

Design strategies framework overview

CONTENT STRATEGIES

Content should include:

- Applications or uses
- Chemistry concepts
- Connections across STEM topics
- Connections to everyday life

FORMAT STRATEGIES

Format should:

- Allow for experimenting with variables
- Allow for observation of phenomena
- Allow for use of tools and materials
- Be hands-on and interactive
- Evoke familiar experiences

OUTCOMES / IMPACTS

Public participants will have:

increased **interest**
in the field of chemistry

- Applications or uses
- Chemistry concepts
- Connections across STEM topics
- Connections to everyday life
- Societal issues

- Allow for observation of phenomena
- Allow for use of tools and materials
- Evoke familiar experiences

increased understanding
of the **relevance** of
the field of chemistry
to their lives

- Chemistry concepts
- Connections to everyday life

- Allow for experimenting with variables
- Allow for observation of phenomena
- Allow for use of tools and materials
- Be hands-on and interactive
- Be simple to do and easy to understand
- Evoke familiar experiences

increased feelings of
self-efficacy about
chemistry (ability to do
chemistry activities and participate
in conversations about chemistry)

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CONTENT: The topics, information, or concepts that visitors discuss / think about / hear about during an activity

CONTENT STRATEGY	DEFINITION	VISITOR EXAMPLE QUOTE
Applications or uses	Information about manmade products or technologies that are created using chemicals or chemistry	<i>“Cool applications—talking about cars and phones and how important batteries are to life and everything [we use them] for.”</i> – Build a Better Battery
Chemistry concepts	Information about a basic concept, term, or idea of chemistry, or explanations about the mechanism(s) behind a concept the visitors are learning about, such as a phenomenon that they are witnessing or discussing	<i>“So how it works how the dry ice creates bubbles”</i> – Sublimation Playground <i>“I understand how the air was pushing to pop it off the bottle. Probably the reason why the cap was trying to pop off”</i> – Rocket Reactions
Connections across STEM topics	Information that helps a visitor make a connection between chemistry and another STEM field or understand chemistry’s role within those other STEM disciplines (i.e. biology, physics, animal physiology, etc.)	<i>“[It’s] cool to think about how the nose reacts to molecular models”</i> – Chemistry Make Scents
Connections to everyday life	Information that helps a visitor make an explicit connection between the concepts in the activity and their own life or personal experiences	<i>“The mac and cheese I feed my kids and lipstick I wear. Just good examples of things have in home and everyday uses and don’t know what is in them”</i> – Nature of Dye
Societal issues	Information about how the activity relates to or could be connected to a societal issue	<i>“Relating it back to our environment, something right here instead of across the world”</i> – What’s in the Water

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FORMAT: The experiences related to what visitors are doing or how they are interacting with the activity

FORMAT STRATEGY	DEFINITION	VISITOR EXAMPLE QUOTE
Allow for experimenting with variables	Visitors are able to change or manipulate a variable or substance as part of an investigation	<i>“Because we experimented with air, marshmallows, balloons, and a cup that takes air out”</i> – Molecules in Motion
Allow for observation of phenomena	Visitors are able to see a phenomena take place, such as seeing a chemical change color or watching air expand	<i>“The part [with] the chemical reaction...the explosion”</i> – Rocket Reactions
Allow for use of tools and materials	Visitors are able to use a tool provided to them in the activity (or models of a tool) to conduct an investigation or learn a chemistry concept	<i>“[I] learned how to use pipette”</i> – Nature of Dye
Be hands-on and interactive	Visitors are able to participate in doing and not just observing	<i>“That we did it and learned about it. He wasn't just showing us, we actually got to do it.”</i> – Chemistry is Colorful
Evoke familiar experiences	Visitors feel that an object, material, or tool in the activity is familiar to them or recognizable from their everyday lives or experiences	<i>“I do ‘labs’ or experiments in school a lot during my science class”</i> – Sublimation Bubbles <i>“Because it was stuff we used everyday”</i> – Chemistry is Colorful
Simple to do and easy to understand	Visitors feel that the activity is replicable, approachable, or accessible. In other words, it was easy to follow and un intimidating with a low threshold to successful participation. This does not imply that the material itself is basic or easy, but that something about the format helped visitors perceive the activity and content as doable.	<i>“More of [how I] got to understand how the process worked and since the activity was simpler [I would] be able to repeat how she did [it]”</i> – Build a Battery

How frequently visitors attributed each design strategy to their increased attitudes towards chemistry

●●● Very often (31+%) ● Sometimes (6-15%)
 ●● Frequently (16-30%) ○ Never/Rarely (0-5%)

	interest	relevance	self-efficacy
CONTENT STRATEGIES			
Applications or uses	●	●●	○
Chemistry concepts	●●	●	●●
Connections across STEM topics	●	●	○
Connections to everyday life	●	●●●	●
Societal issues	○	●	○
FORMAT STRATEGIES			
Allow for experimenting with variables	●	○	●
Allow for observation of phenomena	●●	●	●
Allow for use of tools and materials	●	●	●
Be hands-on and interactive	●●	○	●●●
Be simple to do and easy to understand	○	○	●●
Evoke familiar experiences	●	●	●

Facilitation framework overview

Invite Participation

- Provide an introduction or activity overview
- Introduce and model tools
- Build rapport with participants
- Learn what participants have experienced or know about chemistry
- Encourage everyone to participate
- Aid in transitions between different portions of an activity
- Encourage participants to stay, but give them the option to stop



Support Exploration

- Offer positive feedback
- Provide basic information and vocabulary
- Give step-by-step instructions
- Ask participants to make observations and predictions
- Encourage iteration and continued experimentation



Deepen Understanding

- Describe why or how something is happening
- Provide information and support making connections beyond the activity
- Encourage participants to apply something they learned during the activity
- Encourage participants to explain why or how something is happening



Public learning outcomes:

Positive attitudes towards chemistry, including:

- Increased **interest** in the field of chemistry
- Increased understanding of the **relevance** of chemistry to their lives
- Increased feelings of **self-efficacy** about chemistry

INVITE PARTICIPATION includes facilitation techniques that initiate visitor engagement or participation

FACILITATION TECHNIQUE	EDUCATOR EXAMPLE QUOTE
Provide an introduction or activity overview	<i>“Well [in] chemistry, we have a process where we can take colors that are already mixed, and break them apart. And that's called Chromatography. And that's what we're gonna do today.” - Chemistry is Colorful</i>
Introduce and model tools	Facilitator demonstrates using squeeze bottle while saying <i>“you can give a little squeeze and breathe it in and see if you can match the smell with the picture.”</i> - Chemistry makes Scents
Build rapport with participants	As an aside, facilitator and visitor chat about how smelly the vinegar is, with lines from the facilitator such as <i>“the entire museum is going to smell like vinegar because of this one beaker.”</i> - Build a Battery
Learn what people have experienced or know about chemistry	<i>“Now as you're doing that, do any of those chemicals sound familiar to you? Have you ever used any of those before?”</i> - Rocket Reactions
Encourage everyone to participate	<i>“You can each wear [a glove]. Here, why don't you put that one on?”</i> - Build Battery
Aid in transitions between different portions of an activity	<i>“Alright would you like to try altering your sample or would you like to try testing the tap water? What would you like to try next?”</i> - What's in the Water
Encourage visitors to stay, but give them the option to stop	<i>“There's a couple other things you can try if you'd like to but you can also be done if you'd like to. It's up to you.”</i> - Molecules in Motion

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Support Exploration includes facilitation techniques that maintain visitor engagement in the process of participating in or “moving through” the activity

FACILITATION TECHNIQUE	EDUCATOR EXAMPLE QUOTE
Offer positive feedback	Facilitator confirms visitor's response, saying <i>“O is oxygen. Excellent.”</i> - Chemistry makes Scents
Provide basic information and vocabulary	<i>“So the way that pH works is that we put a scale on it and a lower number is going to be an acid.”</i> - What's in the Water
Give step-by-step instructions	<i>“So I'm going to grab a piece of dry paper towel here. And could you just wad that up for me and I'm going to poke it in the end of this little cup right here. Alright. Make sure that'll stay in there yeah.”</i> - Molecules in Motion
Ask participants to make observations and predictions	<i>“So do you have any predictions what's gonna happen when we take the air out of your bell jar?”</i> - Molecules in Motion
Encourage iteration and continued experimentation	<i>“What do you think you want to add to your rocket to get it to go again?”</i> - Rocket Reactions

Deepen Understanding includes facilitation techniques that encourage and support meaning-making

FACILITATION TECHNIQUE	EDUCATOR EXAMPLE QUOTE
Describe why or how something is happening	<i>“So here's the chemistry of what's going on, what makes this be chromatography, is when you drop the water onto the ink the water dissolves the ink, and makes it break up into different colors that it's made of, the different pigments. And the water then pushes through the paper, and some colors move further than other colors. Some colors will stop right away and some colors will move much further.”</i> – Chemistry is Colorful
Provide information and support making connections outside the activity	<i>“[This is a] Secchi disk. A little circle with a black and white pattern on it and what scientists do is they will lower a disk down into the water until they can't see that pattern anymore and then they can measure how far down they had to lower it and that tells them how clear the water is.”</i> – What's in the Water
Encourage participants to apply something they learned during the activity	<i>“Did some of the smells seem more similar to each other than others?”</i> – Chemistry makes Scents
Encourage participants to explain why or how something is happening	<i>“So what do you think is happening in that chemical reaction inside your rocket tube? Is it the same as it was right at the beginning?”</i> – Rocket Reactions