# ChemAttitudes

## Using Design-Based Research to Develop and Disseminate Strategies and Materials to Support Chemistry Interest, Relevance, and Self-Efficacy

NISE
NATIONAL INFORMAL STEM EDUCATION NETWORK

Museum of Science.

A C S


**Elizabeth Kunz Kollmann**
ekollmann@mos.org


December 2017

# ChemAttitudes research questions

How should hands-on activities, events, and trainings be designed to increase visitors' positive attitudes about interest in, relevance of, and self-efficacy around chemistry?

- How does content, program format, and facilitation techniques for individual hands-on activities impact visitor attitudes about chemistry?
- How does the mix of content and program format within groups of hands-on activities impact visitor attitudes about chemistry?
- How do trainings for facilitation of hands-on activities impact visitor attitudes about chemistry?

# Creation of the theoretical framework

**NISE Net guides**

Nanoscale science informal learning experiences: NISE Network learning framework

NanoDays tips for engaging visitors

2015 NanoDays planning guide

NISE Network program development: A guide to creating effective learning experiences for public audiences

**NISE Net research and evaluation**


Reich, C. (2011). Making the unfamiliar interesting and relevant for museum visitors. In C. Reich, J. Goss, E. K. Kollmann, J. Morgan & A. G. Nelson (Eds.), *Review of NISE Network evaluation findings: Years 1-5* (pp. 118 - 139). Boston: NISE Network.

Kollmann, E. K., Svarovsky, G., Iacovelli, S., & Sandford, M. (2015). *NISE Net research on how visitors find and discuss relevance in the Nano exhibition.* Boston: NISE Network.

Svarovsky, G., Goss, J., Ostgaard, G., Reyes, N., Cahill, C., Auster, R., et al. (2013). *Summative study of the Nano mini-exhibition.* Saint Paul: NISE Network.

Svarovsky, G., Tranby, Z., Cardiel, C., Auster, R., & Bequette, M. (2014). *Summative study of the NanoDays 2014 events.* Notre Dame: NISE Network.

## Education literature

Cahill, C., & Lussenhop, C. (2012). *Effects of feedback from a virtual tutor on computer programming self-efficacy*. Boston: Museum of Science.

Cam, A., & Geban, O. (2011). Effectiveness of case-based learning instruction on epistemological beliefs and attitudes toward chemistry. *Journal of Science Education and Technology, 20*(1), 26-32.

Hattie, J., & Timperley, H. (2007). The power of feedback. *Review of Educational Research, 77*(1), 81-112.

Hidi, S., & Renninger, K. A. (2006). The four-phase model of interest development. *Educational Psychologist, 41*(2), 111-127.

Keller, J. M. (1987). Development and use of the ARCS model of instructional design. *Journal of Instructional Development, 10*(3), 2 - 10.

Myers, R. E., & Fouts, J. T. (1992). A cluster analysis of high school science classroom environments and attitude towards science. *Journal of Research in Science Teaching, 29*, 929-937.

Osborne, J., & Simon, S. (1996). Primary science: Past and future directions. *Studies in Science Education, 27*, 99-147.

Osborne, J., Simon, S., & Collins, S. (2003). Attitudes towards science: A review of the literature and its implications. *International Journal of Science Education, 25*(9), 1049-1079.

Paris, S. G. (1998). Situated motivation and informal learning. *Journal of Museum Education, 22*, 22-26.

Piburn, M. D., & Baker, D. R. (1993). If I were a teacher... qualitative study of attitude toward science. *Science Education, 77*, 393-406.

Potvin, P., & Hasni, A. (2014). Interest, motivation, and attitude towards science and technology at K-12 levels: A systematic review of 12 years of educational research. *Studies in Science Education, 50*(1), 85-129.

NISE Net Research on How Visitors Find and Discuss Relevance in the *Nano* Exhibition

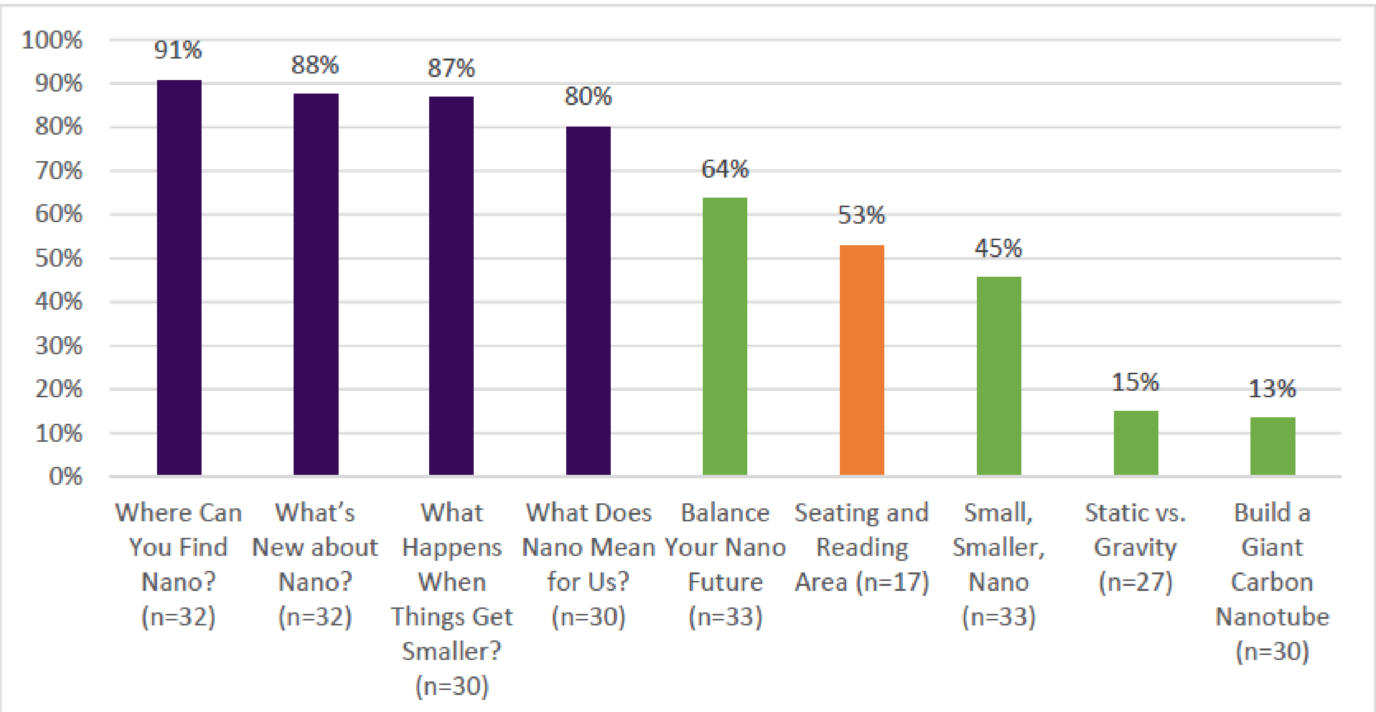
Research Report

By Elizabeth Kunz Kollmann, Gina Svarovsky, Stephanie Iacovelli, and Maggie Sandford

*September 2015*

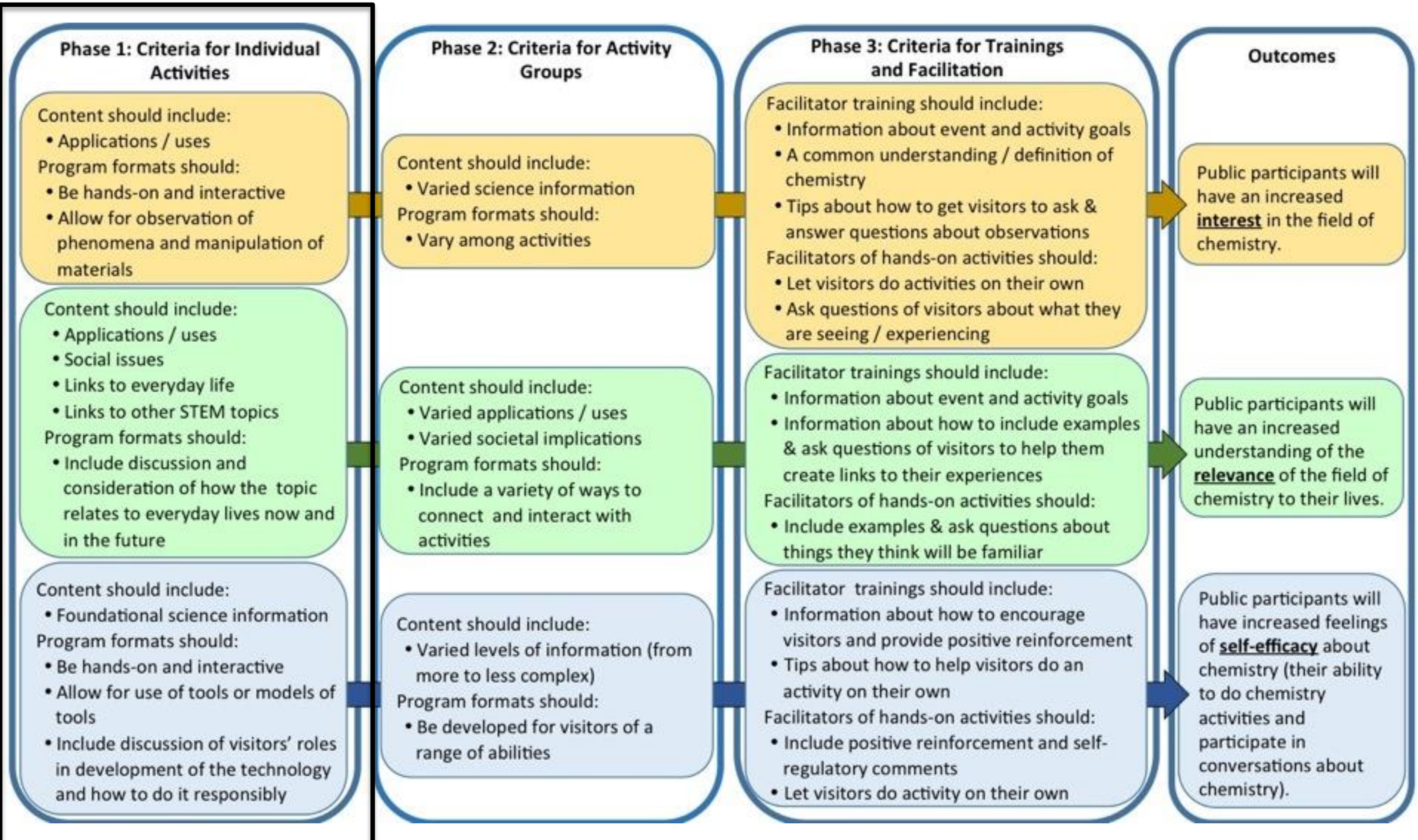
Including content about everyday applications and current societal topics in exhibits and programs may lead visitors to find relevance.

**Figure 2.** The percentage of groups visiting each *Nano* exhibition component who found relevance.




*Note*. In this graph, purple bars represent panel components, green bars represent interactive components, and orange bars represent other kinds of components.

# ChemAttitudes Theoretical Framework – Beginning of Year 1



# Data Collection

- 15 activities tested
- Iterative process
- Data collected:
  - Interviews
  - Observations
  - Videotapes

# ChemAttitudes Theoretical Framework – End of Year 1

| Content Strategies | Format Strategies | Strategies for Trainings and Facilitation | Outcomes / Impacts |
|---|---|---|---|
| Content should include:<br>• Applications / uses<br>• Chemistry concepts<br>• Connections to everyday life<br>• Connections across other STEM topics | Program formats should:<br>• Be hands-on and interactive<br>• Allow for observation of phenomena<br>• Allow for experimenting with variables<br>• Allow for use of tools and materials<br>• Evoke familiar experiences | Facilitator trainings should include:<br>• Information about event and activity goals<br>• A common understanding / definition of chemistry<br>• Tips about how to get visitors to ask & answer questions about observations<br>Facilitators of hands-on activities should:<br>• Let visitors do activities on their own<br>• Ask questions of visitors about what they are seeing / experiencing | Public participants will have an increased **interest** in the field of chemistry. |
| Content should include:<br>• Applications / uses<br>• Connections to everyday life<br>• Connections across STEM topics<br>• Societal issues<br>• Chemistry concepts | Program formats should:<br>• Evoke familiar experiences<br>• Allow for use of tools and materials<br>• Involve observation of phenomena | Facilitator trainings should include:<br>• Information about event and activity goals<br>• Information about how to include examples & ask questions of visitors to help them create links to their experiences<br>Facilitators of hands-on activities should:<br>• Include examples & ask questions about things they think will be familiar | Public participants will have an increased understanding of the **relevance** of the field of chemistry to their lives. |
| Content should include:<br>• Chemistry concepts<br>• Connections to everyday life | Program formats should:<br>• Be hands-on and interactive<br>• Allow for use of tools and materials<br>• Be simple to do and easy to understand<br>• Evoke familiar experiences<br>• Involve observation of phenomena<br>• Involve experimenting with variables | Facilitator trainings should include:<br>• Information about how to encourage visitors and provide positive reinforcement<br>• Tips about how to help visitors do an activity on their own<br>Facilitators of hands-on activities should:<br>• Let visitors do activity on their own<br>• Include positive reinforcement and self-regulatory comments | Public participants will have increased feelings of **self-efficacy** about chemistry (their ability to do chemistry activities and participate in conversations about chemistry). |

Blue = strategies from starting framework    Green = new and emerging strategies

# Design Criteria for **Interest** in the Theoretical Framework

**Content should include:**

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

**Program formats should:**

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

**Outcomes**

Public participants will have an increased **interest** in the field of chemistry.

# Design Criteria for **Relevance** in the Theoretical Framework

**Content should include:**

- Applications / uses
- Connections to everyday life
- Connections across stem topics
- Societal issues
- Chemistry concepts

---

**Program formats should:**

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

**Outcomes**

Public participants will have an increased understanding of the **relevance** of the field of chemistry to their lives.

# Design Criteria for **Self-efficacy** in the Theoretical Framework

**Content should include:**

- Chemistry concepts
- Connections to everyday life

**Program formats should:**

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

→

**Outcomes**

Public participants will have increased feelings of **self-efficacy** about chemistry (their ability to do chemistry activities and participate in conversations about chemistry).

# Next steps: Activity development

- Select 8-10 activities to include in the kit, informed by Phase 1-2 research
- Design and fabricate 250 kits for distribution around the US

# Next steps: Professional resources

- Develop professional resources that communicate project goals and research findings

- Develop training tools related to visitor learning outcomes and facilitation strategies

# Thank you

This presentation is based on work supported by the National Science Foundation under Grant No. DRL-1612482. Any opinions, findings, and conclusions or recommendations expressed in this presentation are those of the authors and do not necessarily reflect the views of the Foundation.