

Making Time for Tinkering: A Playful Pathway Toward STEM Learning

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I first thought science was a demonstration that had a known outcome of what it's supposed to show, and now I see science as more of a process that I learn from. I'm engaged with it now; it's very open-ended and often surprising.

—Teacher Yuwen Ye

When children tinker, they learn essential STEM (science, technology, engineering, and math) concepts through natural play and investigation. Tinkering with materials that foster engagement with scientific phenomena allows learners to explore new pathways and ideas, which in turn helps them gain new knowledge and skills. While tinkering, learners are invited to embrace a mindset of experimentation in their own learning journeys. It's an intentional and reflective process that promotes STEM learning through playful exploration.

At the Exploratorium, a museum of science, art, and human perception in San Francisco, California, we (the authors) have found that our approach to tinkering is well suited to the needs of early learning teachers, especially those who express reluctance to teach STEM directly or who are nervous about their own STEM understanding. Tinkering provides a pathway for teachers to engage in a playful process of investigation and to become more confident in their own approaches; this supports STEM inquiry and learning. In this article, we discuss the importance of teachers' tinkering and provide an activity to help get you started. We also share how you can connect what you learn through your own explorations to STEM practices with young children.

Shifting Your Mindset Through the Process of Tinkering

Creating engaging and impactful tinkering experiences for young children involves planning, facilitating, and reflecting on the activities and investigations that teachers lead with them. An intentional approach to tinkering allows educators to launch tinkering explorations that foster the development of children's STEM understanding

over time. In addition, they may come to understand their own participation in tinkering as a practice that can support the inclusion and celebration of children's individual strengths and contexts. Universal pre-K project coordinator Ryan Kurada noted that "tinkering as adult learners provokes us to reflect on how we are designing equitable opportunities for all children to engage in STEAM learning."

The planning phase offers an opportunity for teachers to immerse themselves in a tinkering mindset. This, in turn, can support the intentional integration of tinkering experiences into a variety of curricular topics and activities. Teachers can also gain crucial insights about areas related to planning, such as choosing materials, posing challenges, arranging the physical environment, and anticipating children's interests and questions to facilitate their STEM learning.

When teachers tinker for themselves, they can reflect on and advance their own levels of curiosity and understanding of STEM concepts. Tinkering can also spark or renew an interest in STEM ideas and activities. Importantly, it helps with working through challenges that may arise. Encountering and overcoming obstacles are core aspects of the tinkering process and essential for learning. By experiencing what it feels like to be "stuck" and what it takes to get "unstuck," teachers can become comfortable with not knowing the answer every step of the way. This was particularly significant for Teacher Yuwen Ye, who was quoted at the beginning of the article. Over time, Yuwen transformed from a "nervous science educator" to a more confident facilitator while engaging in tinkering herself.

We have found balance to be a great topic to encourage a tinkering mindset for teachers. In the following section, we invite you to try an exploration called balancing sculptures as an accessible way to engage in your own tinkering process.

Tinkering with Balance

Balance is one of the common experiences that almost everyone naturally explores. When adults (and children) tinker with balance, they directly experience concepts related to stability, center of gravity, symmetry, weight, shape, and the composition of various materials. In the balancing sculptures tinkering exploration, we offer teachers a range of tools and materials (such as scissors, hole punches, kitchen utensils, office supplies, small toys, and cardboard) to create sculptures with common materials in ways that seem to defy gravity and produce unexpected arrangements of form, shape, and movement.

We share the following suggestions with them as they engage in their balance explorations:

- Allow yourself ample time for experimentation and to fully immerse yourself in the possibilities. Return to your construction, allowing yourself to build, reflect, and restart the process over many days.
- You can adjust your sculpture over time and add complexity as you begin to figure things out.
- If feasible, engage in this activity with friends or colleagues—collaborative tinkering fosters rich experiences.
- Balance sculpture constructions are inherently unsteady, and materials are likely to fall. Choose a space where crashes are okay.

Following are steps you can try!

Step 1: Gather and Explore Objects

Begin by gathering objects in multiples that have different weights and shapes, like forks, pencils, washers, feathers, leaves, and twigs. Consider the qualities of the objects (such as size, weight, and shape) that can make them easy or difficult to balance. Explore each object, and find ways to balance them in unique ways. Experiment by balancing the materials you collected on your finger or even your head!

Step 2: Build a Base

As you become accustomed to balancing, find or make a stable base from everyday objects to build more elaborate balancing sculptures. Once you have a base, you can experiment with placing individual objects on it. For example, you can add the objects you collected to a pencil taped to a mug or stuck in a halved lemon, a pen in a jar of rice or sand, or a ball placed in a cup or tube.

Step 3: Use Connectors

Connectors can be used to balance more than one object at a time. They can be made of materials such as tape, wire, binder clips, and clay to help you extend your sculpture's height, length, and width. You can also create your own connectors using corks, putty, and other art materials. Test and construct connectors that change the look of your sculpture.

Documenting and Reflecting on Your Tinkering Teaching Practice

We have found that making documentation and reflection a part of your tinkering teaching experience can deepen engagement throughout the process. The following are ways to integrate these approaches into your own tinkering practice:

- Capture photos and videos of your balancing sculptures while experimenting with various objects and arrangements—even if they don't turn out as expected. This will allow you to document how your sculpture sways, bobs, and teeters. Balancing sculptures can occasionally topple when gently pushed or when they catch a gust of wind. Sometimes, watching a recording of your sculpture collapsing can be even more engaging than creating one that is perfectly stable!
- Reflection is an important step in the tinkering approach. Take a moment to pause, reflect, and record your observations to connect them with your current practice. You can write in a journal, record a video, or discuss your thoughts and ideas with a colleague or friend to help you further develop them.



Connecting Tinkering Experiences to Teacher Practice

After engaging in these experiences, you can leverage your understanding to consider learning goals that are responsive to the diverse strengths, interests, and needs of the children in your setting. You can also gain insights about how materials, activity starting points, problem-solving approaches, and the overall environment align with the objectives of a tinkering session. (See “Extend Your Professional STEM Learning and Practice” for a professional development resource to deepen your STEM instructional practice.)

To help connect your own tinkering to your practices with young children, consider the following reflection questions:

- What materials did you enjoy using the most? Which ones did you wish you had? Did you have too few options, too many, or just the right number? What materials will you offer children first? What materials might you add later, after you have observed the children’s tinkering?
- How much time did you give yourself to tinker? Did you need more time? Were you interrupted? How will you plan for children to tinker for extended periods and with plenty of space to spread out? Will children be able to return to these ideas and activities over time?
- How did you feel when your balance sculpture crashed? Was this fun or frustrating for you? How can you help to prepare children for frustrations that may arise for them?

Extend Your Professional STEM Learning and Practice

As you make tinkering a part of your professional practice, you may want to dive deeper into resources. California Early Childhood Online (CECO) offers a free online professional development course, STEAM Starters: Tinkering for Early Learners. The materials in this course highlight various

aspects of the tinkering approach, including learning goals, connections to developmentally appropriate explorations, stories from teachers, and video vignettes of what tinkering looks like in various early childhood settings. STEAM Starters also includes three core activity guides addressing balance, motion, and light and shadow. (To access this course, visit caearlychildhoodonline.org/en_home.aspx and search the keyword “STEAM.”)

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Topics: *Other Topics*, *Technology and Media*, *STEM*, *Professional Development*, *Professional Development*, *TYC*

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