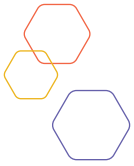


Let's Do Chemistry

Train-the-Trainer Workshop

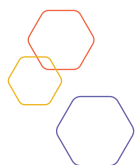
Participant Packet





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MODULE ONE

Welcome

Welcome and thank you for participating in the Let's Do Chemistry Train-the-Trainer Workshop!

This document provides a short overview of what the workshop is and what you'll be doing. If you have questions about the workshop, you can email Emily at ehostetler@mos.org or Kayla at kkeys@mos.org.

About the workshop:

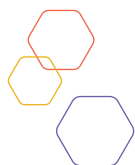
This workshop is the culminating activity of a collaborative project, called ChemAttitudes, that was led by the Museum of Science, Boston, the American Chemical Society (ACS) and the National Informal STEM Education Network (NISE Net). The ChemAttitudes project responded to a National Academies report called *Effective Chemistry Communication in Informal Environments*, which noted that chemistry is one of the least represented of the major disciplines in science museums.¹ A primary deliverable of the ChemAttitudes project was to develop a learning framework for the design and facilitation of informal hands-on activities that will help to stimulate Interest in chemistry, demonstrate its Relevance, and promote a sense of Self-efficacy in people who learn about it. This IRS framework was developed using a process called design-based research, in which researchers assessed the effectiveness of design and facilitation strategies for hands-on chemistry activities with public audiences and made iterative revisions to the framework. The goal of this workshop is to share this new framework with members of the chemistry community (people like you!) who train others to facilitate informal chemistry activities, so that the framework will be more broadly used. You will practice applying the framework to an activity and sharing the ways you do so with other workshop participants. We look forward to learning from all of you.

Want to learn more about the ChemAttitudes project? Watch this short 3-minute video presentation "Let's Do Chemistry! Changing Attitudes about Chemistry": <https://vimeo.com/399952193>

Workshop Participant Expectations:

1. To participate in all aspects of the workshop to the best of their ability
 - Complete pre-online session preparatory work
 - Attend five online sessions
 - Complete post-online session written exercises
2. To learn how to adapt a hands-on chemistry activity to support the IRS framework by completing the given activity exercises
3. To learn how to train others in supporting increased IRS for hands-on activity participants
4. *Optional:* Plan, schedule, and/or host a training based on knowledge gained in the workshop. Participants that complete this optional step will receive an additional \$500 stipend if the following are completed:
 - Complete and submit a Training Workshop Host Report online no later than May 2021. More information about this opportunity will be provided at the conclusion of the workshop.

¹ National Academies of Sciences, Engineering, and Medicine. *Effective chemistry communication in informal environments*. The National Academies Press: Washington, D.C., 2016.



MODULE ONE

Welcome

Overview of the Train-the-Trainer Workshop:

In this workshop, you will learn about the IRS framework in five modules:

- Module 1 will introduce you to the project, the framework, and our goals for this workshop.
- Module 2 will focus on activity format and structure for hands-on activities.
- Module 3 will focus on the design of activities to include chemistry content.
- Module 4 will focus on facilitation of these hands-on activities.
- Module 5 will focus on designing a training to share what you've learned to colleagues and/or activity facilitation volunteers.

Each module will include two components:

- **Individual work.** This includes both preparatory work and exercises that you will complete after the online session, on your own time. In advance of each module, you will complete relevant prep work that will prepare you to have group discussions during the online session. This will involve reading a pdf document and watching a pre-recorded presentation. Then, after our online session discussions, you will apply what you have learned to complete a written exercise that will be submitted to the workshop team before the next online session.
- **Online Sessions.** This includes a recap and overview of the module's subject matter and small group discussions. For the majority of each online session, you will be split up into small discussion groups facilitated by workshop team members. During this time, groups will discuss what they have learned about the module's subject matter, ask questions, and workshop ideas for how you plan to adapt your assigned activity, or implement trainings based on what you have learned.

Hands-on activity assignment:

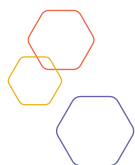
Before the workshop, each participant will be randomly assigned one of two hands-on chemistry activities that you will work on throughout the workshop to help you learn how to adapt an activity to support the IRS framework. Each week, you will learn about an aspect of the framework during your preparatory work, discuss potential adaptations for your activity to support interest, relevance, and/or self-efficacy in activity participants during the online session, then you will apply what you have learned by completing a written exercise in the form of a worksheet, and adapting your physical activity.

We strongly recommend purchasing your activity's physical materials to use throughout the workshop because we believe it's the best way to practice. However, we understand not everyone will be able to collect what is needed for their activity, and we can support workshop participants who need to complete the workshop as a thought exercise rather than physically adapting an activity.

Read through both activity guides at the end of this document to become familiar with them before the next online session. By having a basic understanding of both activities, large group discussions during the online session will be more productive and interesting for participants across activity groups.

Want to see the Let's Do Chemistry "IRS" framework in action? Learn how the American Chemical Society has integrated the framework into their outreach programs by watching this short video:

<https://vimeo.com/416060532>



MODULE ONE

Welcome

IRS Framework Overview:

In 2016, the National Academies of Sciences published a report about *Effective Chemistry Communication in Informal Environments* and a related practical guide. The report noted that chemistry is one of the least represented disciplines in science museums. At about the same time, the Royal Society for Chemistry reported that publics found chemistry to be uninteresting, abstract and not relevant to real life, and inaccessible and hard to understand. The report suggested that “chemophobia” was not the problem. Lack of interest and engagement was.² The two reports gave us the basis for our proposal to the National Science Foundation.

The project aimed to have a strategic impact on publics’ attitudes toward chemistry, specifically, their:

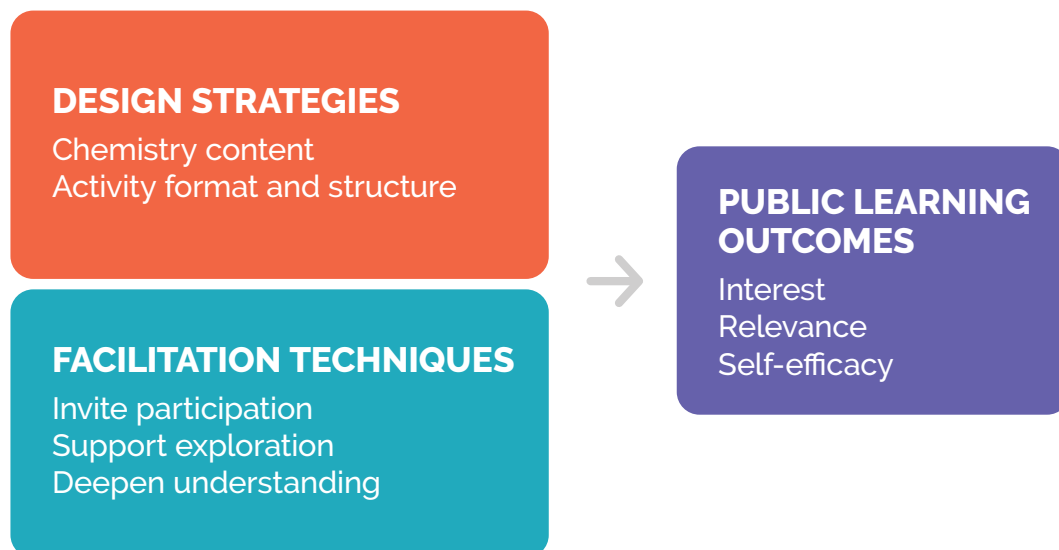
- **interest** in chemistry
- understanding and perception of its **relevance**
- feelings of **self-efficacy** with respect to it

The outputs of this process were a suite of digital and physical materials shared with informal science educators and chemistry professionals across the United States. They included the professional development materials that describe the learning framework as well as a kit of hands-on activities. After going through this process, we were able to develop the IRS framework and learn what strategies can be incorporated in hands-on activity development and facilitation. The graphic below shows how these pieces come together to support the project’s goals related to IRS. As a participant in this workshop, you will become uniquely familiar with the IRS framework, and how to incorporate it in your future work and trainings to support positive chemistry attitudes in everyone.

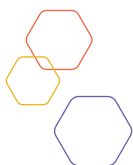
Interest is being particularly engaged in what the activity is about. These thoughts or feelings could be brief or might lead to longer-term interests.

Relevance involves connecting the activity to everyday life and showing how chemistry is used.

Self-efficacy is having a sense of confidence and capability to learn and use chemistry.



² TNS BMRB. *Public attitudes to chemistry: Research report*. Royal Society of Chemistry: London, 2015.



ACTIVITY GUIDE:

Radical Radishes

Use a red radish to test the pH of various household liquids! Color with a red radish on a white piece of paper. Use a pipette to drop a few drops of one the liquids on your red radish markings and observe. Did you see a color change? Red radish is a natural pH indicator! Acidic and basic solutions will cause the radish markings to change color.



Resources Needed:

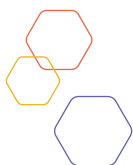
- Red Radishes (1 per person or test)
 - Can sub for red cabbage or red cabbage powder
- Index cards or white paper for coloring
- Baking soda
 - Any basic solution (be mindful of what you choose!)
- Vinegar
 - Any acidic solution (be mindful of what you choose!)
- Plastic 1mL Pipettes
 - A tool to drop the basic and acidic liquids on the red radish stains

Instructions:

1. On a white piece of paper, use the red radish to draw three lines. Rub the radish back and forth on the paper to create three thick lines with some space in between them.
2. Choose a solution to test first. Place a few drops of that solution on one of the radish lines and observe.
3. Repeat with the second solution and observe.

Watch an example of a pH experiment!

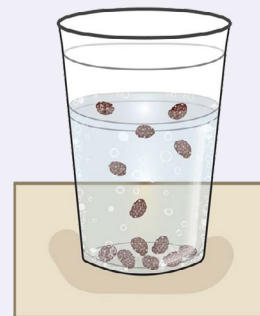
<https://www.youtube.com/watch?v=I18K2upEHLc>



ACTIVITY GUIDE:

Dancing Raisins

Experiment with density and gas by creating your own dancing raisins! Put a small amount of vinegar and baking soda in a cup. What do you see? When mixed together, these two chemicals create a reaction that releases carbon dioxide gas. If you have ever had soda or seltzer water, you might have noticed how they fizz and bubble. Those bubbles are carbon dioxide just like the reaction you made! Pour some seltzer water into a cup and observe the bubbles. Now, add raisins and watch what happens!



Resources Needed:

- Baking soda
- Vinegar
- Seltzer water
- Raisins
- Cups

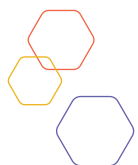
Instructions:

1. Add a pipette full of baking soda solution to the cup. Then, add a pipette full of vinegar solution to the cup. Observe.
2. Pour some seltzer water into a separate cup and observe.
3. Add a few raisins into the cup with the seltzer water and observe.

Watch an example of the dancing raisins experiment!

<https://www.youtube.com/watch?v=9b-6hjXjUlo>

Image Credit: <https://www.teacherspayteachers.com/Product/Dancing-Raisins-3653745>



MODULE TWO

Format

Preparatory work:

To be completed before the Module 2: Activity Format Online Session.

1. Read through this document
2. Watch the Format Strategies video presentation
3. Prepare for the Online Session by reviewing discussion questions

Activity Format Module Overview:

In this module, you will explore how **format** strategies from our framework can help support interest, relevance, and self-efficacy in hands-on activity participants.

In the format strategies video presentation, we reviewed how format strategies support activity participants' positive attitudes toward chemistry, and how you can start to integrate these aspects into your own hands-on activities and trainings. These findings are summarized below and in the Format Research Guide.

Short summary of research findings:

Visitors felt that format was most important to increasing their

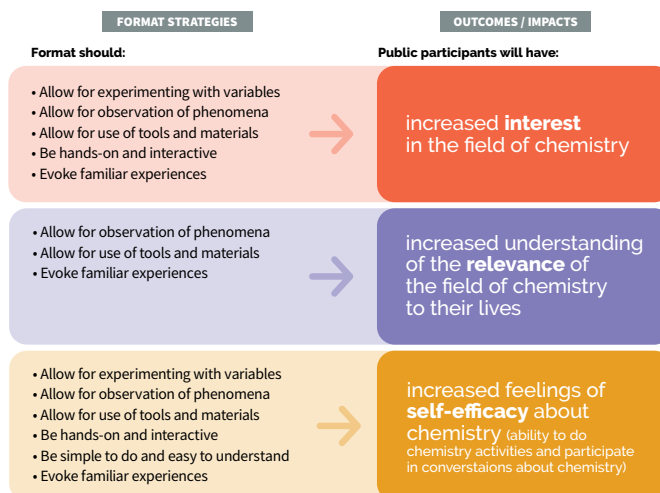
- interest in chemistry
- feelings of self-efficacy in regard to chemistry

Format strategies that appeared most useful for boosting interest, relevance, and self-efficacy were

- allowing for observation of phenomena
- allowing for use of tools and materials
- evoking familiar experiences

Other format strategies that appear to boost interest and self-efficacy include

- allowing for experimenting with variables
- being hands-on and interactive



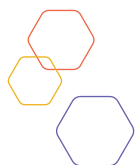
Written Exercise:

To be completed and submitted before the Module 3: Chemistry Content Online Session.

On the next page is a worksheet that outlines the format strategies and if they support interest, relevance, and/or self-efficacy. The worksheet will ask you to think about your activity and how you can integrate some of these strategies to support an increase of interest, relevance, and/or self-efficacy in participants. During our Format Module Online Session we will be discussing these ideas. After the online session concludes, you can complete the worksheet using knowledge you gained from your discussions.

Come prepared to discuss the following questions in small groups during our online session:

- What format strategies does your activity already include? How do those aspect(s) of your activity support interest, relevance, and/or self-efficacy in activity participants?
- Does your activity seem to be lacking support for interest, relevance, or self-efficacy? What format strategies could you use in your activity to support either interest, relevance, or self-efficacy?
- How can you implement these strategies in your activity?



MODULE TWO

Format**How can you use the format strategies in your activity to support the IRS (Interest, Relevance, Self-efficacy) framework?**

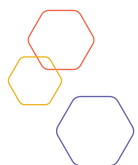
Consider what strategies you think might work well in your activity, check the boxes of the ones you want to use, and describe how you will incorporate them into your activity in the space below. After each strategy below, we have indicated if it supports interest, relevance, and/or self-efficacy by including an I, R, or S. Look at the Format Research Guide for explanations of each technique. Remember, using all of the strategies listed below is not necessarily the best way to support the IRS framework. Consider 1–3 of these strategies below that you can and should emphasize in your activity to make the activity better for participants.

FORMAT

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

- | | |
|--|--|
| <input type="checkbox"/> Hands-on & interactive (IRS) | <input type="checkbox"/> Use of tools & materials (IRS) |
| <input type="checkbox"/> Experimentation with variables (IS) | <input type="checkbox"/> Observation of phenomena (IRS) |
| <input type="checkbox"/> Familiar experiences (IRS) | <input type="checkbox"/> Simple to do & easy to understand (S) |

How will you adapt your activity to support format strategies?



MODULE THREE

Content

Preparatory work:

To be completed before the Module 3: Activity Content Online Session.

1. Read through this document
2. Watch the Content Strategies video presentation
3. Prepare for the Online Session by reviewing discussion questions

Activity Content Module Overview:

In this module, you will explore how **content** strategies from our framework can help support interest, relevance, and self-efficacy in hands-on activity participants.

In the content strategies video presentation, we reviewed how content strategies support activity participants' positive attitudes toward chemistry, and how you can start to integrate these aspects into your own hands-on activities and trainings. These findings are summarized below and in the Content Research Guide.

Short summary of research findings:

Visitors felt that content strategies were most important to increasing their

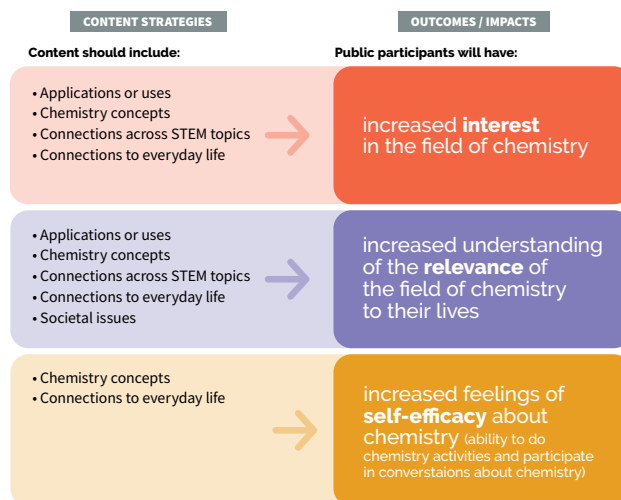
- interest in chemistry
- understanding of its relevance

Content strategies that appeared most useful for boosting interest, relevance, and self-efficacy were

- chemistry concepts
- connections to everyday life

Other content strategies that appear to boost interest and relevance were

- applications or uses
- connections across STEM topics



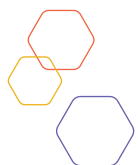
Written Exercise:

To be completed and submitted before the Module 4: Facilitation Online Session.

On the next page is a worksheet that outlines the content strategies and if they support interest, relevance, and/or self-efficacy. The worksheet will ask you to think about your activity and how you can integrate some of these strategies to support an increase of interest, relevance, and/or self-efficacy in participants. During our Content Module Online Session, we will be discussing these ideas. After the online session concludes, you can complete the worksheet using knowledge you gained from your discussions.

Come prepared to discuss the following questions in small groups during our online session:

- What content strategies does your activity already include? How do those aspect(s) of your activity support interest, relevance, and/or self-efficacy in activity participants?
- What content strategies could you use in your activity to support either interest, relevance, or self-efficacy?
- How can you implement these strategies in your activity?
- How would you communicate the importance of including content strategies to support IRS in a future training? How would you share what you've learned in this module?



MODULE THREE

Content

How can you use the content strategies in your activity to support the IRS (Interest, Relevance, Self-efficacy) framework?

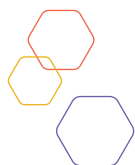
Consider what strategies you think might work well in your activity, check the boxes of the ones you want to use, and describe how you will incorporate them into your activity in the space below. After each strategy below, we have indicated if it supports interest, relevance, and/or self-efficacy by including an I, R, or S in parenthesis. Look at the Format Research Guide for explanations of each technique. Remember, using all of the strategies listed below is not necessarily the best way to support the IRS framework. Consider 1–3 of these strategies below that you can and should emphasize in your activity to make the activity better for participants.

CONTENT

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

- | | |
|---|--|
| <input type="checkbox"/> Chemistry concepts (IRS) | <input type="checkbox"/> Connections across STEM topics (IR) |
| <input type="checkbox"/> Connection to societal issues (R) | <input type="checkbox"/> Connection to everyday life (IRS) |
| <input type="checkbox"/> Applications or uses of chemistry (IR) | |

How will you adapt your activity to support content strategies?



MODULE FOUR

Facilitation

Preparatory work:

To be completed before the Module 4: Activity Facilitation Online Session.

1. Read through this document
2. Watch the Facilitation Framework video presentation
3. Prepare for the Online Session by reviewing discussion questions

Activity Facilitation Module Overview:

In this module, you will explore how some **facilitation** techniques can help support interest, relevance, and self-efficacy in hands-on activity participants.

In the facilitation framework video presentation, we reviewed how using facilitation techniques such as invite participation, support exploration, and deepen understanding can help increase activity participants' positive attitudes toward chemistry, and how you can start to integrate these techniques into your own hands-on activities and trainings. These findings are summarized below and in the Facilitation Framework Research Guide.

Short summary of research findings:

Overall:

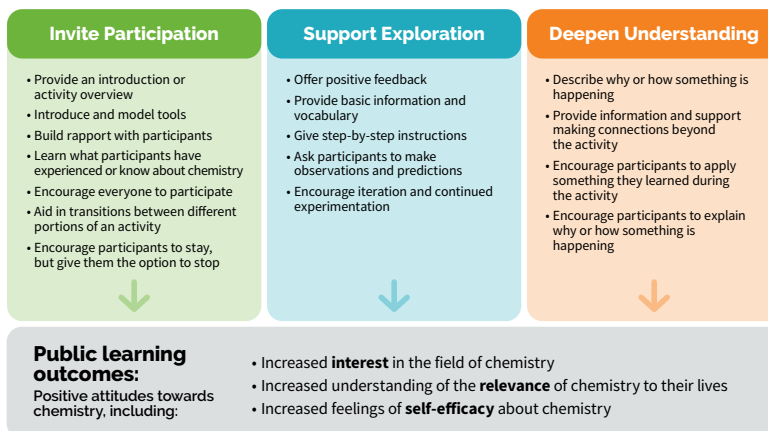
- Facilitation of these activities is nonlinear, and facilitators often flip back and forth between support exploration and deepen understanding techniques.
- Facilitators should be prepared to adjust how they interact and be flexible with each group.

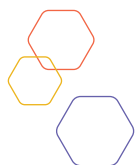
Important Strategies:

- Facilitators should always provide an introduction or activity overview as one of their invite participation techniques.
- The most common support engagement technique was offering positive feedback.
- As part of deepening engagement, facilitators frequently provided information and supported making connections outside the activity.

Connections to Relevance and Self-Efficacy:

- Deepening understanding techniques may increase visitor understandings of relevance, and providing supplemental information is especially helpful.
- Generally using supporting exploration techniques may increase visitor self-efficacy. This attitude may also be supported by the deepening understanding technique of encouraging participants to explain why or how something is happening.
- Discussion about visitors' prior experiences and knowledge may also be helpful to increasing relevance and self-efficacy.





MODULE FOUR

Facilitation

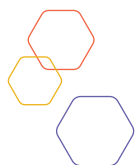
Written Exercise:

To be completed and submitted before the Module 5: Build Your Training Online Session.

On the next page is a worksheet that outlines the techniques highlighted in our facilitation framework. The worksheet will ask you to think about your activity and how you can integrate some of these techniques to support an increase of interest, relevance, and/or self-efficacy in participants. During our Facilitation Module Online Session, we will be discussing these ideas. After the online session concludes, you can complete the worksheet using knowledge you gained from your discussions.

Come prepared to discuss the following questions in small groups during our online session:

- Which of these facilitation techniques do you typically use with hands-on activities? Which were you already planning to include for your activity facilitation?
- How can you incorporate additional techniques in your activity to better support interest, relevance, and/or self-efficacy?
- How can you communicate the importance of the invite, support, deepen facilitation framework to others?



MODULE FOUR

Facilitation

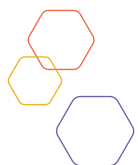
How can you use the techniques of invite, support, deepen from the facilitation framework in your activity to support interest, relevance, or self-efficacy?

Consider what strategies you think might work well in your activity, check the boxes of the ones you want to use, and describe how you will incorporate them into your activity in the space below. Look at the Facilitation Research Guide for explanations of each technique. Remember, using all of the strategies listed below is not necessarily the best way to support the IRS framework. Consider 1–3 of these strategies below that you can and should emphasize in your activity to make the activity better for participants.

FACILITATION TECHNIQUES

INVITE PARTICIPATION

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



MODULE FOUR

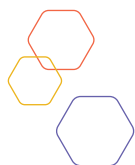
Facilitation

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

- Encourage participants to explain 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
- Describe why or how something is happening



MODULE FIVE

Build Your Training

Build Your Training Module Overview:

Over the last few weeks you have learned all about the IRS framework and how to adapt an activity to support increasing chemistry attitudes in hands-on activity participants. During each module, we discussed some ways to incorporate pieces of the IRS framework into your work and trainings. In this “Build Your Training” module, we will focus on how to translate all the knowledge you have gained into a training you could host for colleagues, activity facilitators, volunteers, and anyone else you may want to train.

Preparatory work:

To be completed before the Module 5: Build Your Training online session.

Below is a list of training resources compiled by the workshop team. This is not a comprehensive list, but we hope some of these available tools and techniques will help the next time you want to share the main ideas from the framework with someone else. Read through some of these materials before our next call and even suggest your own on our next online session. Consider how you might incorporate some of the tools and techniques mentioned in these resources in your own training. All of these materials are linked below and are available at www.nisenet.org/chemistry-kit or www.acs.org/education.

Let's Do Chemistry Professional Development Training Materials:

- Research-to-Practice Guide
- Training Presentation
- Safety Guide

Let's Do Chemistry Facilitator Training Materials:

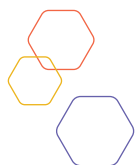
- Facilitator Tip Sheet
- Improv Game
- Fun “Dr. Braxton Hazelby” Facilitation Training Video

ACS Outreach Materials:

- ACS Outreach
- Inquiry in Action
- WonderScience

Written Exercise:

To be completed and submitted one week after the Module 5: Build Your Training online session.



MODULE FIVE

Build Your Training

How would you design a future training for professionals and/or hands-on activity facilitators?

Consider what you have learned during this workshop and build a training that supports others in learning about the IRS (Interest, Relevance, and Self-efficacy) framework. The training you outline below should be designed to support your current and future goals for chemistry outreach and to advance knowledge about hands-on activity creation and facilitation around the IRS framework.

We understand that many normal practices have been put on hold or completely changed due to COVID-19. Please do your best to consider how you might create a training in the near-future, whether that is in-person or online.

1. WHO IS THE AUDIENCE? Will you be hosting a training for other professionals? Or people who will be facilitating activities? Or both? Will the training take place online or in person?

2. HOW DO YOU PLAN ON INVOLVING YOUR PARTICIPANTS? The best way to learn is to practice! How will you have your training participants actively participate? What will the goals of their training activity be? How can you support those learning goals using something beyond a PowerPoint or video?

3. WHAT IRS FRAMEWORK CONTENT WILL YOU INCLUDE? What part of the IRS framework is most important for you to share to support your training participants? How can the framework help them become better activity facilitators? Consider how discussing the content and format strategies within activities could help them become more confident facilitating. What do they need to know to help train others?

4. HOW WILL YOU USE EVALUATION? Will you evaluate your training and/or your newly adapted activities? If so, how? What questions can you ask to improve your future work?

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)

Research Reference Guide

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 unthreatening 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

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