Tinker Tank 101

Reference Materials for Staff Facilitators

Prepared by

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PACIFIC SCIENCE CENTER

ABOUT THIS COLLECTION

Welcome to Tinker Tank! We're excited that you're here.

This is a collection of brief explainers intended to ground you in the ideas that drive how Tinker Tank at Pacific Science Center operates. First, it provides an overview of what Tinker Tank is, why we do it, and suggestions for facilitating visitor safety. Next, this collection unpacks what learning means to us, followed by a discussion of how we teach. It also provides a deeper dive into strategies for welcoming, supporting, and designing experiences in Tinker Tank. Throughout the following pages, you'll find **blue spotlights** that share quick tips and bottom lines for you to remember.

None of these materials are meant to be comprehensive; you're not likely to find details about the day-to-day here. However, these pages should provide an overview of ideas you can revisit later: a "Further Reading" section offers links to more in-depth resources on each subject.

Working in Tinker Tank is an exercise in flexibility and multitasking. Many of the theories and frameworks in this package will paint a tidy picture of learning. As a Tinker Tank facilitator (or a facilitator in any maker space), you'll soon find that learning can sometimes be (quite literally) messy. We ask that you take these ideas and add them to your facilitation toolbox – but use your judgment when selecting which strategy is best for the job at hand. Each learner will enter with their own set of ideas, motivations, abilities, and interests. It's our privilege to help them joyously explore, in whatever way works for best them.

While this collection is written first and foremost for Tinker Tank facilitators at PacSci, we hope our colleagues and peers find value, learn from, and have fun with it!

Caitlin McQuinn, Maker and Innovation Lab Manager
Diana Johns, VP of Exhibits, Education, and Outreach

Thanks for Victoria Bonebrake and Mary Murray, of MEMconsultants, for their work authoring this manual.

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WHAT IS TINKER TANK?

Tinker Tank is a guest-directed, hands-on design space where participants are challenged to use their creativity, problem-solving skills, and experience to persevere through roadblocks, discover new approaches and solve fun engineering tasks. Museum maker spaces, including Tinker Tank, share common goals. These goals include self-directed learning, discovery of the familiar and unfamiliar, and collaborative possibilities.

Staff & Support

The Tinker Tank team is a small crew within Pacific Science Center's maker and innovation lab department. Should you ever need help or guidance at work, these are some people you should know to lean on:

Maker and Innovation Lab Manager: Caitlin McQuinn

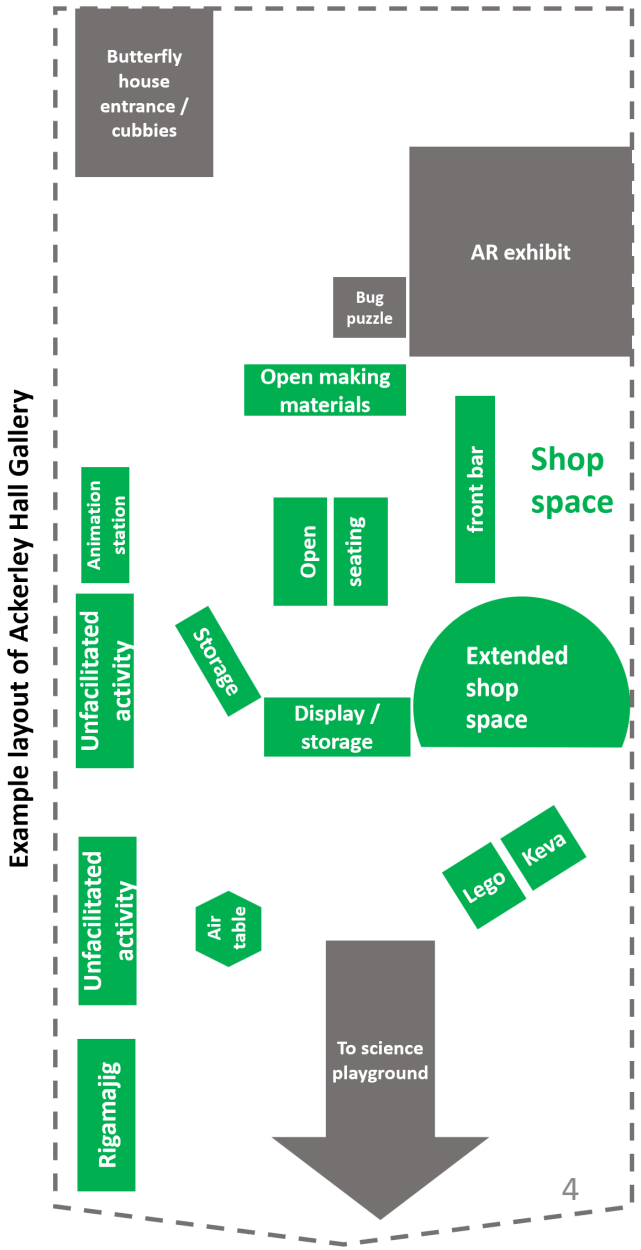
Safety Specialist: Sal Ponce

Intended Audiences

Tinker Tank activities are designed to be developmentally appropriate for people ages 8 up, although we may sometimes offer alternative activities for younger children with caregiver support. Depending on the activity, some age demographics will be more common than others; adults, for example, tend to be drawn to laser cutting and other technical projects. Creating an attractive and welcoming environment for people across a variety of ages and abilities is an ongoing challenge for this space, and for maker spaces in general.

Floor Plan & Zones

To the right is a rough diagram of Ackerley Hall Gallery with the Butterfly House walls at the top. Areas in green are related to **Tinker Tank**. This floorplan reflects a snapshot in time; Tinker Tank is regularly rearranged as new activities are introduced or cycle off the floor. Areas in gray are not maker spaces *but are still under the supervision of Tinker Tank staff*. In addition to Tinker Tank duties, all staff are expected to provide hospitality, monitor the general exhibits, reset activities, and place calls for exhibit repairs when necessary.



WHY TINKER TANK?

Tinker Tank exists because we believe in the power of hands-on experiences to ignite curiosity and fuel passion for discovery, experimentation, and critical thinking in all of us. In a world that is often fast-paced and impersonal, we want to create a space where people of all ages can be confident in expressing their curiosity, see the value in trying again and form the awareness and empathy necessary to build better community.

Tinkering vs. Making vs. Engineering

Despite the name, the Tinker Tank space is designed to engage visitors in making, engineering, and tinkering. **Tinkering** engages in the playful use of tools and materials to find out how they work. **Making** involves the creation of objects that may or may not serve a function. **Engineering** is the design and creation of objects, machines, or processes that do a job.

REMEMBER: You don't have to be an engineer to do this work.

You just have to know enough to encourage visitors to try and explore, picking up again even when they fail. Tinker Tank is meant to be a low-stakes safe space where failure is part of the journey. Working in Tinker Tank is as much about being a good facilitator of scientific thinking as it is about knowing specific technical skills.

Theory of Change

On the next page, you'll find the logic model that describes Tinker Tank's strategy to make change for our guests and community. In trying to build toward our vision, there are three main goals that we have set for our practice:

1. We encourage exploring novel approaches to challenges so that visitors are inspired to follow through and act on their ideas.
2. We emphasize making and tinkering, failure and iteration so that visitors feel empowered to seek out more making experiences.
3. We provide a trusted, safe place, tools and materials, and people so that visitors repeatedly engage with us, fostering stronger connections with our neighbors.

Check out the logic model for more details.

WHY TINKER TANK?

Theory of Change, Dec. 2018

Tinker Tank is a place where a guest can *learn something* from *making something.*

We encourage exploring novel approaches to challenges…	We emphasize making and tinkering, failure and iteration…	We provide a trusted, safe place, tools and materials, and people…
SO THAT guests experience feelings of surprise, delight, and wonder	SO THAT guests are pushed past their comfort zone	SO THAT individuals interact and build connections based on shared experiences
WHICH LEADS TO guests generating new questions based on their own curiosity	WHICH LEADS TO a sense of accomplishment	WHICH LEADS TO Tinker Tank being seen as a hub of making and tinkering education in the Seattle community
AND IN TURN are inspired to follow through and act on their ideas	AND IN TURN guests feel empowered to seek out more making experiences	AND IN TURN repeat engagement fosters stronger connections with our neighbors

Ultimately, Tinker Tank contributes to building a community in which all people are equipped to tackle challenges in innovative ways with confidence.

HOW DO WE MAKE TINKER TANK A SAFE EXPERIENCE?

Tinker Tank gives visitors more freedom to create, explore, and work with real tools than most other PacSci experiences. However, certain amount of risk comes with that freedom.

In order to grow, learners must take risks; but to do so safely, we must give Tinker Tank visitors the right kind of support. It is up to you, the staff, to **introduce** concepts to visitors, **model** skills and behavior, and **monitor** activities to ensure that the experience remains fun and rewarding for everyone.

Elements of Safety

Tinker Tank staff and visitors should work together to create an environment where everyone can:

Be as safe as necessary.	Rather than designing the environment to be as safe as *possible,* recognize that some risk is *necessary* for visitors to learn and improve.
Know their own limits.	Trust caregivers to know what their child is or isn't capable of and lean on parents as helpers in teaching and coaching children.
Feel free to explore.	Give visitors the freedom to test their limits, try their own experiments, and solve their own problems.
Practice fine motor skills.	Some skills require practice to master. Find out how familiar visitors are with the techniques necessary to work with tools they want to try and provide opportunities to practice.
Practice impulse control.	Be clear that all are welcome as long as they are ready to focus, even if that means coming back later.
Show respect for tools.	Model for visitors the "dos: and "don'ts" for care and safety when working.

3 Ways You Can Foster Safety

Think of these as the three "roles" you can play for visitors over the course of an interaction, though not every interaction will follow the entire arc:

1. **Introduce:** Layout the tools and materials, describing their uses and features.
2. **Model:** Get a feel for visitors' familiarity with the skills you are focusing on. Demonstrate how to safely use the tools and explain why those practices are important.
3. **Monitor:** Keep an eye out for unsafe or concerning behavior, coaching visitors on ways to improve their technique when appropriate.

REFLECTIONS ON SAFETY

Thought questions

- Do you know the location of first aid kits in Tinker Tank?
- Are you familiar with safety protocols?
- Do you know who and when to call for help?
- What other safety questions or concerns do you have about working in Tinker Tank?
  → Jot them down to share with the Tinker Tank manager and/or a PacSci safety specialist.

Activity

Role-play the following safety scenarios with a partner. How would you respond as a Tinker Tank staff person?

1. A first grader who is accompanied by a parent wants to use a large handsaw on a woodworking project.
2. A kindergartener who is unaccompanied wants to use a drill press.
3. An adult visitor who has never worked with a bandsaw asks if they can try it.
4. A teen working with a power drill is using it to antagonize their peers.

Drop-In vs. Workshops: Selecting tools for the job

In Tinker Tank, you'll commonly encounter visitors in one of two ways: during drop-in visits or facilitated workshops. Which tips, tricks, and tools you use may differ depending on your scenario. Use the space on pages 26-27 to reflect on how you might apply the ideas and suggestions we've discussed thus far.

WHAT DO WE MEAN BY LEARNING?

An overview of how we think about learning in Tinker Tank

Many theories and frameworks exist to help inform our understanding of how learning is created and the way it is used. They all rely on assumptions about how people operate so that we can make sense of and respond to their behavior. While the specifics of what we teach in Tinker Tank might differ from day to day, how and why we teach will largely be based on the ideas described here.

Constructivism Explained

In Tinker Tank, we base our understanding of learning on the theory of **constructivism**. Constructivism assumes that learning is an active, constructive process: it is something you can build upon as you go. Information a person gains is linked to prior knowledge; and that process happens when you connect your mental "building blocks" in meaningful and memorable ways. Constructivists believe that:

- Knowledge is constructed, not innate.
- Learning is an active process.
- Knowledge is socially constructed.
- Knowledge is personal.
- Learning exists in the mind.

REMEMBER: Constructing knowledge involves practice and failure

Your job is to facilitate a learning environment where visitors can actively participate in constructing their own knowledge: building on what they already know, so that they can problem-solve for the future.

Visitors come in with a wide range of experiences and will leave with equally varied outcomes. ***Don't expect everyone to get it right on the first, second, or even third try: practice and failure are important parts of learning.*** Set that expectation for visitors and encourage them to keep trying.

WHAT DO WE MEAN BY LEARNING?

Key theorists in this field include Jean Piaget and Lev Vygotsky. **Piaget** is famous for describing the stages of child development and the different processes learners might use to adapt incoming knowledge. **Vygotsky** is famous for describing how learning is constructed through social interactions.

Piaget's Processes of Adaptation

Piaget described three processes that learners might use when they encounter and want to integrate new learning. Whether a learner uses any of these processes depends on many factors that are personal to individuals.

Assimilation happens when a learner takes the incoming knowledge and transforms it to fit what they already know - they add the building block of knowledge to their already existing structure.

Accommodation is when a learner shifts part of their worldview - the basis of their knowledge structures- to fit the new information.

Equilibration is when a learner tries to seek a balance between their internal thinking and the external world; they try to find ways where both things can be true.

Zone of Proximal Development

Vygotsky built upon the basics of constructivism and described a process called **social constructivism**, where social interactions can facilitate learning. By interacting with a "more knowledgeable other" – that is, anyone who knows more about the subject, regardless of age or status – learners can reach beyond the bounds of what they can already do unaided, reaching their fullest potential. That space, the distance between what a person can do and all they could ever do with a given subject, is called the zone of proximal development, or ZPD. See the figure on the right for a diagram.

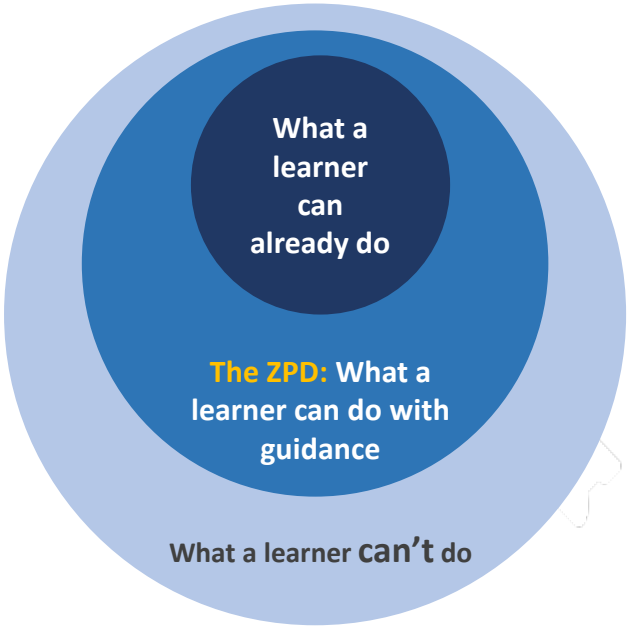


Figure 1. The zone of proximal development

REMEMBER: You are a more knowledgeable other

Don't be intimidated by this title – your skills and familiarity with the tools in Tinker Tank make you more knowledgeable than most visitors, which qualifies you for the role! Remember not to assume what visitors already know. Asking will allow you to make the most of your time together and helps to build trust.

WHAT DO WE MEAN BY LEARNING?

Families & knowledgeable others

You will encounter many types of visitors in Tinker Tank, representing a diverse set of identities and group compositions. **Families** are an important segment of our audience, and you should know a couple things about how they tend to engage.

Family Learning

Many visitors to Tinker Tank will be in family groups. Families are intergenerational groups who share relationships, histories, and memories; they don't have to be biologically related. If a group considers themselves a family, they are one.

What sets families apart from other groups is the role adults play with youth and children during the visit. Adults can be observers, facilitators, friends or playmates, teachers, supervisors, or play other roles specific to their family's dynamic. Understanding these roles can help you to leverage their experiences.

TENSIONS: The line between "scaffolding" and "bulldozing"

Caregivers may want to jump in to guide their kids, and that can be a good thing! We know from research that when adults have the physical space to collaborate with their children and have clarity about the activity's goals, both kids and their adults have more engaging, satisfying experiences.

Other times, caregivers will be a little too helpful and go out of their way to clear obstacles, depriving their child of the learning experience that comes from overcoming them on their own. If you notice this behavior, you can take one of two strategies: actively engaging with the child in a way that invites their creative freedom or redirecting (even distracting) the adult so that the child is free to experiment independently. Sometimes adults need gentle reminders that there are no right or wrong answers, that solving puzzles is part of the fun of learning, and that struggle leads to growth.

Share the stage (and the responsibility)

You're not the only knowledgeable other in the room – don't forget about the caregivers, other adults, and other young people around you! Encourage visitors to engage one another through friendly competitions, challenges, or collaborations. Part of the magic of learning in Tinker Tank is learning from each other.

Help caregivers to help their kids

Each family will have its own dynamic, but here are some tips for facilitating alongside caregivers:

- Make sure everyone understands the activity's goal.
- Redirect bulldozing adults, so kids have opportunities to explore.
- Remind everyone that there are no right or wrong answers.

WHAT DO WE MEAN BY LEARNING?

Frameworks for observing learning

Frameworks give us a lens for observing and discussing complex human behavior. In Tinker Tank, we focus on two: the Visitor Engagement Framework and the Dimensions of Learning Framework. These two examples are a good starting point for considering what learning *looks like* in action and guide our evaluation by informing us what we *look for* when determining how effective our experiences are. Note: No single framework can fully capture the nuances of learning across richly diverse communities.

Visitor Engagement Framework

Chantal Barriault created the visitor engagement framework (VEF) to describe the learning behaviors of science museum visitors interacting with hands-on exhibits. The framework takes ten possible learning behaviors and splits them across three stages or levels of learning which demonstrate different depths: initiation, where a person is getting oriented to the activity; transition, which are more purposeful and committed actions; and breakthrough, where a person shows a sense of commitment to the experience. Table 1 provides more detail about the specific behaviors you might observe. In Tinker Tank, we aim to help visitors reach a "breakthrough", which indicates the deepest level of learning.

Dimensions of Learning Framework

The dimensions of the learning framework were created by the Exploratorium's Tinkering Studio and Evaluation Team to define fundamental characteristics of tinkering that are reflective of learning. These dimensions include 1) engagement, 2) initiative and intentionality, 3) social scaffolding, and 4) development of understanding. Table 2 details the specific indicators for each dimension and shows how the indicators align with Tinker Tank's theory of change.

Tables detailing these frameworks are on the following page.

REMEMBER: Signs of learning can come from anywhere

In Tinker Tank, signs of learning can look like any number of things, such as:

- playing
- seeking help
- persisting with a challenge
- changing tactics
- applying knowledge
- sharing information with others

Giving up out of frustration is not a sign of learning.

WHAT DO WE MEAN BY LEARNING?

Table 1. Visitor Engagement Framework

Stage / Level	Observable behavior
Initiation	Support or assistance by staff or another visitor
	Spending time watching others engaging in the activity
	Starting the activity
Transition	Expressing positive emotional responses
	Pushed past comfort zone
	Completing the activity
Breakthrough	Referring to past or future experiences
	Seeking and sharing information with others
	Sense of accomplishment
	Engaged and involved: testing variables, making comparisons

Table 2. Dimensions of Learning Framework

Learning Dimensions (Category)	Indicators (Learning Behavior)	Alignment with Sections of Tinker Tank's Theory of Change
Engagement	Engage in activities	#1– Encourage exploring novel approaches to challenges
	Display motivation or investment	
Initiative and Intentionality	Set one's own goals	
	Seek and respond to inspiration	
	Seek and respond to feedback	#2– Emphasizing making and tinkering, failure and iteration
	Persist to achieve goals in the problem space	
	Take risks or show courage	
Social Scaffolding	Request help in solving problems	#2– Emphasizing making and tinkering, failure and iteration #3– Providing a trusted, safe place, tools and materials, and people
	Offer help in solving problems	
	Inspire new ideas or approaches	
	Connect to others' works	#3– Providing a trusted, safe place, tools and materials, and people
Development of Understanding	Express realization	#1– Encourage exploring novel approaches to challenges #2– Emphasizing making and tinkering, failure and iteration
	Apply knowledge	
	Strive to understand	#2 – Emphasizing making and tinkering, failure and iteration

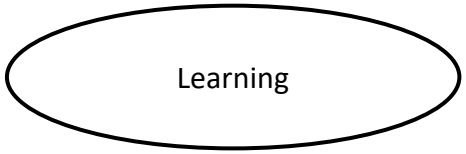
REFLECTIONS ON LEARNING

Thought questions

- How do these definitions of learning compare to other definitions you've encountered?
- Looking at the two frameworks for learning, how are they the same? How do they differ?
- In the section about bulldozing, we talk about supporting children in ways that invite their creative freedom. What questions or strategies could you deploy in that scenario?

Activity: Concept Mapping

Sit down with a piece of blank paper and a pen. Write the word "learning" in the middle and create a concept map of ideas around it. What still confuses you about the learning concepts discussed in this section? Talk through these points with your training leader.



Drop-In vs. Workshops: Selecting tools for the job

In Tinker Tank, you'll commonly encounter visitors in one of two ways: during drop-in visits or facilitated workshops. Which tips, tricks, and tools you use may differ depending on your scenario. Use the space on pages 26-27 to reflect on how you might apply the ideas and suggestions we've discussed thus far.

HOW ARE WE TEACHING?

Design thinking & empathy-based problem-solving

Design thinking is a systemic way of problem-solving that can be used by students and professionals alike. In Tinker Tank, design thinking is at the heart of all that we do: we use the cycle as a teaching tool so that each of our activities, in some way, opens a space for visitors to problem-solve and innovate creatively.

Design Thinking Cycle

One thing that makes design thinking different from other teaching models is that instructors serve as facilitators and advisors rather than as the source of solutions or answers. Learners lead the process of empathizing, defining, ideating, prototyping, and testing possible solutions. Though referred to as a cycle, learners don't need to run through the full gamut of steps in any particular order; any stage of the cycle can be revisited at any time as new discoveries are made.

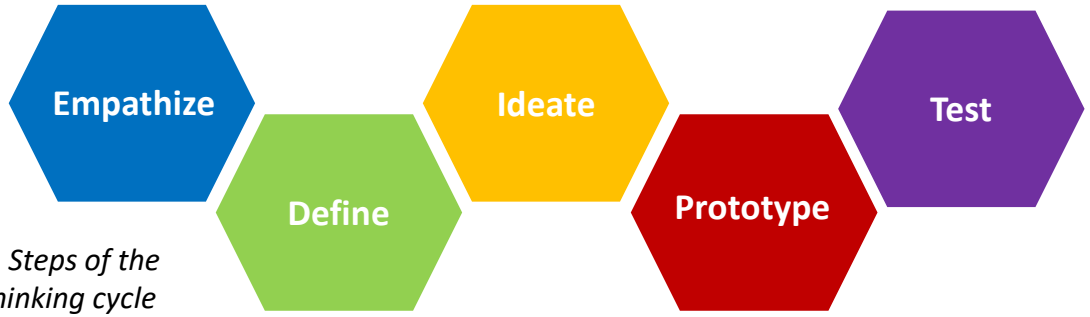


Figure 2. Steps of the design thinking cycle

Empathy-based Problem-solving

The most important step of the design thinking cycle is the very first one: empathizing. That means taking the time to consider who we are designing for, what challenges or obstacles we need to help them overcome, and how those persons live or interact with the world. Whenever possible, this involves talking directly to end-users. Thoroughly understanding who we are designing for sets the tone for how long and how well the rest of the process goes. Even in science, practicing empathy is an important part of building a better world.

Use your problem-solving and people skills together

TO DO

Beyond science and engineering, there's also a human side to what learners can take away from their experience at Tinker Tank.

- Model and engage people in different ways of looking at the world.
- Give visitors a chance to practice empathy. Ask them: who they're designing for? What kinds of needs does that person have?

HOW ARE WE TEACHING?

Basics of universal design

Universal design is a lens or way of thinking about your work when creating inclusive experiences. You may have heard the term accessible design, which relates to this concept; the two ideas differ in that universal design seeks to be inclusive for all people based on characteristics *beyond* just their abilities.

Supporting Intersecting Identities

Universal design addresses where our identities intersect by considering how people interact with experiences based on their:

Age	**Gender**	**Stature**	**Race/ethnicity**
Culture	**Native language**	**Learning style preference**	**Ability**

The Seven Principles

Folks at the Center for Universal Design created a tidy list of considerations you should make when creating universally inclusive experiences. They are:

1. **Equitable use:** do you disadvantage or stigmatize any groups of users?
2. **Flexibility in use:** can you accommodate a wide range of individual preferences or abilities?
3. **Simple & intuitive use:** is it easy to understand regardless of the user's experience, knowledge, language skills, or concentration level?
4. **Perceptible information:** are you communicating necessary info effectively, regardless of ambient conditions or the user's sensory abilities?
5. **Tolerance for error:** do you minimize hazards or consequences of unintended actions?
6. **Low physical effort:** can it be used efficiently and comfortably with minimal fatigue?
7. **Size and space for approach:** is there room to approach, reach, and manipulate regardless of body size, posture, or mobility?

REMEMBER: When it comes to access and inclusion, every little bit counts

You won't always have complete control over your spaces, and you won't often have the chance to design things from scratch. Retrofitting something to make it accessible is ok! Just remember that universal design principles can apply to projects as big as a building and as small as an object or experience.

REMEMBER: Create inclusive spaces and interesting challenges

It may seem like the puzzles and challenges of Tinker Tank run counter to universal design principles but remember that we're designing *environments* so that people are empowered to generate solutions.

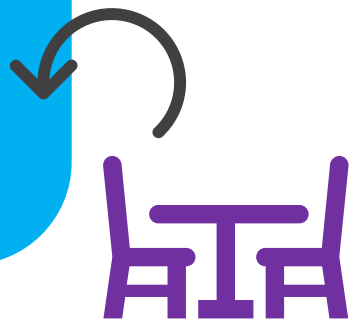
HOW ARE WE TEACHING?

Considerations for universal design

The following is a non-exhaustive list of considerations you should make when aiming for universal design**.** The lists are broken down into three kinds of strategies: physical inclusion, social inclusion, and cognitive inclusion. Use these considerations alongside the human characteristics on the previous page when assessing how inclusive your experiences are.

PHYSICAL INCLUSION

- ❑ Navigation & reach
- ❑ Seating
- ❑ Lighting levels
- ❑ Signage
  - ❑ Font style
  - ❑ Size
  - ❑ Line length
  - ❑ Contrast
  - ❑ Placement
- ❑ Accessible media
  - ❑ Sound level
  - ❑ Captions
- ❑ Tactility



SOCIAL INCLUSION

- ❑ Approachable staff
- ❑ Welcoming environment
- ❑ Opportunities for everyone placed together. NOT "separate but equal"

COGNITIVE INCLUSION

- ❑ Multi-sensory or complementary experiences
- ❑ Audio descriptions
- ❑ Braille translations
- ❑ Multi-lingual text
- ❑ Images that support & replicate text

REFLECTIONS ON TEACHING

Thought questions

- Why is it important for our visitors to practice empathy?
- What do you think the intention is for teaching design thinking to our learners?

Activity: Concept Mapping

Use design thinking to help visitors practice design thinking! Brainstorm an activity that we might use in Tinker Tank based on concepts of design thinking. Use the following prompts to guide your thinking. (Remember, **empathize** with the visitor, then **ideate**).

1. What the base skill (wood construction, knitting, laser cutting, metal working, etc.)?
2. What is the problem visitors are trying to solve? Make this as open-ended as possible.
3. What kinds of tools and supplies will you need?
4. How can visitors test their creation?

Activity: Part Two

Test your **prototype**! Find a partner and try out each other's activities. What works well? What might you change? Use the design thinking cycle to **iterate** on your activity. Pay special attention to changes you might make to be more inclusive (see the human characteristics and considerations listed on the previous pages).

Drop-In vs. Workshops: Selecting tools for the job

In Tinker Tank, you'll commonly encounter visitors in one of two ways: during drop-in visits or facilitated workshops. Which tips, tricks, and tools you use may differ depending on your scenario. Use the space on pages 26-27 to reflect on how you might apply the ideas and suggestions we've discussed thus far.

HOW DO WE WELCOME VISITORS INTO TINKER TANK?

Visitor motivations

Understanding **visitor motivations** can help us to create more meaningful and memorable experiences. While the reasons people come can be multiple and multi-faceted, there are some over-arching categories we can lean on to inform our practice.

Why Do Visitors Come?

Through a series of studies done over many years, museum learning researcher **John Falk** categorized five motivations for museum visitation. Please see the table below for a summary of those categories. Within Tinker Tank, some common visit motivations visitors have expressed include:

- Caregivers want activities to keep their children occupied.
- Caregivers want their children to learn STEM-related skills.
- Children wanting to play or with curiosity to explore.
- Children being drawn in by things that are new to them, "risky", or "adult".

Many of our visitors will be adults with children, but we aim to create spaces where both can feel comfortable tinkering.

Table 3. Summary of Falk's museum visitor motivational identities

Explorers	Come with a curiosity or general interest in discovering more about the subject.
Facilitators	Visit to satisfy the needs and desires of someone they care about, other than themselves.
Professionals/hobbyists	Have a strong interest in the subject and are seeking specific info, or want to see how info is conveyed.
Experience Seekers	Want to "collect" an experience so they've "been there, done that."
Spiritual pilgrims	Hoping to reflect, rejuvenate, or bask in the wonder of a place.

Intentionally set and reset expectations

Tinker Tank is so unlike other exhibits that you will inevitably need to set and reset visitors' expectations. Here are some strategies you can use:

- Get as close to yes as possible.
- If circumstances allow, it's ok to say yes to unusual requests.
- If you have to say no, explain the limitations (e.g., time).
- If you can, suggest other resources (other places and times where you can do the desired activity).
- Redirect to the next most exciting activity or an activity that achieves similar outcomes.

If someone wants to do a restricted activity, you shouldn't leave room for negotiation. Instead, be firm but kind in explaining that it's not that we don't believe they can do it, but because it's the rule and what we feel we need to do to ensure this space is safe for everybody.

SUPPLEMENT: Tips for inclusive language

The following are suggestions for inclusive language you can use when interacting with visitors. In Tinker Tank, there aren't any hard or fast rules about language and terminology, but we want you to do your best to be respectful and inclusive of everyone. That means approaching conversations with kindness and humility: avoid adjectives or statements that may carry a negative judgement and don't make assumptions about people you don't know. Understand that mistakes and missteps happen, but an acknowledgment and sincere apology can go a long way. And when in doubt, don't be afraid to politely ask questions when you *need* to know something. Modeling the request yourself creates an opening to talk about it. For example:

"By the way, my name's Victoria, and I use she/her pronouns. What about you?"

For more ideas and suggestions, check out the Progressive's Style Guide by SumOfUs.org.

Groups of people:	Folks, people, visitors, learners
Age:	Younger people, teens, older people, seniors
Gender:	They/them, my friend, (first name if known), (self-identified pronouns)
Ability:	Disabled person, non-disabled, person who is (blind, etc.)
Economics:	Lower-income, unhoused, houseless, food insecure
Immigration:	Asylum seeker, person seeking citizenship, refugee, undocumented immigrant
Indigeneity:	Native American, Indigenous, First Peoples, Coast Salish people, (Specific Tribe Name)
Race & Ethnicity:	Ethnic minority, racial minority, linguistic minority, people of color, (self-identified race/ethnicity)

TENSIONS: Addressing uncomfortable topics in conversation

We want visitors to bring their whole selves into Tinker Tank– and sometimes that means addressing topics that make us uncomfortable. Role playing or thinking through possible responses ahead of time is one way to ease that discomfort. Think it through: what are some potentially uncomfortable subjects that might arise? What might you say in that situation?

HOW CAN WE SUPPORT VISITORS' LEARNING?

Strategies for supporting inquiry-based learning

Once a visitor has been drawn into Tinker Tank, it's time to explore an activity together. One of the best ways to support a visitors' exploration is to ask questions. The process of guiding learners through questions and reflection is called **inquiry-based learning**.

Why Ask Questions?

Asking questions is a powerful tool because it helps both you and the visitor by:

For you

- Gives you feedback on learners' process.
- Helps you assess their level of understanding.
- Helps you assess their ability to apply learned concepts and knowledge.
- Keeps the discussion on track.

For visitors

- Focuses their attention.
- Arouses interest.
- Stimulates and guides thinking and reflection.
- Encourages observation and prediction.
- Explores different viewpoints.
- Summarizes progress and consolidates learning.

Questions Lead to Learning and Discovery

Asking a lot of questions requires learners to take a lot of risks in giving answers. Strive to create a welcoming atmosphere where all answers are safe by:

- Praising every answer and pointing out what is right about it.
- Allowing learners to explain their reasoning and change their conclusions.

Give learners lots of wait time when they respond to your questions. The longer you stay silent after asking a question, the better and more thorough the answers will be.

Ask questions for your sake, as well as theirs

Looking at the benefits of questioning noted at the left, how might you ask questions related to each bullet point? Remember to form questions that allow an open-ended response whenever possible.

Just like in improv, use *"Yes and..."*

We never want to say "no" to a guest's response, even if it's incorrect. Instead, try to accept the statement in a way that validates their statement while adding something to it. For example:

> *Guest: I'm afraid the butterflies will bite me.*
>
> *Staff: Yes, I think the butterflies have weird-looking mouths, too.*

It is more likely to alienate a visitor if you say flat out that butterflies won't bite.

HOW DO I KNOW WHEN A LEARNER NEEDS HELP?

Tips and strategies for knowing when to step forward and step back

In Tinker Tank, we are all about fostering a **growth mindset** – we want all of our visitors to believe that their talents, intelligence, and abilities can be further developed. People with a growth mindset seek opportunities to learn, gain new skills and enhance their existing skills. In contrast, someone with a fixed mindset believes their abilities, talents, intelligence, or personality traits are something they are born with and largely don't change. **Carol Dweck** coined these terms, growth mindset and fixed mindset.

Stepping Forward vs. Stepping Back

One thing that we hope to impart with our teaching is that challenges are not just opportunities for failure-- growth comes from trying (and sometimes failing) to solve problems. We want the process itself to be rewarding. In our space, we practice the following:

- Favoring **creativity** rather than rote practice.
- Highlighting **mistakes as opportunities** for discovery.
- Stressing the inherent value of **process over product.**
- Focusing on activities with **multiple possible outcomes.**
- Promoting **enthusiasm and playfulness.**
- Providing opportunities for visitors to **communicate** about their work.

Tempting though it might be to jump in with a correct answer, the journey toward learning is more impactful when the visitor does it. Sometimes you must let learners go down dead ends that you know are dead ends just because they need to figure it out. What you *can* do is lean into tricks and tools rooted in inquiry-based learning. Ask questions that will help visitors unpack what's working, what they need, and where they might go next.

Be comfortable in the struggle – and help visitors be there, too

TO DO

It's important to encourage learners to keep trying and puzzling. Many of the problems learners encounter out in the world are complex, not well-defined, and lack a clear solution and approach– just like the activities we try to provide. Learners in Tinker Tank should see challenges and failure as a chance to grow and do better. **If a visitor is distressed or wants to give up, it's time for an intervention.** That could mean:

- a pep talk to keep spirits up,
- questions to get ideas flowing,
- demos or practice for fine skills, or
- examples to provide inspiration.

HOW CAN WE BETTER SUPPORT OUR VISITORS?

What evaluation says about how we can improve visitor experiences in Tinker Tank

PacSci's prior evaluation of Tinker Tank (funded by a grant from the Institute of Museum and Library Sciences) has helped us understand how visitors perceive their experience and what they want or need more of. Additionally, in early 2022, PacSci employee Caitlin McQuinn visited maker spaces across the continental US and observed unique practices that sustained visitors' interest. Ideas from both of those sources are summarized here.

Creating More Multi-generational Activities

Though the sample size was small, data from the evaluation implied that guests who both facilitated and participated in Tinker Tank displayed more transition and breakthrough behaviors than those who exclusively participated. Traditional crafts such as sewing, knitting, and woodworking are strong draws from multi-generational engagement. Older family members who already possess related skills enjoy bringing their younger families to learn.

Facilitating to Surmount Visitors' Mental Roadblocks

During interviews, Tinker Tank visitors talked about times they felt pushed out of their comfort zone. These occurrences were usually prompted by a lack of inspiration or hitting a roadblock in the construction of their project. Visitors tended to seek examples, follow diagrams, or change construction methods to overcome those feelings. In addition to giving encouragement, Tinker Tank staff can provide a wide variety of examples for inspiration. When roadblocks are skill-related, staff can provide guided practice and demonstrations. For example, The New York Hall of Science focuses on simple skill-building to build visitors' confidence.

Empathize with the people that *you* are designing for

TO DO

In Tinker Tank, we are both teaching design thinking and *using* design thinking. When we create activities and experiences, we try to envision our audience: what do they enjoy? What do they need to be successful?

HOW CAN WE BETTER SUPPORT OUR VISITORS?

What evaluation says about how we can improve visitor experiences in Tinker Tank

Fostering Connections to Personal Life

Asked to verbalize what they were thinking while testing out new activities, Tinker Tank visitors tended to have thoughts about their personal lives that weren't always related to the activity at hand. Strengthening personal connections may help sustain interest in the projects while allowing visitors to see how STEAM concepts fit into their personal lives. For example, try to ask questions that allow visitors to reflect on their prior experiences, such as:

- Have you done anything like this before?
- Where have you seen something similar?
- What do you remember about that experience?
- Do you know anyone who works with ____?

REMEMBER: People are drawn to experiences that reflect parts of themselves

Both examples (see left) demonstrate the role identity plays in how people engage in learning environments– even Tinker Tank.

Engaging Adults as Well as Children

For some solo adult visitors (even teens), the simple presence of a lot of young children makes them automatically assume it's "not for them." Some maker spaces that best engage teens and single adults set age restrictions on the spaces or workshops to create a more focused, less distracting, more "adult" work environment. Others have a mix of large and small chairs to be inclusive of both groups. Try to create challenges that appeal to adults and children; encourage cooperative or competitive play between visitors for added appeal.

TENSIONS: Creating inviting spaces for people of *all* ages and abilities

The question of how to create an inviting maker space for everyone is an ongoing challenge.
At Tinker Tank, we want to experiment with a variety of strategies, and your input is essential! For example, how can we make the space inviting for adults as well as kids?

- How can we ensure riskier tools are restricted but still accessible?
- How can we accommodate people of all statures, sizes, and abilities?

REFLECTIONS ON SUPPORTING VISITORS

Thought Questions

Think about a time you struggled to learn something.

- How did your teacher react?
- How did you overcome that challenge?
- What lessons from that experience can you carry into Tinker Tank?

Revisit the tension questions from the previous page, alone or with a partner.

- How can we make the space inviting for adults as well as kids?
- How can we ensure riskier tools are restricted but still accessible?
- How can we accommodate people of all statures, sizes, and abilities?
- What other considerations should we make that we haven't already?

Activity: Visitor Encounters

Role-play the following scenarios with a partner. How would you respond?

1. Tinker Tank is hosting a special session for teens to work on projects when a third grader walks by and asks to join.
2. A visitor wants to 3D print a keychain but doesn't realize that it will take eight hours.
3. A visitor wants to use a specialty tool that Tinker Tank doesn't own.
4. A child is scared about hitting their fingers with a hammer.

Activity: Reading Signals

Knowing when to step in and help a visitor means knowing what it looks like when they're struggling. It may be easier to notice signs in workshops where visitors work toward a common goal. What are some signs that a drop-in visitor needs support?

REFLECTIONS ON SUPPORTING VISITORS

Drop-In vs. Workshop: Selecting tools for the job

Use the space below to reflect on how you might apply the ideas and suggestions we've discussed in these pages. Does this work look different in each scenario? Are some more challenging to implement than others?

Apply Tips and To Dos ...	... to Drop-Ins ...	... and to Workshops.
Facilitate for scientific thinking (pg. 5)		
Introduce, model, & monitor (pg. 7)		
Allow practice and freedom to fail (pg. 9)		
Embrace your role as expert (pg. 10)		
Share the stage and responsibility (pg. 11)		
Support caregivers (pg. 11)		
Notice signs of learning (pg. 12)		

REFLECTIONS ON SUPPORTING VISITORS

Encourage empathy in visitors (pg. 15)		
Use universal design as a lens (pg. 16)		
Set and reset expectations (pg. 19)		
Use questions to assess learning (pg. 21)		
Validation and redirection (pg. 21)		
Normalize growth mindset (pg. 22)		
Use empathy in your own work (pg. 23)		
Allow space for visitors to relate (pg. 24)		
Support evaluation efforts (pg. 27)		

HOW CAN EVALUATION STRENGTHEN TINKER TANK?

How PacSci uses evaluation

Evaluation, in the nonprofit sector, is a systemic process used to obtain information on an organization's activities, its impacts, and the effectiveness of its work. Organizations use evaluation to improve their activities and describe their accomplishments. The related field of visitor studies is focused on understanding and enhancing learning experiences in informal learning settings through research, evaluation, and dialogue. Evaluation is often mistakenly thought of as just data collection. Still evaluation is an iterative cycle that includes asking questions, collecting data to answer those questions, and using the data to learn.

PacSci, as an organization, has a longstanding value and habit of using evaluation: we value data, we value experimentation and innovation, we build in feedback loops to improve programming, and we share what we learn in order to help advance the field.

What We Want to Learn Through Evaluation of Tinker Tank

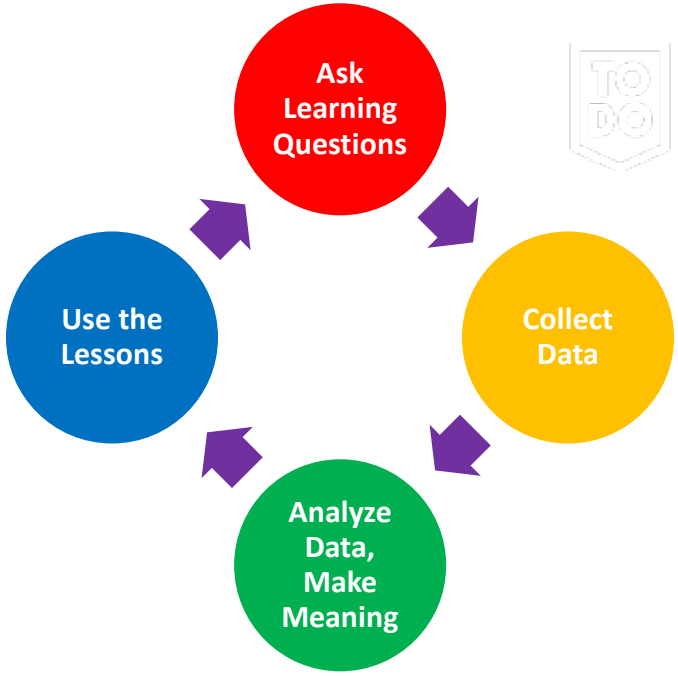
We have two kinds of learning questions specific to Tinker Tank.

Outcome Evaluation Questions

- What are the short- and long-term benefits to those who engage in Tinker Tank?
- Does Tinker Tank's participation forward the mission of PacSci to ignite curiosity and fuel a passion for discovery, experimentation, and critical thinking?

Process Evaluation Questions

- What role does facilitation play in improving the outcomes of Tinker Tank?
- What does effective facilitation look like? How does this differ between drop-ins and workshops? What do facilitators need to be effective?
- How does activity choice impact outcomes? Do the current activities achieve intended goals and outcomes, or can changes increase their effectiveness? What criteria should be used to select future activities?



Data collection might include surveys, observation tools, interviews, focus groups, or other qualitative or quantitative data. Evaluation resources shown on page 30 offer a list of tools and instruments that might be used in Tinker Tank.

WHAT OUTCOMES DO WE ANTICIPATE FROM TINKER TANK?

Understanding what outcomes of a particular program you anticipate is a first step to planning to collect data. There are many potential benefits to participation in tinkering, engineering and project-based learning. These include:

STEM Learning. Outcomes related to Science, Technology, Engineering, and Math are not limited to content knowledge but also include social, emotional, and developmental outcomes. In other words, we want to know if Tinker Tank: increases engagement and interest in STEM learning and activities, hone STEM knowledge and skills, boosts value and awareness of the relevance of and role STEM plays in careers and everyday life or impacts visitor identity as a person who can do or does STEM.

Executive Functioning skills are the mental processes that enable us to plan, focus attention, remember instructions, and juggle multiple tasks successfully. Children aren't born with these skills—they are born with the potential to develop them. Researcher Tom Brown breaks executive functions down into six "clusters:

1. Organizing, prioritizing, and activating tasks,
2. Focusing, sustaining, and shifting attention to tasks,
3. Regulating alertness, sustaining effort and processing speed,
4. Managing frustration and modulating emotions,
5. Utilizing working memory and accessing recall, and
6. Monitoring and self-regulating action.

21st Century skills are identified as supporting youth success in school, work, and life; some might call them soft skills, while others recognize their critical importance. The Youth Development Executives of King County, in partnership with the RoadMap project, break them down in the following manner:

1. Creativity: ideation, imagination, innovation;
2. Critical thinking: metacognition, problem-solving, analytical thinking; and
3. Interpersonal skills: collaboration, communication, conflict resolution, compassion and cultural competence.

Be an Evaluation Team Player

Program evaluation isn't about judging individual performance: it's about finding out what works and can be improved. Evaluation results benefit the whole team, and the process works best when everyone pitches in. There are different ways that facilitators can support the evaluation of Tinker Tank:

- Help clarify and narrow the short list of **desired outcomes**.
- Help determine what **effective facilitation** looks like and the best way to measure and document it.
- Support those who are tasked with data collection.
- Help document lessons learned during the pilot of Tinker Tank activities.

TINKER TANK EVALUATION RESOURCES

Pacific Science Center received a two-year grant from the Institute of Museum and Library Sciences (IMLS) to develop and test a variety of evaluation and assessment tools in Tinker Tank. In 2019, staff modified and tested various existing evaluation and assessment tools to determine how they could be best used within Tinker Tank specifically. More details about modifications and methodologies used in this study can be found alongside the tools in this document.

What We Learned About the Tools and Instruments

Tinker Tank evaluation isn't limited to these five tools, but the 2019 Audience Impact Study provided insight into how these tools might be used. The following table gives an overview of the tools, their requirements, and considerations. For more details, check out the instrument protocols here: [insert link here]

Tool	Aim	Type	Occurrence	Supplies	Interaction	Kind of Learning Question + Notes
Visitor Engagement Framework	Looks for levels of visitor engagement.	Mixed methods	During	Worksheet Pencil Clipboard Timer	No	**Outcomes**. Requires full, undivided attention of data collector. Need enough space to eavesdrop unobtrusively.
Dimensions of Learning Framework	Looks at types of learning behaviors.	Mixed methods	During	Worksheet Pencil Clipboard Timer	No	**Outcomes**. Requires full, undivided attention of data collector. Need enough space to eavesdrop unobtrusively.
Think Aloud	Provides insight into what visitors are thinking while working.	Qualitative	During	Recorder Transcription	Yes	**Process**. Requires on-the-spot orientation for participants.
Interview	Provides insight into visitors' prior experiences and future intentions.	Qualitative and/or Quantitative	After	Recorder Transcription	Yes	**Outcomes** or **Process**. Customizable. A good complement to observations to capture nuances with probing follow-up questions.
Interactive Multiple-Choice Survey	Provides quick counts of responses to closed-ended questions.	Quantitative	After	Activity board Pre-cut strings	Yes	**Outcomes** or **Process**. Customizable. Only works for closed-ended questions. Fun and appealing to visitors.
Activity Screen	Ensures that the right questions are asked when facing choice-points about activities.	Qualitative	Before and During	Minimal	No	**Process**. Flexible tool for use by individuals or at team meetings.

FURTHER READING

Safety in Tinker Tank

Introduce, model, monitor	Boston Children's Museum "Tinker Kit"

Theories and Frameworks for Learning

Constructivism	Simply Psychology "Constructivism"
Piaget	Simply Psychology "Piaget"
Zone of proximal development	Simply Psychology "The Zone of Proximal Development and Scaffolding"
Family learning	Engage Families "Family Learning 101"
Visitor engagement framework	Barriault and Pearson (2010)
Dimensions of learning framework	Exploratorium DoLF

Design thinking

Design thinking cycle	John Spencer "What is design thinking?"
Empathy-based problem-solving	Edutopia "Teaching empathy through design thinking"

Universal design

Guidelines for exhibits	NISE "Universal Design Guidelines for NISE Network Exhibits"
Guide for science museums	AccessISL "Equal Access: Universal Design for Your Informal STEM Learning Program"
Learning styles	Yale Center for Teaching and Learning "Learning Styles as a Myth"

FURTHER READING

Welcoming visitors

Falk's visitor motivations	Falk (2010)

Inquiry-based learning — Edutopia "What the heck is inquiry-based learning?"

Supporting visitors' learning — PacSci "Introduction to Interpretation"

Helping visitors

Growth mindset	Intelligent Change "What Is Growth Mindset and How to Achieve It"
Learning Through Mistakes	KQED MindShift "Math and Science Inquiry: The Importance of Letting Students Stumble"
Stepping forward vs. back	Connected Science Learning "Fostering a STEAM Mindset"
	Brookings "Teaching problem-solving: Letting students get stuck and unstuck"

Evaluating Tinker Tank

Museum evaluation	Adams (2012)
Visitor studies	Foutz and Stein (2009)
Tinker Tank 2019 evaluation	PacSci "Year 1 Audience Impact Report 2019"

SOURCES

Slide	Source Materials and Credits
Safety (7)	Porter, T., & Fredricks, B. (n.d.). Tinker Kit Educator's Guide. Boston Children's Museum. Retrieved June 25, 2022, from https://www.bostonchildrensmuseum.org/sites/default/files/pdfs/Tinker_Kit_Educators_Guide_singles_web.pdf
Constructivism (9-10)	Piaget, J. (1952). *The origins of intelligence in children*. New York: International Universities Press, Inc., pp. 1-20. Vygotsky, L.S. (1978). *Mind in society: The development of psychological processes.* Boston, MA: Harvard College, pp. 19-57 and 79-91.
Family Learning (11)	Bourque, C.M. & Houseal, A.K. (2012). *Family learning in free-choice educational settings: A review of the literature for the National Park Service.* Technical report prepared for the National Park Service. Washington, DC.
Frameworks (12-13)	Barriault, C., & Pearson, D. (2010). Assessing Exhibits for Learning in Science Centers: A Practical Tool. Visitor Studies, 13(1), 90–106. https://doi.org/10.1080/10645571003618824 Gutwill, J. P., Hido, N., & Sindorf, L. (2015). Research to Practice: Observing Learning in Tinkering Activities. Curator (New York, N.Y.), 58(2), 151–168. https://doi.org/10.1111/cura.12105
Design Thinking (15)	Alrubail, R. (2015, June 2). Teaching Empathy Through Design Thinking. Edutopia. https://www.edutopia.org/blog/teaching-empathy-through-design-thinking-rusul-alrubail
Universal Design (16-17)	DO-IT Center (2020). Equal Access: Universal Design for Informal Science Learning. Retrieved October 12, 2022, from https://www.washington.edu/doit/sites/default/files/atoms/files/EA_UD_ISL_01_08_22_a11y.pdf
Welcoming (19)	Falk, J. H. (2006). An Identity-Centered Approach to Understanding Museum Learning. Curator (New York, N.Y.), 49(2), 151–166. https://doi.org/10.1111/j.2151-6952.2006.tb00209.x
Supporting Learning (21)	DeLyria, J., & Slettedahl, L. (2013). *Introduction to Interpretation*. Pacific Science Center.

SOURCES

Slide	Source Materials and Credits
Supporting Learning (21)	DeLyria, J., & Slettedahl, L. (2013). *Introduction to Interpretation*. Pacific Science Center.
Helping (22)	Carsten Conner, L., Tsurusaki, B., Tzou, C., Sullivan, P. T., Guthrie, M., & Pompea, S. (2019). Fostering a STEAM Mindset Across Learning Settings. Connected Science Learning, 1(12). https://www.nsta.org/connected-science-learning/connected-science-learning-october-december-2019/fostering-steam-mindset
Supporting Visitors (23-24)	Evaluation Department. (2020). *Design, Build, Test, Repeat!: Tinker Tank Evaluation for 2019* [Evaluation Report]. Pacific Science Center.
Outcomes (29)	Afterschool Alliance. (2013). Defining youth outcomes for STEM learning in afterschool. Washington, DC: Author. Retrieved from http://informalscience.org/research/ic-000-000-003-885/Defining_Youth_Outcomes_for_STEM. Brown, T.E. (2008, February). Executive functions: Describing six aspects of a complex syndrome. *Attention Magazine*, 12-17. https://chadd.org/attention-article/executive-functions-describing-six-aspects-of-a-complex-syndrome/ Youth Development Executives of King County (2014, May). Skills and dispositions that support youth success in school: Executive Summary of Parts 1 and 2. https://ydekc.org/wp-content/uploads/2015/11/Skills-and-Dispositions-Executive-Summary-May-20141.pdf

SUPPLEMENT: Safety Rules & Policies

TEXT

RADIO CALLS

Each staff person is issued a radio …

CALL SIGN	ACTIVITY

SUPPLEMENT: Example of a typical workday in Tinker Tank

TEXT

TIME FRAME	ACTIVITY	NOTES