thinking Step 5: Test

Students decide to test their prototypes by presenting three-dimensional blueprints and replicas to the teachers. Teachers make notes about what they like best in each replica. Students review the feedback and build one final replica. *Note: Students may need to go back and repeat previous stages of the design thinking process.*

Finish It Up

From the final replica, students determine the cost of building or buying the new lounge furniture. They make a plan and take it to the administration. The goal is for students to get the funding to build or buy the items for the teachers' lounge. They may decide to do a small fundraiser. Or, maybe they can't do it this year but administration is OK with students sprucing up the lounge by painting it, adding plants, and making pillows.

Take It Further

Each year, students make a new piece of furniture. Students work with local carpenters and interior decorators to learn about furniture and room design. They learn to use design software. As they interact with carpenters and interior decorators, students learn what people in these professions do on a day-to-day basis.

How Is STEAM Addressed?

- **Science:** Students learn about recycling and upcycling and why the processes matter.
- **Technology:** Students use search engines to conduct research and use design software to build small-scale prototypes and/or furniture designs.
- **Engineering:** Students use engineering to build their 3D replicas, and think about the best materials to use.
- **Arts:** Students use their creativity to design their miniature furniture replicas, to select colors and materials that appeal to the teachers, to make pillows, and to arrange the room in a way that's practical and aesthetically pleasing.
- **Mathematics:** Students use skills such as measuring and scaling/ratios, angles, and fractions when building their replicas.

Are Students Working in a Makerspace?

Yes. By providing students with the tools needed to develop their replicas, and allowing them to be creative and inventive, the facilitator provides a makerspace. The facilitator ensures a safe environment as students learn a new skill and use tools they've likely never used before. They can also use new technology like 3D software for designing rooms and furniture.

Career Pathways That Can Be Explored

Drivers, sorters, mechanics, technicians, designers, machine operators, recovery center managers

Can you think of more? Add them below!

____

____

____

Good design's not about what medium you're working in.
It's about thinking hard about what you want to do and
what you have to work with before you start.

—Susan Kare

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STEAM Approach: Staff Self-Check

What to do: ***If the STEAM approach is new to program staff,*** ask them to use this self-check individually to gauge their knowledge and interest in aspects of the STEAM (or STEM) approach to teaching and learning. Once they identify strengths and pinpoint areas where they want to learn more, invite them to discuss their findings, questions, and concerns.

After you've used the STEAM approach for a few weeks, have staff do the self-check again. Invite them to discuss how they've grown as STEAM educators. If several staff members find a certain aspect challenging, consider making it the focus of a future professional development event.

Why it matters: Staff enthusiasm helps to spark student engagement. The hands-on, inquiry-based, STEAM learning approach encourages creativity, new perspectives, and student interest.

STEAM is a learning approach that uses science, technology, engineering, the arts, and mathematics (STEAM) as access points for guiding student inquiry, dialogue, and critical thinking.

Every staff member can support your program's STEAM approach in some way. Some may think of fun ways to help students learn STEAM vocabulary terms. Some might have ideas for activities. Others may enjoy leading projects, sharing their own knowledge and expertise, or reaching out to engage STEAM professionals and community partners.

STEAM Approach Self-Check

Instructions: Put a check mark by each statement that's true for you. Then review the statements with no check marks and circle one or two areas where you'd like to improve or learn more.

Sparking Interests, Expanding Horizons

- ☐ I use inquiry-based learning to awaken curiosity and a sense of wonder about the world.
- ☐ I listen for and tap into students' interests.
- ☐ I provide opportunities for students to tackle real-world challenges or to create things that have value or meaning.
- ☐ I introduce students to STEAM vocabulary, concepts, materials, and experiences.
- ☐ I create activity centers or makerspaces to provide opportunities for active exploration.
- ☐ I create opportunities for STEAM-related field trips.
- ☐ I provide materials that support STEAM concepts and exploration.
- ☐ I give students opportunities to give presentations, demonstrations, and performances.
- ☐ I invite diverse local professionals in STEAM fields to share their stories and expertise.
- ☐ I form student groups, clubs, or committees for STEAM activities and projects.

Connecting STEAM With School Content

- ☐ I offer opportunities for interdisciplinary learning.
- ☐ I'm aware of state and district STEAM standards and goals for students.
- ☐ I know the names of my students' school-day teachers, especially those who teach science, math, technology, and the arts.

- ☐ I communicate with students' school-day teachers and career guidance counselors.
- ☐ My students use STEAM vocabulary.
- ☐ My students can explain how STEAM activities connect with school learning.
- ☐ My students can explain and use the design thinking process.

Dedicating Time to STEAM

- ☐ I blend STEAM into the program in a variety of ways.
- ☐ I dedicate program time to STEAM activities.
- ☐ I make STEAM materials available to students.
- ☐ I support students' STEAM learning during homework time.
- ☐ I allocate the appropriate amount of time for STEAM activities and projects.
- ☐ I pay attention to student attendance, participation, and engagement in STEAM activities.

Tapping Resources to Support STEAM Learning

- ☐ I'm aware of local STEAM resources and expertise.
- ☐ I engage families and invite them to contribute their skills and knowledge.
- ☐ Students are aware of local businesses, institutions, organizations, and universities involved with STEAM.
- ☐ I invite experts to present during program time.
- ☐ I identify and use high-quality STEAM activity and project plans.
- ☐ I use STEAM curriculum effectively.
- ☐ I draw on skilled volunteers and university partners.
- ☐ I plan and provide career exploration activities.
- ☐ I make sure students have access to tools and technology for STEAM exploration.

Ensuring Student Participation and Engagement

- ☐ Students attend consistently.
- ☐ Students seem eager to explore and engage with STEAM materials and activities.
- ☐ Students ask questions and seek to know more about STEAM topics.
- ☐ Students can describe and explain their STEAM activities and projects.
- ☐ Students persist over time, in ways that are age appropriate.
- ☐ Students participate in individual and group presentations or demonstrations.
- ☐ Students listen to, watch, or consider presentations and demonstrations respectfully.
- ☐ Students actively engage in activity and project planning and development, as appropriate.
- ☐ Students offer ideas and comments, and take part in brainstorming activities.
- ☐ Students participate in review, feedback, and suggestion sessions with staff and peers.
- ☐ Students use equipment and materials properly.
- ☐ Students respect the safety rules when doing activities and experiments.

Reflecting on My Knowledge, Skills, and Growth as a STEAM Educator

- ☐ I'll use the Staff Observation and Review Checklist on the next page to self-assess and reflect on my knowledge, skills, and growth as a STEAM educator.
- ☐ I'll ask my supervisor or a trusted colleague to use the Staff Observation and Review Checklist on the next page to provide feedback on my performance as a STEAM educator.

Staff Observation and Review Checklist

Directions: Use this as a self-assessment or as an observation checklist to provide specific feedback to another staff member.

Creates an engaging STEAM learning environment	Strong	OK	Needs work
Motivates students from outset			
Presents activities in a way that builds excitement and engagement			
Creates opportunities for youth leadership and independent work			
Solicits and honors student voice and choice			
Facilitates student expression and creativity			
Ensures equitable access and inclusion			
Engages students in establishing procedures and norms			
Facilitates active learning			
Supports group work			
Provides inquiry-based activities and experiential learning			
Models STEAM vocabulary, demonstrates techniques, and provides information or guidance when appropriate			
Refers youth to tools and resources when appropriate			
Facilitates use of outside resources			
Ensures that students understand activity goals and objectives			
Checks for comprehension			
Creates groups, buddy systems, or other supports for English learners and students with special needs			
Asks open-ended questions			
Guides students in providing constructive feedback to peers			
Supports self-reflection and a growth mindset			
Engages other adults			
Works respectfully and effectively with volunteers			
Works respectfully and effectively with experts and partners			
Works respectfully and effectively with parents and families			
Builds own skills			
Attends trainings			
Participates actively in trainings			
Leads segments or trainings			
Suggests topics for trainings			
Actively seeks skill-building opportunities and resources			
Participates openly in reviews			
Revises work and seeks feedback			
Supports peers			

Comments:

Use this space to record insights, ideas, and goals to improve your knowledge and practice of STEAM education:

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STEAM at a Glance

What to do: Review this infographic to get familiar with the five STEAM disciplines and the characteristics of STEAM education.

Why it matters: Seeing what's possible can help you design engaging STEAM projects and activities that build students' competence and confidence.

STEAM

An educational approach to learning that uses science, technology, engineering, the arts, and mathematics as access points for guiding student inquiry, dialogue, and critical thinking.

Science

A systematic way to collect and organize knowledge about the world through observation and experimentation.

Technology

Any tool developed by a human to help solve a problem.

Engineering

The use of science and mathematics to design and make things.

Arts

Activities like dance, drama, film, literature, music, and visual arts that use skill and imagination to communicate an idea or an aspect of the human experience.

Mathematics

The study and use of numbers and their operations to describe, measure, predict, and explain occurrences and relationships in the physical world.

Note: *This diagram shows the STEAM definition used by the Institute for Arts Integration and STEAM.*

Four Characteristics of STEAM Education

Creative	Interdisciplinary	Experiential	Inquiry Based
Tackles a real-world challenge or creates something that has value or meaning.	Includes content and skills from more than one field of knowledge.	Provides opportunities for active exploration (for example, through a makerspace).	Follows the design thinking process.

Use of **design thinking + makerspace** is one of many possible models for STEAM education.

Design thinking is a five-step problem-solving process used by engineers and inventors:

1. **Empathize**: Conduct research to develop a deep understanding of the challenge you're addressing and the audience for your solution.
2. **Define**: Clearly define and articulate the problem to be solved.
3. **Ideate**: Brainstorm creative ideas, then narrow down a few to test.
4. **Prototype**: Build a real-life representation (prototype) to test part or all of the solution.
5. **Test**: Engage in short-cycle testing of the prototype and use feedback and research to improve the product.

A **makerspace** is a collaborative environment designed to allow students to make, create, learn, invent, and share.

- **Making** began as a grassroots movement. Its focus on experiential learning inspires creativity, imagination, and inventiveness. At the heart of making are hands-on experiences that are student-driven, invite creative exploration of materials, and harness children's love of play.
- **Makers**: These are the students who are working in the makerspace and performing the act of "making." You, as the facilitator, are also a maker! You're making a meaningful learning opportunity for your students.

Facilitators of the *design thinking + makerspace* STEAM education model perform six tasks:

1. Consider STEAM education variations and characteristics.
2. Activate the power of design thinking and makerspaces.
3. Plan to mitigate risks.
4. Choose your mission and implement your STEAM activity.
5. Ensure a smooth link to program goals by implementing the activity with fidelity.
6. Assess, reflect, and celebrate!

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STEAM Careers: Myth Busting

What to do: Try these discussion starters if you have students who think careers in science, technology, engineering, the arts, and mathematics (STEAM) are beyond their reach or not relevant to their lives or career paths.

Why it matters: Young people who think they aren't "smart enough" or who think STEAM subjects don't connect to their future lives may not have had enough support to explore them. You can help to spark their interest and fire up their curiosity.

Discussion starter: If you're not interested in STEAM subjects in school, do you think that means STEAM careers aren't right for you?

Share this insight: When I hear someone say, "I'm just not interested in math or science or the arts," I always think, "Ah, so you're not interested *yet*." Curiosity isn't a fixed quality. It changes with new experiences. In a video interview for Doing What Works (U.S. Department of Education, 2007), Dr. Jon Star of Harvard University says developing interest in something is "a process." He says it can be sparked by instructional activities and nurtured by adult support. Having new and different experiences can help you see connections between what you're learning in school and what happens in the real world. Never say never!

Discussion starter: Do you think school is the best or only place to learn about STEAM subjects?

Share this insight: An article in *American Scientist* says school isn't where most Americans learn most of their science. Authors John Falk and Lynn Dierking (2010) explain, "The 'school-first' paradigm is so pervasive that few scientists, educators, or policy makers question it. This despite two important facts: Average Americans spend less than 5 percent of their life in classrooms, and an ever-growing body of evidence demonstrates that most science is learned outside of school." There's no predicting where curiosity, once ignited, might lead. Some 75 percent of Nobel Prize winners in the sciences say their passion for science was sparked outside of school (Friedman & Quinn, 2006).

Discussion starter: Do you think boys are more interested than girls in science, technology, engineering, and math?

Share this insight: It's a myth that STEM activities only interest boys. Although males once dominated fields like math, science, and engineering, the gender gap is closing. In the U.S. in 2019, women accounted for a third (34 percent) of people employed in STEM occupations; however, few (11.6 percent) were women of color (Catalyst, 2022). Women continue to be underrepresented in STEM-related careers, and researchers suggest that confidence, more than ability, may be a factor in the gender difference (Morrison, 2019).

Minority populations are also underrepresented in technical and scientific fields. For example, Blacks or African Americans, Hispanics or Latinos, and American Indians or Alaska Natives are underrepresented in science and engineering (National Science Foundation, 2019). Offering STEM education in afterschool settings allows students who are typically underrepresented in the sciences to experience engaging STEM activities, discover new interests, and consider careers in STEM-related fields (Afterschool Alliance, 2021).

Discussion Starter: Do you think science, technology, engineering, the arts and mathematics will be more important 10 years from now, or less important compared to now?

Share this insight: As our economy has shifted from manufacturing to information and technology, career opportunities have also changed. The Pew Research Center (Funk & Parker, 2018) reports that employment in STEM occupations grew 79 percent between 1990 and 2018, which outpaced overall job growth, and computer jobs increased by 338 percent. The projected median income for STEM occupations in 2032 is more than twice that of non-STEM occupations (U.S. Bureau of Labor Statistics, 2023). Also, there's a growing recognition that the arts can play an important role in career preparation. For example, an article in the *Journal of Microbiology & Biology Education* (Segarro et al., 2018) describes how the arts can be used to train well-rounded, creative scientists.

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Student Portfolio Planning and Review Checklist

What to do: Use these ideas to plan for incorporating portfolios into an activity or project. Students can use the planner on the second and third pages, and staff can use the checklist on the last page to provide feedback on the student portfolios.

Why it matters: Student portfolios enable students to demonstrate their learning, creations, and growth over time. Portfolios help students assess their own progress, reflect on what they've learned, and show family members and others what they've accomplished.

Ideas for Portfolio Containers

Portfolios may be kept in a folder, box, or large envelope marked with:

- Student's name
- Title or purpose of project or collection
- Date started and completed

Ideas for Portfolio Content

The portfolio content should demonstrate learning based on goals and objectives. Items to include may be selected by the student, or by the student and staff. Here are some items a STEAM portfolio might include:

- Activity log that shows the number of activities completed
- Project write-ups or demonstrations
- Field trip descriptions
- Journals, reviews, reports
- Photographs, artwork, sketches
- Screenshots or printouts
- Learning contracts and evaluations
- Other items selected or created by the student

Portfolio Planner

Portfolio Plan

Name:____

Date started: ____________________ Completion date: ____________________

Title: ____

Project, topic, subject, or focus area:______________________________

____

1. What is the purpose of my portfolio?

   I want to show that I learned/worked on/went to/tried/did/made ____________

   ____

   I hope people who look at my portfolio will ______________________

2. What will I include?

   Required items (list): Target date

   a. ______________________ ____________
   b. ______________________ ____________
   c. ______________________ ____________
   d. ______________________ ____________
   e. ______________________ ____________

   Other items (optional):

   f. ______________________ ____________
   g. ______________________ ____________
   h. ______________________ ____________
   i. ______________________ ____________
   j. ______________________ ____________

3. How will I evaluate my portfolio? ______________________________

4. How will my teacher evaluate it? ______________________________

Considerations for Deciding What to Include

Before including an item, ask:

- Does this fit with the purpose?
- Should it be attached to another item (to show before/after or draft/finished)?
- Does it demonstrate what it needs to?
- Do I already have something that shows this?
- Do I need to label the piece or write an explanation of why it's included?

Self-Assessment Before Final Submission

1. Before submitting the portfolio, check:

• Are all required materials there?	Yes	No
• Do they show what they are supposed to show?	Yes	No
• Are they well organized and neatly presented?	Yes	No
• Can they be easily understood?	Yes	No
• Is there anything I want or need to add? (Specify: _______________)	Yes	No

2. Does my portfolio show that I achieved the objectives or purpose? Yes No

3. How would I rate the contents of my portfolio?
   - Excellent
   - Very good
   - Good
   - Fair
   - Weak

4. What are two important things I've learned?

Portfolio Review Checklist

Review date: ______________________________

Reviewed by: ______________________________

Portfolio owner: ______________________________

Portfolio subject area or focus: ______________________________

____

____

Does the portfolio include required selections and materials?

Required item (list)	Included	Missing
1. ____________	______	______
2. ____________	______	______
3. ____________	______	______
4. ____________	______	______
5. ____________	______	______

Were the objectives met?

Objective (learning, skill, product, experience, time, other)	**Objective Met?** (yes, no, partly)	**Demonstrated by**	**Not Demonstrated, Need to See More**

Comments:

____

____

____

____

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Student Self-Monitoring Checklist for Project Work

What to do: Use this tool to reflect on your thoughts, feelings, and behaviors before, during, and after project work.

Why it matters: Self-monitoring is an important skill for success in school and work. It helps you identify areas of strength and areas you might want to work on.

Project Start-Up Self-Check

Thoughts and Feelings	Write your answers here
The goal(s) of the project is/are…	
My project tasks are…	
My system for keeping track of work is…	
I am most excited for…	
A question I have is…	
A personal strength I can use is…	
I might need help with…	

Self-Monitoring Checklist

Behaviors	Check a Box (Yes or No)	Support your "yes" or "no" response by describing your behavior here
I pay attention and listen when adults or other students speak.	☐ yes ☐ no	
I take part in discussions during group work.	☐ yes ☐ no	
I do my fair share of the work.	☐ yes ☐ no	
I talk only about the topic or project while we're working.	☐ yes ☐ no	
I use respectful language when I disagree with others.	☐ yes ☐ no	
I only talk with others in my group during group work.	☐ yes ☐ no	
I keep my voice down so I won't distract other groups.	☐ yes ☐ no	
I use time effectively without wasting it.	☐ yes ☐ no	

Self-Selected Areas for Growth

There's always room to take your performance to the next level. Select two or three behaviors from your self-monitoring checklist that you'd like to change. Use this chart to plan how you'll do that.

	Behavior 1	Behavior 2	Behavior 3
What behavior do you want to grow?			
How will you know you have accomplished the goal?			
What do you need to help make this happen?			

Anyone who has never made a mistake
has never tried anything new.

—Albert Einstein

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The Five Whys Questioning Technique

What to do: Use this guide to record students' use of the Five Whys technique to identify the root cause of a problem that interests them. Start by recording the problem statement. Then asks five whys to drill down to what's causing the problem.

Why it matters: Knowing the root cause of a problem helps with understanding the audience and defining the right target before brainstorming possible solutions.

Problem statement:	
Question 1:	Why…
Answer 1:	
Question 2:	Why…
Answer 2:	
Question 3:	Why…
Answer 3:	
Question 4:	Why…
Answer 4:	
Question 5:	Why…
Answer 5:	
Root cause of problem:	

If you do not know how to ask the right question, you discover nothing.

— W. Edwards Deming

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