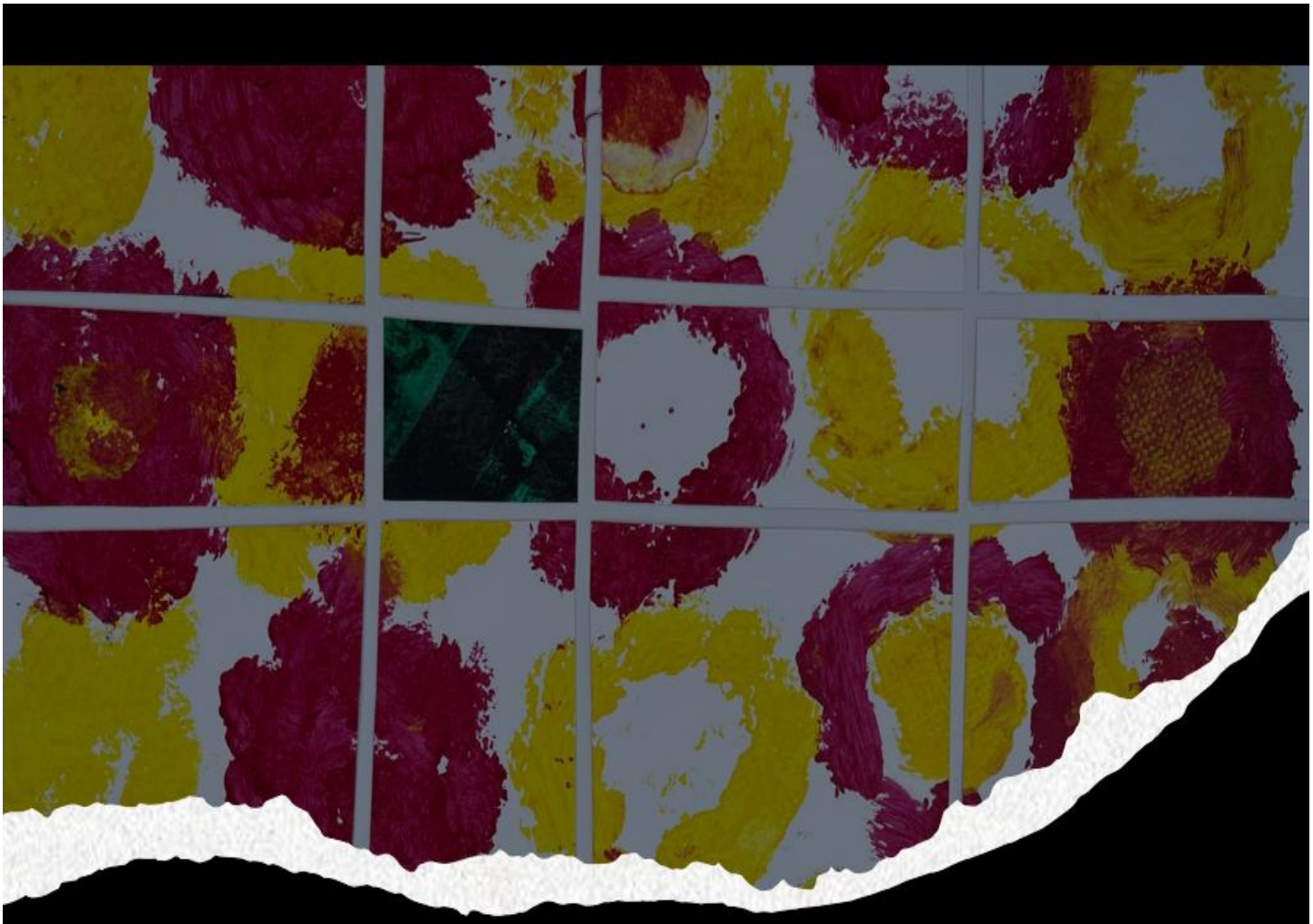


Imagination in STEM

A Project Index

Museum of Science, Boston 2022

Image credit: Mary Brooks

About this Project Index

The Museum of Science, Boston (MOS) received funding from the National Science Foundation to carry out a conference grant exploring connections between research and practice at the intersections of imagination, STEM (science, technology, engineering, and mathematics), and ISE (informal STEM education). A series of virtual convening events were held from September 8-17, 2021. (Learn more at our InformalScience.org project page or visit the convening's YouTube Playlist).

As part of the convening deliverables, the Museum of Science, Boston collaborated with researchers, practitioners, and other informal STEM education professionals to compile a set of projects that infuse imagination in a range of ways. This product serves to catalog these projects, organizing them by:

- Project Title, Contributor, and Affiliation
- Project Context and Format
- Project Audiences
- Imaginative Ways of Thinking

This publication is meant to serve as a catalogue of projects – research studies, exhibitions, programs, and in- or out-of-school-time activities – from which to draw inspiration towards developing more imaginative STEM futures.

This Project Index was developed by the contributions of many people:

Project Index Contributors: Adrian Melia, Adrienne Testa, Alana Parkes, Brendan Bo O'Connor, Brigitta Rongstad, Chris San Antonio-Tunis, Cliff Lee, Dale McCreedy, Deena Weisberg, Gina Svarovsky, Isabel Huff, James Monroe, Jonathan Fanning, Kristen Vogt Veggeberg, Lauren Hirsch, Lucinda Presley, Marta Biarnes, Mary Brooks, Mary Jackson, Mia Shaw, Preeti Gupta, Rae Ostman, Scott Pattison, Shannon Mersand, Susan Letourneau

Museum of Science, Boston team: Ann Atwood, Katie Baur, Emmett Fung, Rachel Fyler, Jessica Ghelichi, Sonya Harvey-Justiniano, Becki Kipling (PI), Liz Kunz Kollmann, Sarah May (Co-PI), Alana Parkes, Tim Porter, Christine Reich (Co-PI)

External Evaluator: Amanda Krantz (Kera Collective)

Project Advisors: Baptiste Barbot, Helen Hadani, Paul Harris, Jeremy Hoffman, Gillian Judson, Michelle Kortenaar, Stacey Mann, Dale McCreedy, Rae Ostman, Billy Spitzer, Karen Wilkinson

Suggested Citation (APA 7th Edition)

MOS. (2022). *Imagination in STEM: A Project Index.* Museum of Science, Boston, MA.
Note: Suggested citations for individual contributors are included within each project page.

This material was developed by the Museum of Science, Boston, with support from the National Science Foundation under Award #DRL-1906899. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the Foundation.

Organization of this Project Index

The **25 projects** included in this resource are organized into sections by **Format**, and alphabetically by **Project Title** within each section. Appended indices present all contents of this resource, organized by **Project Contributor**, **Project Format**, **Project Audience(s)**, and **Imaginative Ways of Thinking**.

Project Contributor

Each project has been listed with an affiliated Project Contributor or Contact. This contact information is accurate as of the completion of this resource in December 2022. The Museum of Science, Boston team may periodically update this resource. We apologize for any outdated or incorrect information presented here at the time of reading.

Project Formats

Projects are categorized into the following contexts and formats (though some projects include overlapping formats, and some projects could be implemented in a range of contexts; they are categorized by the primary format for the project):

- Informal Education Contexts: Exhibitions
- Informal Education Contexts: Programming
- Formal Education Contexts: Curriculum and Professional Development
- Out-of-School Time Contexts: Programming and Curriculum
- Research: Research Studies and Design-Based Research

Project Audiences

Projects are also categorized by the audience(s) they aim to address or serve (some projects serve multiple audiences; they are categorized by primary or ultimate audience served):

- Public Audiences: Children and families
- Public Audiences: Adults, general visitors, general public
- School Audiences: Students and teachers
- Program Participants

Imaginative Ways of Thinking

Through the work of the Conference Grant, the team at the Museum of Science, Boston compiled hundreds of definitions of imagination – from literature on imagination's role in STEM practice and STEM education, to definitions shared by professionals in an online survey. From these definitions, the Boston team sought not to unearth the most common responses, but to organize *features* of these definitions so professionals might find more utility towards integrating imagination into their own work.

The table below presents the high-level categories of the different features that make up definitions of imagination. This organizing tool invites users to trace their own connections between relevant elements, ultimately crafting definitions of imagination that are useful in their own contexts.

For this Project Index, we asked contributors to name the top Ways of Thinking their project involves, and we have organized the projects loosely around clusters of Ways of Thinking emergent from our research. These clusters, and the list of Imaginative Ways of Thinking included, are not comprehensive, but rather serve as an informal way of organizing the many ways imagination might emerge in our work.

A Framework to Define Imagination in STEM

Essence How imagination is characterized / what it is	Ways of Thinking Cognitive, physical, social, and emotional imaginative processes	Context Contexts towards which imagination is focused, or in which it emerges
Ability **Activity** **Capacity** **Faculty of mind** **Foresight** **Process**	**Conceptualizing** **Creativity** **Embodying** **Feeling** **Generating Novelty** **Moral Thinking** **Navigating Inconsistency** **Organizing** **Playing** **Problem Solving** **Possibilities Thinking** **Relating** **Self-identifying** **Sensing** **Socializing** **Storytelling** **Understanding** **Visualizing** **"What if?"-ing**	**Self and Social Contexts** Within the self In relation to others **Contexts of Presence and Absence** In reality To the senses Within experiences Related to what is known **Fictive or Hypothetical Contexts** In relation to fictitious possibilities Within narrative or storytelling In play scenarios **Temporal Contexts** Relating to past or future

See the full Framework and other resources on our InformalScience.org Project Page.

Table of Contents: Projects by Context and Format

Informal Education Contexts: Exhibitions

Informal Education Contexts: Exhibitions

This section includes descriptions of exhibitions that encourage imagination among museum visitors and other members of the public.

Arctic Adventure

Project Description:

The Arctic Adventure exhibition invites you to be an active participant. Become an Arctic researcher as you use technology (including ground-penetrating radar and ice core drills) to explore our changing environment. The exhibition itself changes, too. Lighting hues mimic the Sun's motion over the course of the day. The scenery, and the animals you find in it, vary with the seasons.

Project Format:

Exhibition

Imaginative Ways of Thinking:

Role-playing

Noticing

Speculating

Associating

Institution:

Museum of Science, Boston

Funding:

The Francis W. Davis Fund; The Sophia and Bernard M. Gordon Fund; The Henry Snow Hall, Jr. Fund; The Institute of Museum and Library Services (MA-10-19-0206-19); Jacquie and Ira Stepanian

Project Contact:

Tim Porter
tporter@mos.org
Senior Director, Public Science Communication
Museum of Science, Boston

Project Dates:

2020 to present

Project Resources:

https://www.mos.org/exhibits/arctic-adventure

Image credit: Museum of Science, Boston

Arctic Adventure

Project Audience:

- Public museum visitors.

Project Goals:

- Visitors learn about a range of technologies that can be used to make observations about the environment they are in.
- Visitors identify the constraints and affordances of different technologies.
- Visitors explore a given technology to learn the extent of its capabilities and usefulness.

Imagination's role in the project:

Imagination as a vehicle for feeling transported:

- Multisensory and large-scale physical elements create an immersive environment. The immersion "works" because imagination drives visitors to feel like they are someplace else.

Imagination as a tool for seeing larger patterns:

- While the exhibit highlights individual climate-related changes, imagination fosters deeper pattern-finding.

Imagination as a way to see yourself as a scientist:

- Narrative elements invite role-playing within the exhibit. Visitors' imagination then becomes a tool for seeing themself (or their future self) as a scientist.

Suggested Citation (APA 7th Edition):

Parkes, A. (2022). Arctic Adventure Project Page. In *Imagination in STEM: A Project Index* (pp. 7-8). Museum of Science, Boston.

Imaginative Ways of Thinking:

Role-playing

Visitors engage "as if" they were arctic researchers. For example, visitors can use ground penetrating radar to safely trek across a glacier.

Noticing

Immersive details encourage visitors to notice individual animals and environments, and then make connections to notice broader patterns related to climate change.

Speculating

Visitors wonder about the connections they notice: What might it mean that this animal's environment has changed? What else do we need to learn to find out?

Associating

Visitors draw on individual observations (e.g., changes in animal behavior or environment) and piece together a larger narrative about climate change.

Image credit: Museum of Science, Boston

Life on the Edge

Project Description:

Life on the Edge is an interactive traveling interactive exhibition where visitors will learn how understanding life on the Earth helps us search for life in our solar system and beyond.

Project Format:

Exhibition

Imaginative Ways of Thinking:

- Creativity
- Self-identifying
- Embodying
- Possibilities thinking

Institution:

Sciencenter

Funding:

This exhibit is based upon work supported by NASA under award #NNX16AM22G.

Project Contact:

Adrienne Testa
Atesta@sciencecenter.org
Director of Exhibits and Facilities
Sciencenter

Project Dates:

October 1, 2016 - Ongoing

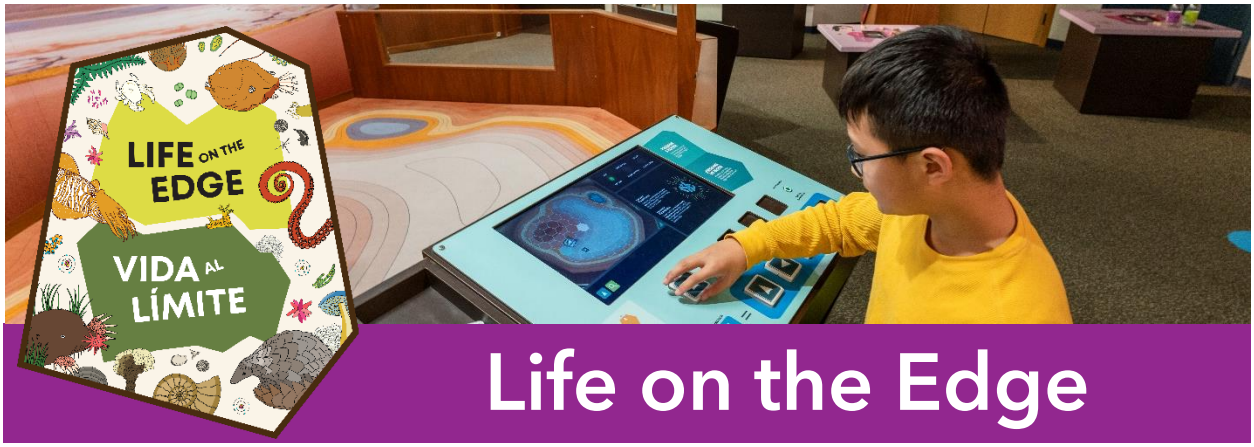
Project Resources:

Informalscience.org project page

NASA JPL project page

http://www.sciencenter.org/life-on-the-edge.html

Image credit: Sciencenter



Life on the Edge

Project Audience:

- Youth ages 8-14 and Families; Bilingual (English and Spanish); Smaller museums in rural communities

Project Goals:

- Introduce visitors to extreme organisms and environments on Earth
- Visitors will understand that:
  - Studying life on Earth and extreme Earth environments helps us understand the possibilities for life in space.
  - Discovering life outside of Earth could change the way we think about ourselves and our world.
  - Life on Earth is ubiquitous and adaptable

Imagination's role in the project:

Imagination as a trait or capability:

- Visitors have to imagine the possibilities for life in space.

Imagination as a theoretical framework:

- Through experiencing interactives that demonstrate tools scientists use, visitors will think like scientists.

Imagination as an outcome:

- We directly ask our visitors to practice imagination when we ask questions in the exhibit like "How would you feel if we discovered life on another planet?"

Suggested Citation (APA 7th Edition):

Testa, A. (2022). Life on the Edge Project Page. In *Imagination in STEM: A Project Index* (pp. 9-10). Museum of Science, Boston.

Imaginative Ways of Thinking:

Creativity

Using magnetic blocks, visitors build an "alien" that could survive in a non-Earth environment.

Embodying

Visitors think like scientists and imagine how different tools help us learn more about environments in space.

Self-identifying

Reflection questions encourage experiencing our exhibit through the lens of imagination since life on Earth is a dataset of one.

Possibilities thinking

Visitors consider the meaning of discovery, origins of life on Earth, and likelihood of finding life in space.

Image credit: Sciencenter

We are Water: Connecting Communities

Project Description:

With support from rural communities and their libraries, We are Water creates a place to meet and share stories about water and to explore and learn about water together. The project brings a traveling exhibit and educational programming, with topics inspired by community voices and stories, to libraries in the Four Corners Region of the Southwestern United States (CO, UT, NM, AZ).

Project Format:

Traveling Exhibition,
Take-Home and In-person Programming

Imaginative Ways of Thinking:

Storytelling

Exploring

Thinking

Institution:

Cooperative Institute for Research in Environmental Sciences (CIRES) Education & Outreach

Funding:

National Science Foundation (DRL- 1907024)

Project Contact:

Brigitta Rongstad
Brigitta.Rongstad@colorado.edu
Education & Outreach Associate, Program Manager for We are Water
CIRES Education and Outreach
University of Colorado Boulder

Project Dates:

January 2020 – December 2023

Project Resources:

https://wearewater.colorado.edu/
InformalScience.org project page

Image credit: Daniela Pennycook

We are Water: Connecting Communities

Project Audience:

- Rural, Indigenous, LatinX Communities in the Four Corners Region of Southwestern U.S.

Project Goals:

- To engage visitors with diverse scientific and cultural perspectives on water topics through exhibits, programs, and learning resources.
- To connect visitors with local water topics, stories, and concerns in their communities.
- To grow rural and tribal library staff capacity to engage diverse audiences in STEAM and multiple ways of knowing about water in the natural world.
- To advance informal science learning scholarship through a culturally responsive approach.

Imagination's role in the project:

Imagination as a process:

- Activities encourage people to think about and play with scenarios about water and what it means in the past, present, and future, getting them interested in thinking about water and others in their communities.

Imagination as a trait or capability:

- People come into the programs or exhibition with their own perspectives of the world around them that influence their interactions.

Suggested Citation (APA 7th Edition):

Rongstad, B. (2022). We Are Water: Connecting Communities Project Page. In *Imagination in STEM: A Project Index* (pp. 11-12). Museum of Science, Boston.

Imaginative Ways of Thinking:

Storytelling

Different perspectives from community members evoke emotional responses, such as hope at what can be imagined for future generations.

Exploring

Young learners can create their own landscapes and see how it affects where water goes.

Thinking

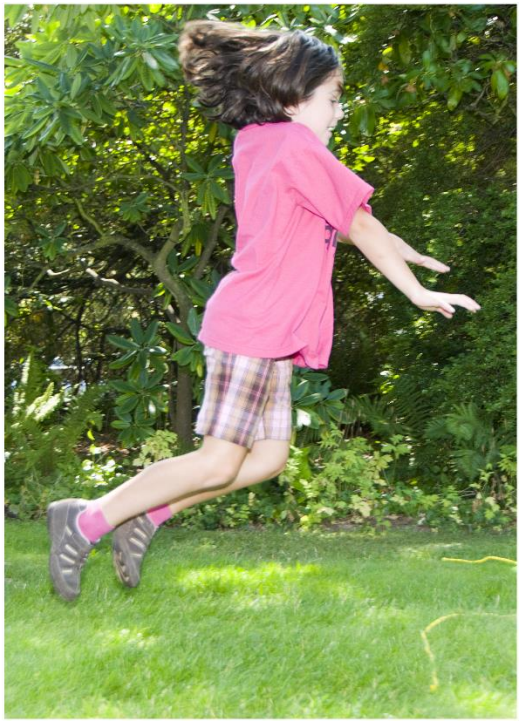
Learners consider what we can do to work towards a better future.

Image credit: Brigitta Rongstad

Informal Education Contexts: Programming

Informal Education Contexts: Programming

This section includes programs, activities, and other facilitated offerings from informal education contexts that invite imaginative thinking among audiences.



Action Reaction

Project Description:

Action Reaction is an empathy-based, kinesthetic activity, where kids engage their imaginations through animal perspective-taking. Presented with various animal scenarios, they are asked to embody the animal and predict the animal's emotional response to the situation.

Project Format:

Kinesthetic perspective-taking game

Imaginative Ways of Thinking:

Empathizing

Perspective-taking

Embodying

Institution:

Woodland Park Zoo; Seattle Aquarium; Point Defiance Zoo and Aquarium

Funding:

Anonymous Funder

Project Contact:

The Advancing Empathy Team at Woodland Park Zoo
empathy@zoo.org

Project Dates:

2015-2018

Project Resources:

InformalScience Project Page
Fostering Empathy for Animals: Research-based Practices

Image credit: Dennis Dow

Action Reaction

Project Audience:

- Early elementary (4-8-year-olds)

Project Goals:

- Children practice using empathy skills through animal perspective-taking.
- Children can predict an animal's emotional reaction in a variety of situations.
- Children can provide clear reasoning for their estimations of an animal's emotional experience.

Imagination's role in the project:

Imagination as a basic empathy skill:

- Imagination helps kids see things from an animal's perspective and consider how their own actions can impact them.

Imagination as a part of a developmental framework:

- Activating imagination is foundational to the development of empathy in early learners. The ability to engage in perspective-taking takes a lot of cognitive effort and benefits from continual practice

Suggested Citation (APA 7th Edition):

Jackson, M. (2022). Action Reaction Project Page. In *Imagination in STEM: A Project Index* (pp. 15-16). Museum of Science, Boston.

Imaginative Ways of Thinking:

Empathizing

Children are encouraged to perceive, understand, and care about the experience of another animal or person.

Perspective-taking

Children are presented with different animal-based scenarios asked to take the perspective of the animal and consider the animal's emotional perspective or response to the situation.

Embodying

Encouraging kids to engage in biomimicry through role playing and "acting like the animal" helps kids connect with animal movement, shifting their minds to be in tune with the animal's physical perspective.

Image credit: AR Lopez

Engineering with Empathy

Project Description:

Activity developers, researchers, and facilitators iteratively developed six engineering activities to prompt learners to consider who they were designing for and why. Narrative elements like characters, settings, and problem frames were added to activities to evoke empathy, and research examined the impact of this approach on girls' engagement in engineering design practices.

Project Format:

Drop-in activities in an engineering exhibition

Imaginative Ways of Thinking:

- Empathizing
- Perspective-taking
- Problem-solving
- Possibilities thinking

Institution:

New York Hall of Science; Tech Interactive; Scott Family Amazeum; Creativity Labs at UC Irvine

Funding:

National Science Foundation (DRL-1712803)

Project Contact:

Suzy Letourneau
sletourneau@nysci.org
Senior Research Associate
New York Hall of Science

Dorothy Bennett
dbennett@nysci.org
Director of Creative Pedagogy
New York Hall of Science

Project Dates:

2017-2021

Project Resources:

InformalScience Resource Page
Museum practitioner guide
Research article (J-PEER)
STEM for All Showcase Video (2022)

Image Credit: New York Hall of Science

Engineering with Empathy

Project Audience:

- 7–14-year-old girls; family groups

Project Goals:

- To deepen engagement in engineering design practices, particularly for girls ages 7–14 years
- To support empathy as an integral part of the engineering design process

Imagination's role in the project:

Imagination as part of the design process:

- Activities in the project emphasized that engineers need to imagine multiple aspects of the situation that may be relevant, understand problems from other people's points of view, and consider alternative possibilities and divergent solutions.

Imagination as a malleable skill:

- Narratives evoked empathy and supported human-centered approaches to engineering design, an approach to practice that can be fostered over time.

Imagination as intrinsically valuable:

- Narratives provided an invitation to engage with engineering problems, and activities used open-ended narrative elements that left space for learners to define who to help and what problems to solve, based on their own ideas and personal experiences.

Suggested Citation (APA 7th Edition):

Letourneau, S. & Bennett, D. (2022). Engineering with Empathy Project Page. In *Imagination in STEM: A Project Index* (pp. 17-18). Museum of Science, Boston.

Imaginative Ways of Thinking:

Empathizing

Children respond to other people's emotions, imagine others' perspectives, and take action to help others.

Perspective-taking

Children imagine someone else's perspective or point of view; a cognitive aspect of empathy.

Problem-solving

Children engage in engineering design, a general approach to solving problems that includes defining a problem, ideation (brainstorming solutions), testing, and iterating a prototype.

Possibilities Thinking

Children practice problem-scoping (defining key elements of the problem) and ideation, both of which involve possibilities thinking.

Image Credit: New York Hall of Science

Frankenstein200

Project Description:

Inspired by Mary Shelley's novel Frankenstein, this project developed transmedia learning experiences, including an online digital narrative and hands-on activities. The Frankenstein200 toolkit includes seven hands-on activities that were used by 50 science centers and museums across the United States.

Project Format:

Hands-On Activities

Imaginative Ways of Thinking:

Expressing ideas

Problem-solving

Institution:

Arizona State University in partnership with the NISE Network

Funding:

National Science Foundation (DRL-1516684)

Project Contact:

Rae Ostman
rostman@asu.edu
Research Professor
Arizona State University

Project Dates:

2015-2021

Project Resources:

https://www.nisenet.org/frankensteinkit
https://csi.asu.edu/

Image credit: Science Museum of Minnesota for the NISE Network

Frankenstein200

Project Audience:

- General museum audience; Families with children ages 6 and up

Project Goals:

- To encourage participants to practice creativity and reflection; explore ideas related to responsible research and innovation; and consider emerging technologies such as artificial intelligence and genetic engineering.
- Project research examined the transmedia learning environment as well as the use of the hands-on activities in informal learning settings.

Imagination's role in the project:

Imagination as a process:

- By using their imagination and creativity, participants become creators, which provides an opportunity to consider ideas related to responsible research and innovation.

Suggested Citation (APA 7th Edition):

Ostman, R. (2022). Frankenstein200 Project Page. In *Imagination in STEM: A Project Index* (pp. 19-20). Museum of Science, Boston.

Imaginative Ways of Thinking:

Expressing ideas

Participants create something to look or work a certain way; participants tell a story, play with a character, and/or imagine a scenario.

Problem-solving

Participants set goals and figure out how to address them with available tools and materials; come up with new ways of approaching a task or problem; and recognize progress and think ahead to next steps.

Image credit: Science Museum of Minnesota for the NISE Network

Go Carbon Neutral! Challenge

Project Description:

The Go Carbon Neutral! Challenge asked students to propose a transportation-related solution to help Boston achieve its goal of carbon neutrality by 2050. Competitors were invited to network with green tech entrepreneurs to develop their proposal, as well as attend professional development sessions focused on creating a career in green technology and climate change mitigation.

Project Format:

Program

Imaginative Ways of Thinking:

- Futures thinking
- Problem solving
- Creativity
- Possibilities thinking

Institution:

Museum of Science, Boston

Funding:

General Motors

Project Contact:

Jonathan Fanning
jfanning@mos.org
Education Associate in Community Initiatives
Museum of Science, Boston

Project Dates:

2019 - 2021

Project Resources:

https://www.mos.org/go-carbon-neutral-2020

Image credit: Museum of Science, Boston

Go Carbon Neutral! Challenge

Project Audience:

- Undergraduate students and the general public

Project Goals:

- To provide professional development and networking opportunities for undergraduate students.
- To encourage the next generation of STEM professionals to bring innovative solutions to climate change problems.
- To make climate change problem-solving accessible to the public.
- To inform the public about the need for unique solutions to the climate crisis, and empower and inspire them to pursue climate mitigation action.

Imagination's role in the project:

Imagination as core to the project:

- The program relied on the imagination of students to develop exciting, worthwhile solutions for the future.

Imagination as inspiration towards action:

- The program encouraged public audiences to imagine solutions in their communities and how they, too, can contribute to solutions.

Suggested Citation (APA 7th Edition):

Fanning, J. (2022). Go Carbon Neutral Project Page. In *Imagination in STEM: A Project Index* (pp. 21-22). Museum of Science, Boston.

Imaginative Ways of Thinking:

Futures thinking

Students are placed "in 2050" when Boston is fully carbon neutral, then imagine solutions that brought us to this future situation.

Problem solving

Students work with professional mentors to imagine solutions towards a carbon-neutral future, given certain energy, population, and transportation needs.

Creativity

Students bring their own creativity to approach the problem and solutions in a range of ways.

Possibilities thinking

Students find solutions in unexpected places. By inviting young people to imagine the future they will be part of, rather than rely on today's experts, the proposed solutions can be astonishing.

Image credit: Museum of Science, Boston

Mission: Mars

Project Description:

Mission: Mars is an engineering design challenge in which visitors design, build, and test a prototype Mars surface habitat that is as big as possible while still able to collapse down into a small capsule.

Project Format:

Hands-on activity

Imaginative Ways of Thinking:

- Simulating
- Prototyping
- Playing
- Problem-solving

Institution:

Museum of Science, Boston

Funding:

NASA (NNX16AM21G)

Project Contact:

Adrian Melia
amelia@mos.org
Manager, In-Gallery Learning
Museum of Science, Boston

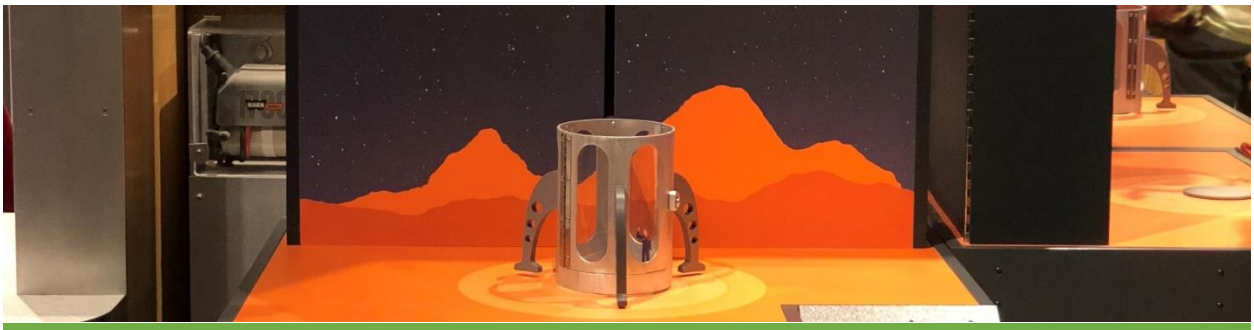
Project Dates:

2019 to present

Project Resources:

Engineering Design Workshop
Informalscience.org project page

Image credit: Museum of Science, Boston



Mission: Mars

Project Audience:

- Families; school groups

Project Goals:

- Engage visitors in engineering design process and engineering habits of mind.
- Engage visitors in learning about technical challenges of space exploration.
- Inspire the next generation of aerospace engineers and scientists.

Imagination's role in the project:

Imagination as a process:

- Imagination is a step in the engineering design process, in which visitors are encouraged to envision and plan solutions to a problem.

Imagination as a motivator:

- Creating an imaginative context – establishing surface habitats on Mars – is a motivating factor for visitors to engage with the activity.

Suggested Citation (APA 7th Edition):

Melia, A. (2022). Mission: Mars Project Page. In *Imagination in STEM: A Project Index* (pp. 23-24). Museum of Science, Boston.

Imaginative Ways of Thinking:

Simulating

The activity presents an imagined context (Mars habitat), inviting visitors to make connections to this simulated real-world scenario as they create their designs.

Prototyping

Visitors build a model and test it given the constraints of the imagined context. Prototyping within this context helps visitors make sense of and address the constraints through testing.

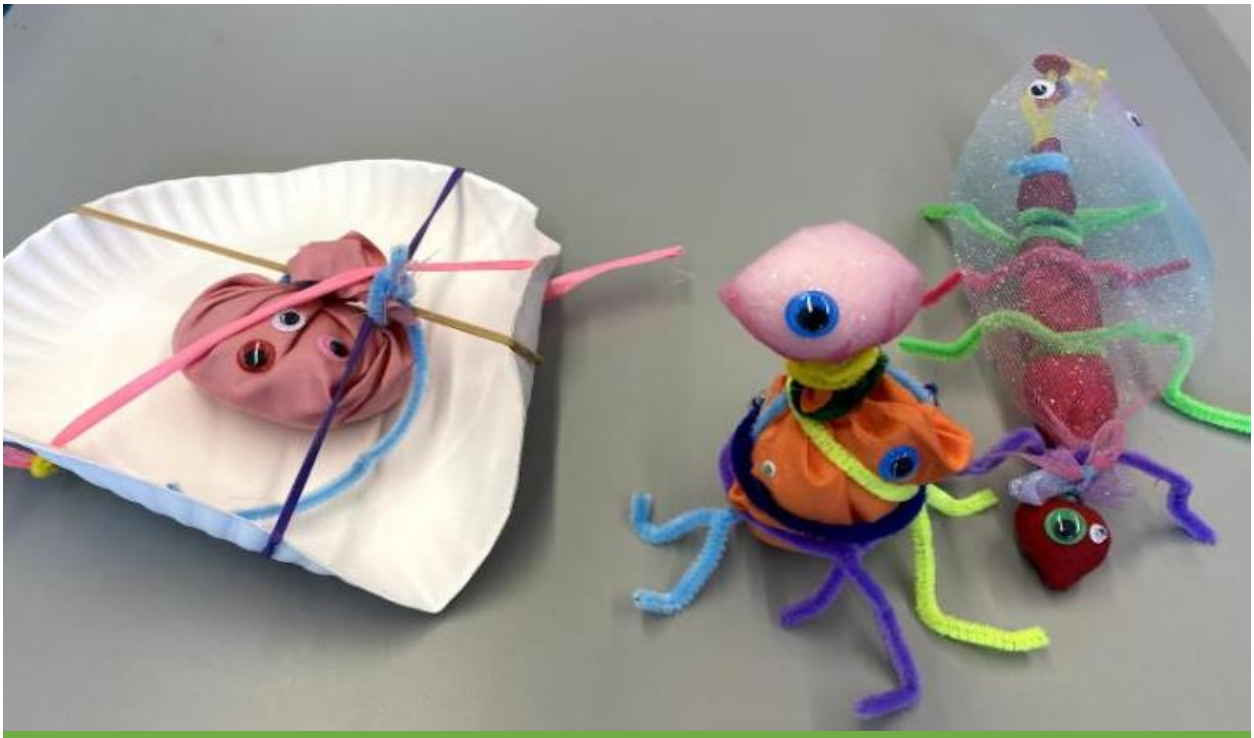
Playing

The low-risk nature of the activity encourages visitors to be playful in their designs, building more imaginatively than they might in a higher-stakes environment.

Problem-solving

The activity presents a pre-determined problem, constraints, and materials. Visitors create solutions to the challenge and iterate on their ideas and designs.

Image credit: Museum of Science, Boston



Out of this World Aliens

Project Description:

An art class in which process, not product, is the ultimate goal. Participants design an alien based on inspiration from their own observations from pop culture, creatures from the natural world, and examples of soft sculpture. Students are never shown a completed project before they start to create their own, relying on their imagination to create.

Project Format:

In-museum class

Imaginative Ways of Thinking:

- Associating
- Wondering
- Observing
- Possibilities Thinking

Institution:

The Regnier Family Wonderscope
Children's Museum of Kansas City

Project Contact:

Lauren Hirsch
ltaylor@wonderscope.org
Director of Programs
The Regnier Family Wonderscope
Children's Museum of Kansas City

Project Dates:

May 2021

Project Resources:

https://wonderscope.org/programs/

Image credit: Lauren Hirsch

Out of this World Aliens

Project Audience:

- Children (1-12 years) and their adults.

Project Goals:

- To foster fine motor skills development through soft sculpture
- To foster observation skills
- To foster critical thinking skills

Imagination's role in the project:

Imagination as process:

- Children and adults connect with materials through observation and discussion.
- Children foster agency over resources and invite creative inquiry while integrating the arts.

Suggested Citation (APA 7th Edition):

Hirsch, L. (2022). Out of This World Aliens Project Page. In *Imagination in STEM: A Project Index*. (pp. 25-26). Museum of Science, Boston.

Imaginative Ways of Thinking:

Associating

Kids make associations to what they initially think an "alien" might look like.

Possibilities Thinking

Through a slideshow including examples of aliens from pop culture and animals from the natural world combined with loose examples of soft sculpture, participants broaden thinking about how an alien may look and function.

Wondering

At the end of the slideshow, adults and children discuss what an alien could possibly look like, then think about how to translate their ideas with a variety of materials provided.

Observing

Participants take prompts from different environments to think about what would be needed to, for example, live in a place filled with water.

Image credit: Lauren Hirsch

Staying in Science

Project Description:

Longitudinal study of high school youth in NYC who participated in mentored science research programs at informal science organizations. The study focused on pathways that students pursued and their resources/obstacles etc. Youth co-researchers supported the research effort.

Project Format:

Research-to-practice partnership

Imaginative Ways of Thinking:

- Self-identification
- Possibilities thinking
- Challenging
- Perspective-taking

Institution:

American Museum of Natural History

Funding:

National Science Foundation (DRL-1561637)

Project Contact:

Preeti Gupta
pgupta@amnh.org
Senior Director of Children, Family and Youth Programs
American Museum of Natural History

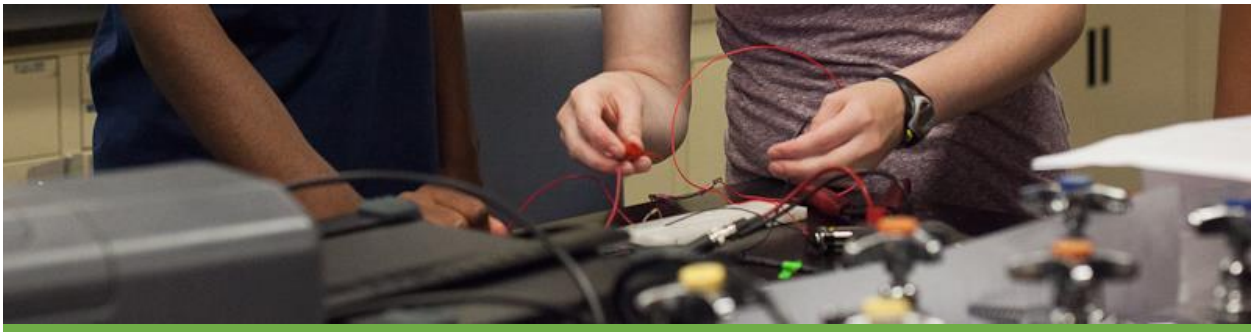
Project Dates:

2016 to present

Project Resources:

InformalScience.org project page

Image credit: Marissa Dwyer



Staying in Science

Project Audience:

- High school and college youth

Project Goals:

The project sought to…

- examine relationships among and changes in youth participation with STEM over time;
- examine resources used and obstacles faced in pursuing STEM-enabled pathways;
- use study findings to inform practitioners on how to better support youth.

Imagination's role in the project:

Imagination as an outcome:

- The program creates an environment in which young people can feel safe and equipped with tools to start (and continue) imagining a world of scientific activity that might not yet exist.

Imagination as a research approach:

- Including youth co-researchers encouraged adult researchers to attend to aspects of youth's social life in new ways.

Suggested Citation (APA 7th Edition):

Gupta, P. (2022). Staying in Science Project Page. In *Imagination in STEM: A Project Index* (pp. 27-28). Museum of Science, Boston.

Imaginative Ways of Thinking:

Self-identification

Youth see themselves as a STEM person.

Possibilities thinking

Youth see the variety of STEM work and the pathways to move towards STEM careers.

Challenging

Youth see that the scientific endeavor can be "better," looking at scientific work from a social justice lens.

Perspective taking

Researchers attend to aspects of youth's social life that might otherwise go un-imagined, particularly with input from youth co-researchers.

Image credit: Marissa Dwyer

SubSpace: Adult Experiences

Project Description:

Art, science, and technology collide, creating a new wave of nightlife that's intelligent, provocative, and one-of-a-kind. From musical tributes in the Planetarium to performance art installations, SubSpace is an ever-evolving lab for Boston's most intriguing and immersive experiences.

Project Format:

Programming

Imaginative Ways of Thinking:

- Empathizing
- Perspective-taking
- Possibilities thinking

Institution:
Museum of Science, Boston

Funding:
Lowell Institute
Barbara and Malcolm L. Sherman
Reno Family Foundation
Lee and Nile Albright
Science Sandbox, an initiative of the Simons Foundation
Other private funding sources

Project Contact:
James Monroe
jmonroe@mos.org
Senior Producer, Adult Programs and Theater Experiences
Museum of Science, Boston

Project Dates:
Ongoing

Project Resources:
https://www.mos.org/explore/subspace
SubSpace YouTube Playlist

Image Credit: Museum of Science, Boston

SubSpace: Adult Experiences

Project Audience:

- Public adult audiences

Project Goals:

- Create opportunities to examine science and technology issues in ways that are relevant, accessible, and entertaining for all adults from all communities.
- Fuse together science, technology, art, and nightlife to explore STEM-related topics through diverse voices and lenses, ways of learning, performance mediums, and groundbreaking immersion.
- To utilize public programming as a tool to re-imagine what is considered a conversation on science, to amplify issues around the social sciences, and to change the narrative around who a science museum represents through inclusive, community-based programming.

Imagination's role in the project:

Imagination as an avenue for access:

- Re-imagining STEM experiences allows us to create different access points for many different communities, inviting broadened participation and amplifying the perspectives of marginalized communities.

Imagination as a catalyst for science engagement:

- Making science and our institution feel more imaginative for adults invites them to have fun, re-envision our space, and re-examine their relationship with science.

Suggested Citation (APA 7th Edition):

Monroe, J. (2022). SubSpace: Adult Experiences Project Page. In *Imagination in STEM: A Project Index* (pp. 29-30). Museum of Science, Boston.

Imaginative Ways of Thinking:

Empathizing

Audiences are invited to engage with the perspectives and experiences of their own and others' communities.

Perspective-taking

Audiences broaden their perspectives about how science and technology can impact their lives and how they, too, can contribute to STEM and society – not just as bystanders, but as participants.

Performers (researchers, speakers, artists, etc.) can re-imagine how their work can be accessible and relatable to more than one community.

Possibilites thinking

Performers use the museum's technologies and immersive theaters to push the way they look at their art and work, and reimagine how they can create and develop their artistry.

Image Credit: Museum of Science, Boston

Science Alliance of Tennessee

Tennessee Rural Impact Project

Project Description:

A grant-funded program that takes an asset-based approach to leveraging and expanding the resources of six museums to build connections across home, school and community in support of STEM learning in rural communities.

Project Format:

Community Engagement Project

Imaginative Ways of Thinking:

- Possibilities Thinking
- Transforming
- Envisioning
- Innovating

Institution:

Discovery Center at Murfree Spring in partnership with the Science Alliance of Tennessee (SA)

Funding:

Institute of Museum and Library Services (MG-249465/OMS/21)

Project Contact:

Dale McCreedy
dmccreedy@explorethedc.org
VP of Audience & Community Engagement
Discovery Center at Murfree Spring

Project Dates:

2021-2024

Project Resources:

https://www.explorethedc.org/community

Science Alliance of Tennessee

Tennessee Rural Impact Project

Project Audience:

- K-2 children and families, school, communities; Science Alliance partners.

Project Goals:

- To foster children's curiosity, wonder and problem-solving skills using STEM curricula and community connections that set students on a positive trajectory of learning where they live and play.

Imagination's role in the project:

Imagination as a process:

- Partners work to think outside the box, to push to think of different solutions than we have in the past; transformation, change, and imagination are all part of this process.

Suggested Citation (APA 7th Edition):

McCreedy, D. (2022). Tennessee Rural Impact Project (TRIP) Project Page. In *Imagination in STEM: A Project Index* (pp. 31-32). Museum of Science, Boston.

Imaginative Ways of Thinking:

Possibilities Thinking

Partners reflect on our own work and what else is possible.

Transforming

Partners consider how to tweak and leverage what we have to create something new and responsive.

Envisioning

Partners think about and reflect on the process.

Innovating

Partners co-create and collaborate to think outside the box, imagining new possibilities.

Image credit: Science Alliance of Tennessee

Formal Education Contexts: Curriculum and Professional Development

Formal Education Contexts: Curriculum and Professional Development

This section includes imagination-infused curriculum, lessons, and professional development offerings from formal education contexts.

Discovery Project

Project Description:

Students utilize personal interest, research, and physical items to solve problems through maker-centered activities. Projects ranged from building a Lego sorter to sort the makerspace Legos, to creating a portable cell phone charger that charges when you walk, to programming a robot to move salt down a long table.

Project Format:

Makerspace project

Imaginative Ways of Thinking:

- Empathizing
- Problem-solving
- Prototyping
- Visualizing

Institution:

Program conducted in high schools

Project Contact:

Shannon Mersand
shannonmersand@gmail.com
Instructional Technology and School Media Specialist
Marlboro High School

Project Dates:

Ongoing

Project Resources:

https://www.shannonmersand.com/

Image credit: Shannon Mersand

Discovery Project

Project Audience:

- Appropriate for all grades/ages

Project Goals:

- Students problem-solve, persist, and take risks.
- Students imagine solutions to a wide range of problems that affect them and the world around them.

Imagination's role in the project:

Imagination as a process:

- Students considered what they knew, what problem they wanted to solve (and what they know about the problem), and how they could combine the two.

Imagination as a social connector:

- Students worked and imagined together, sharing ideas to fill in each other's "imagination gaps" to solve problems they couldn't otherwise solve alone.

Imagination as empowerment:

- Tapping into imagination made students feel empowered and raised self-efficacy; by the end, even those who thought they couldn't, did successfully solve their problem.

Suggested Citation (APA 7th Edition):

Mersand, S. (2022). Discovery Project Page. In *Imagination in STEM: A Project Index* (pp. 35-36). Museum of Science, Boston.

Imaginative Ways of Thinking:

Empathizing

When students choose a problem that affects someone besides themselves, they consider how others feel, how the problem affects them, and why it might be important to that person.

Problem-solving

Students identify the problem to solve, THEN when they run into obstacles along the way, students have to reconsider their approach.

Prototyping

Students create a physical item to solve their problem.

Visualizing

Student sketch out plans before they are able to do any actual building, thinking about materials to use; by seeing all the materials available, they were encouraged to consider and visualize the process based on the existing materials.

Image credit: Shannon Mersand

DNA Mutations: STEAM Work

Project Description:

In this lesson, students use paintings to create representations of genetic mutations and their effects on protein structure and function. Students individually create paintings of lines or circles, then pair with a partner to cut up both their paintings and swap pieces based on what type of mutation they would like to represent (e.g., point mutation, small deletion).

Project Format:

Arts-integrated lesson

Imaginative Ways of Thinking:

- Representing
- Translating
- Reflecting
- Visualizing

Project Contact:

Mary Brooks
mwbrooks110@gmail.com
STEAM Education Consultant & Curriculum Designer

Project Dates:

Ongoing

Project Resources:

https://www.marybrooksteam.net/

Image credit: Mary Brooks

DNA Mutations: STEAM Work

Project Audience:

- Middle to high school students

Project Goals:

- Students create interpretations of DNA mutations and subsequent effects on protein structure and function.
- Students practice engaging with the unknown.
- Students deepen their grasp of science concepts as they translate concepts from concrete DNA sequences to abstract art representations of the central ideas.

Imagination's role in the project:

Imagination as an invitation to science learning:

- Imagination's role is to engage students in and personalize the content through centering students' visualizations and interpretations.

Imagination as a way to bring all students to the table:

- Imagination invites both students who see themselves as "science-y" and as "artsy" to make personal connections between science and their own identities.

Imagination as a tool for problem-solving:

- Imagination enables pairs of students work together to create finished artwork that accurately reflects their understandings.

Suggested Citation (APA 7th Edition):

Brooks, M. (2022). DNA Mutations: STEAM Work Project Page. In *Imagination in STEM: A Project Index* (pp. 37-38). Museum of Science, Boston.

Imaginative Ways of Thinking:

Representing

Students imagine how to visually represent something that is unseen with the naked eye.

Reflecting

Students write artist's statements that include explanations of how science concepts informed their artistic choices.

Translating

Students take their understanding of mutations and represent this visually as abstract art.

Visualizing

Students imagine what initial and mutated genes look like.

Image credit: Mary Brooks

Through My Window

Project Description:

A story-based, multimedia curriculum featuring a full-length middle grades novel with related lessons. Appropriate for both formal and informal learning environments, Through My Window was designed to help students understand the connections between engineering and society, see that engineers do many types of things, and envision themselves as potential future engineers.

Novel summary: In *Talk to Me*, fourteen-year-old Sadina is fighting the clock to keep her mother from being arrested for a crime she didn't commit. Sadina thinks her sister, Maddie, has information that could prove their mother is innocent. There's one big problem: Maddie can't talk. She has selective mutism, an anxiety disorder that makes it impossible for her to talk to anyone—except Bella, her robotic cat. Sadina searches desperately for a way to help her sister communicate. She teams up with her friends to transform Bella into Chattercat, a talking robot that just might get some answers from Maddie.

The book is accompanied by three interactive learning adventures (one about Artificial Intelligence, one about Engineering Design, and one about Engineering Ethics) and additional enrichment activities.

Project Format:

Curriculum

Imaginative Ways of Thinking:

- Feeling
- Perspective-taking
- Understanding
- Embodying

Institution:

Springfield Technical Community College
Smith College

Funding:

National Science Foundation
(1223868 and 1223460)

Project Contact:

Isabel Huff
izhuff@yahoo.com
Curriculum Designer and Training Specialist
Springfield Technical Community College

Project Dates:

2013-2018

Project Resources:

Through My Window Website

Image credit: Evanleigh Davis

Through My Window

Project Audience:

- Upper elementary and middle school teachers, afterschool educators, and students

Project Goals:

- Students understand the impact engineers can have on society, including ethical dilemmas they face.
- Students see that engineers do many types of things, from artificial intelligence to materials engineering.
- Students envision themselves as potential future engineers.
- Support/Validate the power of Imaginative Education theory to engage students in engineering.

Imagination's role in the project:

Imagination as a theoretical framework:

- The stories upon which the curriculum is based are aligned with the theory of Imaginative Education (IE) by Kieran Egan. IE outlines cognitive tools (for middle schoolers, these include limits and extremes of reality, heroes and heroines, and binary opposites) that help structure meaningful learning.

Imagination as a valuable capability:

- By imagining themselves as characters in the stories, students can understand and perspective-take on experiences they have not had themselves.

Suggested Citation (APA 7th Edition):

Huff, I. (2022). Through My Window Project Page. In *Imagination in STEM: A Project Index* (pp. 39-40). Museum of Science, Boston.

Imaginative Ways of Thinking:

Feeling

Compelling engineering stories with relatable characters help students emotionally engage (they care about the characters in the story) and as a result learn about engineering more deeply.

Perspective-taking

Students see the world (or a particular design challenge) through the eyes of one or more characters in the story.

Understanding

Students understand the engineering design process as a way of approaching problems and see the broad variety of work engineers do.

Embodying

Students learn to embody the role of an engineer.

Image credit: TEEMS

Transforming Engineering Education for Middle Schools (TEEMS)

Project Description:

A story-based, multimedia middle school curriculum that integrates engineering with science curricula. TEEMS was designed to help students understand the connections between engineering and society, see that engineers do many types of things, and envision themselves as potential future engineers.

Example Unit: The *Molasses Disaster* engineering design unit features the story of Marielle and Leo, two fictional Latinx teens who brave a storm and a soon-to-be-demolished bookstore to rescue mysterious boxes. The boxes hold papers – outlines, maps, newspaper, photos – that tell the true story of the 1919 Boston Molasses Flood, all gathered by their grandmother for a book she's writing. Students embody Marielle and Leo as they reconstruct the story. Guided by notes left by their grandmother about the disaster, Marielle and Leo (and students) find out what happened to cause a tank to collapse and release a massive flood of molasses. Exploring what went wrong – and why – gives students an intriguing and nuanced first look at the engineering design cycle and why it's so important.

Students then apply what they've learned by identifying the phases of the design cycle in real-life engineering scenarios. At the end of the unit, students engage in a design challenge of their own.

Project Format:

Curriculum

Imaginative Ways of Thinking:

- Feeling
- Perspective-Taking
- Understanding
- Embodying

Institution:

Springfield Technical Community College
Smith College

Funding:

National Science Foundation
(DRL - 1813572 and 1814033)

Project Contact:

Isabel Huff
ishuff@stcc.edu
Curriculum Designer and Training Specialist
Springfield Technical Community College

Project Dates:

2018-2023

Project Resources:

TEEMS Teacher Site

Image credit: TEEMS

Transforming Engineering Education for Middle Schools (TEEMS)

Project Audience:

- Middle school teachers and students

Project Goals:

- Students understand the impact engineers can have on society.
- Students see that engineers do many types of things, from working in space to planning cities to designing technology.
- Students envision themselves as potential future engineers.
- Support/Validate the power of Imaginative Education theory to engage students in engineering.

Imagination's role in the project:

Imagination as a theoretical framework:

- The stories upon which the curriculum is based are aligned with the theory of Imaginative Education (IE) by Kieran Egan. IE outlines cognitive tools (for middle schoolers, these include limits and extremes of reality, heroes and heroines, and binary opposites) that help structure meaningful learning.

Imagination as a valuable capability:

- By imagining themselves as characters in a story, students can understand and perspective-take on experiences they have not had themselves.

Suggested Citation (APA 7th Edition):

Huff, I. (2022). Transforming Engineering Education for Middle Schools (TEEMS) Project Page. In *Imagination in STEM: A Project Index* (pp. 41-42). Museum of Science, Boston.

Imaginative Ways of Thinking:

Feeling

Compelling engineering stories with relatable characters help students emotionally engage (they care about the characters in the story) and as a result learn about engineering more deeply.

Perspective-taking

Students see the world (or a particular design challenge) through the eyes of one or more characters in the story.

Understanding

Students understand the engineering design process as a way of approaching problems and see the broad variety of work engineers do.

Embodying

Students learn to embody the role of an engineer.

Photo courtesy of Dark Tide by Stephen Puleo

Fairytale Engineering

Project Description:

In this workshop, teachers experience fun, hands-on fairytale design challenges that develop their own engineering skills and foster their own positive STEM identity. After the workshop, teachers have the skills and tools to immerse children in their classrooms in play, storytelling, and engineering.

Project Format:

Teacher professional development workshop

Imaginative Ways of Thinking:

- Creating solutions
- Future thinking
- Storytelling
- Playing

Institution:
STEMSpark

Project Contact:
Marta Biarnes
martabiarnes@stem-spark.com
Founder, CEO
STEMSpark

Project Dates:
2018 to present

Project Resources:
https://www.stem-spark.com/

Image credit: © STEMSpark

Fairytale Engineering

Project Audience:

- Early childhood / elementary school educators

Project Goals:

- Empower teachers' sense of STEM identity.
- Teachers will have the skills and tools to immerse children in their classrooms in play, storytelling, and engineering so that students can build, test, and try again alongside their favorite storybook characters.

Imagination's role in the project:

Imagination as a process:

- Imagination is a process for solving a problem.

Imagination as valuable:

- Within the early learner community, imagination is tied in with creativity, play, and spontaneity.

Imagination as an outcome:

- Imagination produces an outcome that helps problem-solve; the more visible the connection between imagination and STEM, the more we value it.

Suggested Citation (APA 7th Edition):

Biarnes, M. (2022). Fairytale Engineering Project Page. In *Imagination in STEM: A Project Index*. (pp. 43-44). Museum of Science, Boston.

Imaginative Ways of Thinking:

Creating solutions

Invite teachers to have different materials and engineer their own ways, creating unique solutions for imaginary characters.

Future thinking

Encourage teachers to consider how they will implement the ideas from the workshop into the classroom.

Storytelling

Telling the story of the fairytales; retelling the story in an empowering way through "science-telling."

Playing

Invite teachers to feel like they can play and they can encourage students to play; create space for pretend play.

Image credit: © STEMSpark

Out-of-School Time Contexts: Programming and Curriculum

Out-of-School Time Contexts: Programming and Curriculum

This section includes examples of imagination-infused programming, activities, and curriculum designed for out-of-school time contexts.

Engineering at Home

Project Description:

Engineering At-Home is a suite of activity books with embedded engineering challenges for families to try at home with a variety of simple, everyday materials.

Project Format:

Hands-on activity; at-home activity

Imaginative Ways of Thinking:

Planning

Creating

Testing

Improving

Institution:

EiE, Museum of Science, Boston

Project Contact:

Heather Gunsallus
eie@mos.org
VP, STEM Education, MOS in School
Museum of Science, Boston

Project Dates:

Ongoing

Project Resources:

EiE Families

Illustration credit: Jennifer Naalchigar

Engineering at Home

Project Audience:

- Families with children ages 4 to 11

Project Goals:

- Engage families in the Engineering Design Process.
- Increase families' confidence to engage in engineering activities together.

Imagination's role in the project:

Imagination as a process:

- Imagination is a step in the engineering design process, in which families are prompted to envision potential solutions to a problem and consider how to measure success.

Imagination as a lens towards the future:

- Activities prompt caregivers to see their children's creative potential, and prompt learners and those who support them to imagine future possibilities in STEM.

Imagination as an opportunity for creativity:

- The open-ended, non-prescriptive nature of the engineering challenges invites more freedom to explore creative solutions to engineering problems.

Suggested Citation (APA 7th Edition):

San Antonio-Tunis, C. (2022). Engineering at Home Project Page. In *Imagination in STEM: A Project Index* (pp. 47-48). Museum of Science, Boston.

Imaginative Ways of Thinking:

Planning

Participants envision how they might solve an engineering problem, then represent that idea through drawing.

Creating

Participants use household materials and everyday supplies to physically build their envisioned idea.

Testing

Participants try out their design, assessing it within an imagined scenario (e.g., testing a bug trapper; testing a pulley system to transport peppers).

Improving

Participants reflect on the results of their testing, envision improvements, and make changes to their design.

Illustration credit: Jennifer Naalchigar

Fabric Science Curriculum

Project Description:

A lecture on the history, economics, and chemical/ physical structure of fabric throughout history, followed by a series of experiments on making and testing fabric and wool through cleaning and processing agents.

Project Format:

Program

Imaginative Ways of Thinking:

- Cultivating Knowledge
- Fostering Understanding
- Addressing Challenges
- Brainstorming

Institution:

Pathway to Adventure Council,
Boy Scouts of America

Funding:

Private Funder; Partnered with National Geographic Education

Project Contact:

Kristen Vogt Veggeberg, MPA, PhD
Kristen.vogt@scouting.org
Director of STEAM and Exploring
Pathway to Adventure Council

Project Dates:

August 2020 – May 2022

Project Resources:

STEM in Scouting Program Page

Image Credit: Kristen Vogt Veggeberg

Fabric Science Curriculum

Project Audience:

- Youth (ages 8-14; Grade 3-5, 6-8)

Project Goals:

- Youth learn the effects of different chemicals and subsequent reactions on fabric
- Youth learn about the socio-economic impact of fabric on human culture and history
- You learn about the environmental impacts of 'fast fashion' and fabric production
- Youth envision historical and scientific concepts of fabric creation and its impact on culture.

Imagination's role in the project:

Imagination as necessary for problem-solving:

- Students envision the changes and story of fabric throughout human history, and conceptualize how fabric evolved alongside human culture.

Imagination as a vehicle for understanding:

- Students come to new understandings of how certain processes (e.g., fabric production) have come to be across the planet.

Suggested Citation (APA 7th Edition):

Vogt Veggeberg, K. (2022). Fabric Science Curriculum Project Page. In *Imagination in STEM: A Project Index* (pp. 49-50). Museum of Science, Boston.

Imaginative Ways of Thinking:

Cultivating Knowledge

Youth take what they currently know and grow their understanding of fabrics through a historical and environmental lens.

Fostering Understanding

Youth generate new ideas about fabrics that shape understandings, such as how fabric—and the science of it—came about through different parts of human history and geography.

Addressing Challenges

Youth confront problems related to the environmental impact of fabric production and treatment, and, then, dream of solutions to them.

Brainstorming

Youth experiment with different elements of both fabric production and creation, and they discuss fabric's impact on society.

Image Credit: Kristen Vogt Veggeberg

Imagining Mars

Project Description:

Using STEAM content and practices, we integrate informal learning and higher-level thinking skills with formal education. This project is driven by work with the NASA Jet Propulsion Lab's Mars project. In this project, we integrate science with visual art, imagination, creativity, innovation, and other disciplines to solve a real-world Mars problem.

Project Format:

Out-of-school time multi-visit program

Imaginative Ways of Thinking:

- Problem-solving
- Creativity
- Innovating
- Synthesizing

Institution:

ICEE Success Foundation

Funding:

Texas Commission on the Arts, United Way of East Central Texas, National Art Educators Foundation, NASA Science Mission Directorate Science Education Cooperative Agreement Notice (NNH15ZDA004C)

Project Contact:

Lucinda Presley
lucinda.presley@gmail.com
Executive Director
ICEE Success Foundation

Project Dates:

2009 to present

Project Resources:

iceesuccess.org
Texas Commission on the Arts Program

Image Credit: Lucinda Presley

Imagining Mars

Project Audience:

- 1st through 8th grade students and teachers, with a focus on underserved students

Project Goals:

- Students engage in and learn the science standards
- Students integrate science content and practices with those of other disciplines
- Students increase their creative and innovative skills
- Students demonstrate the importance of visual art, as it helps drive these processes
- The project researches and develops the most effective transdisciplinary learning that promotes content acquisition along with creative thinking

Imagination's role in the project:

Imagination as the driver of the project:

- The project is centered on the ability to imagine a solution to a problem, especially through visualization. Imagination is the driver, and STEAM is the mechanism through which this happens, as visual thinking and visual art content and skills provide deeper science understanding and problem-solving capabilities.

Suggested Citation (APA 7th Edition):

Presley, L. (2022). Imagining Mars Project Page. In *Imagination in STEM: A Project Index* (pp. 51-52). Museum of Science, Boston.

Imaginative Ways of Thinking:

Problem-solving

Students imagine what it would be like to live on Mars and consider how to solve a specific real-world problem to make human life on Mars possible.

Creativity

Student teams integrate science and art practices to come up with novel ideas, visualize possibilities, design a solution, and make it with found objects.

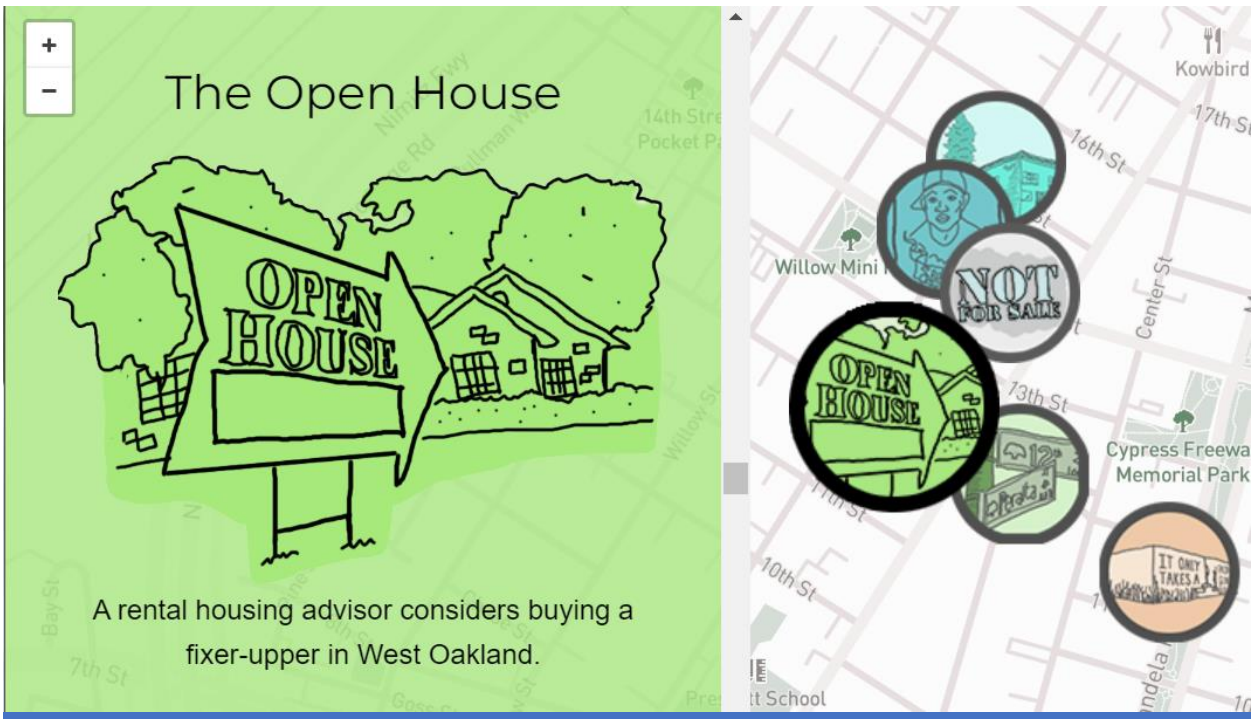
Innovating

Students discuss and present how their thinking, science, and art worked together to solve their problem.

Synthesizing

Students approach the problem from transdisciplinary perspectives, synthesizing, without boundaries, content and practices to innovatively and imaginatively solve problems.

Image Credit: Lucinda Presley



West Side Stories

Project Description:

This large-scale project between youth and adults that culminated in an interactive map that utilizes audio and video media to highlight the impact of gentrification in the community of West Oakland through iconic places, people, stories (video and audio), and images.

Project Format:

Youth-led out-of-school time media production program; Paid internship

Imaginative Ways of Thinking:

- Narrative
- Collegiality
- Perspective-taking
- Future Dreaming

Institution:

YR Media

Funding:

National Science Foundation (DRL-1323791)

Project Contact:

Clifford Lee
cl.lee@northeastern.edu
Professor of Education
Mills College at Northeastern University

Elisabeth Soep
lissa.soep@yrmedia.org
Special Projects Producer and Senior Scholar-in-Residence, YR Media

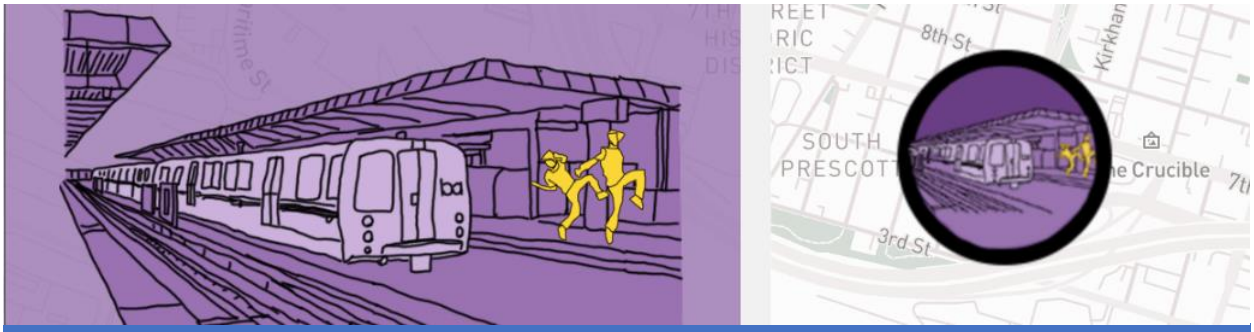
Project Dates:

2014-2015

Project Resources:

https://yr.media/westsidestories/
How We Made Youth Radio's West Side Stories Code for What?

Image credit: https://yr.media/westsidestories/



West Side Stories

Project Audience:

- 14–24-year-old, majority BIPOC youth, and other youth underserved in Computer Science education

Project Goals:

- Teach design, storytelling, computational thinking, data analysis and how they interact.
- Tell the story of gentrification through history, individual stories, and socio-economic impacts.
- Create a highly engaging interactive that draws people in and pushes them to ask deeper questions about themselves and their communities.

Imagination's role in the project:

Imagination as process:

- Youth imagined the perspective of the audience and story they wanted to talk about and how it impacts others' perspective of their West Oakland community.

Imagination as ideation:

- Youth generated ideas about where and how to gather information and ask questions.

Imagination as central:

- Imagination's value became more explicit over time.

Suggested Citation (APA 7th Edition):

Lee, C. (2022). West Side Stories Project Page. In *Imagination in STEM: A Project Index* (pp. 53-54). Museum of Science, Boston.

Imaginative Ways of Thinking:

Narrative

Youth shape the narrative of their community, telling the story of gentrification to deepen understanding of the nuances of this topic, and presenting non-dominant stories.

Collegiality

The project embraced a pedagogy of collegiality between adults and youth staff.

Perspective-taking

Youth consider the project's audiences (and how they might take up the content), its impact, and people involved.

Future Dreaming

Youth imagined the world they want to see through the product they created for others and through the narratives audiences leave with.

Image credit: https://yr.media/westsidestories/

Research: Research Studies and Design-Based Research

Research: Research Studies and Design-Based Research

This section presents research studies and design-based research that explores or leverages imaginative thinking in various ways.

Applying Imagination to Foster Empathy and Collaboration

Project Description:

Study exploring the role of imagination in fostering empathy, altruism, and collaboration. Also exploring means in which we can amplify imagination and as a consequence heighten these connections.

Project Format:

Research study / Activity, experiment

Imaginative Ways of Thinking:

- Empathizing
- Moral Thought
- Perspective-taking
- Visualizing

Institution:
University of Albany, SUNY

Funding:
John Templeton Foundation

Project Contact:
Brendan Bo O'Connor
bgaesser@albany.edu
Assistant Professor
University of Albany, SUNY

Project Dates:
2014-2016

Project Resources:
Imagination and Moral Cognition Lab

Image credit:
https://gaesserlab.wixsite.com/gaesserlab/home

RESEARCH

Applying Imagination to Foster Empathy and Collaboration

Project Audience:

- General public

Project Goals:

- Increase in understanding of the ways in which imagination helps us connect and collaborate with others.
- Develop interventions that can be used to apply these findings to real-world settings.

Imagination's role in the project:

Imagination as a process:

- That by better understanding that process, we understand how we engage with the world and how we engage with other people.

Imagination as an outcome:

- We can use that knowledge to develop better theories of imagination that allows us to better apply it to real-world outcomes.

Suggested Citation (APA 7th Edition):

O'Connor, B. B. (2022). Applying Imagination to Foster Empathy and Collaboration Project Page. In *Imagination in STEM: A Project Index* (pp. 57-58). Museum of Science, Boston.

Imaginative Ways of Thinking:

Empathizing

Increase caring and concern for another's well-being.

Moral Thought

Increase willingness to engage with and help others including out group members.

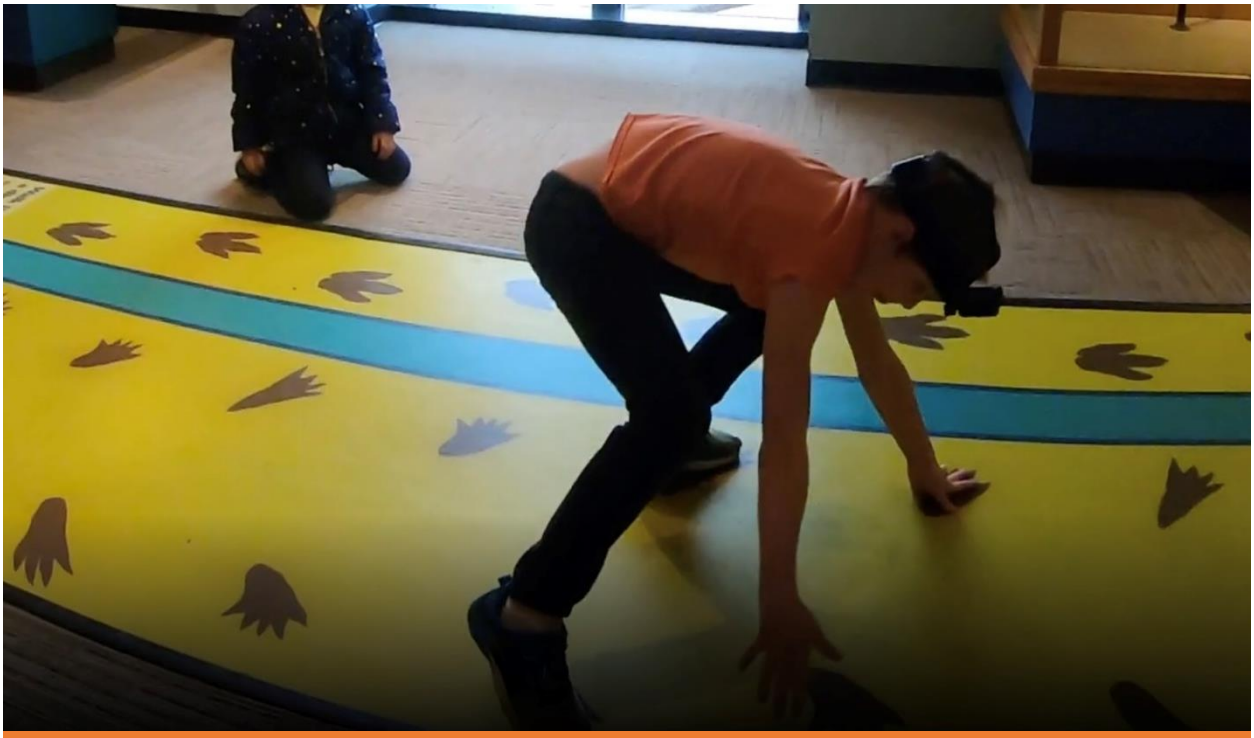
Perspective Taking

Increase consideration of other people's thoughts and feelings.

Visualizing

Increase the vividness of imagery as a means of down-streaming consequences of empathy, perspective taking, and moral thought (we use visualizing that affects these).

Image credit:
https://gaesserlab.wixsite.com/gaesserlab/home



Dinos and GoPros

Project Description:

Study investigating how children naturalistically explore the dinosaur exhibit in the Academy of Natural Sciences by recording their interactions with the exhibit, and with their families, using GoPros.

Project Format:

Research study

Imaginative Ways of Thinking:

Visualizing

Wondering

Navigating Inconsistency

Institution:

Villanova University

Funding:

National Science Foundation (DRL-1929935)

Project Contact:

Deena Weisberg, PhD
deena.weisberg@villanova.edu
Assistant Professor, Department of Psychological and Brain Sciences
Villanova University

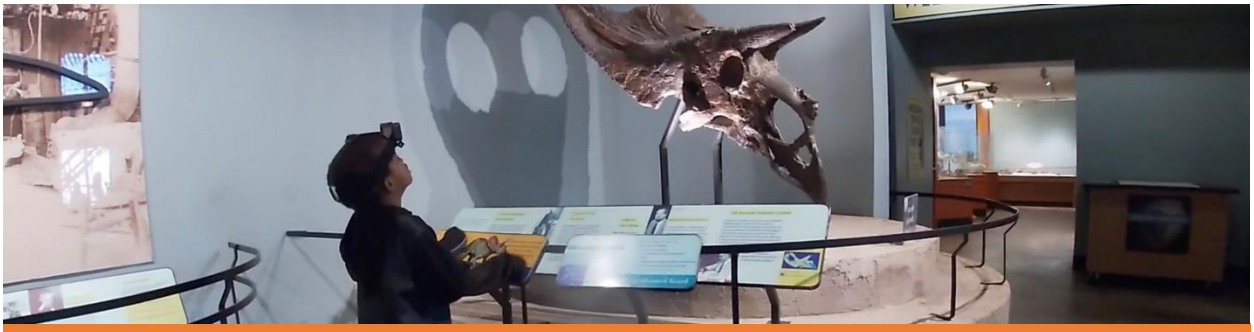
Project Dates:

2019-2020

Project Resources:

www.starlabkids.org
www.ansp.org

Image credit: Deena Weisberg



Dinos and GoPros

Project Audience:

- Children (6-9 years) and their families.

Project Goals:

- To see what children learn in the exhibit.
- To see how children interact with the exhibit elements and the people around them.
- To see whether their experiences in the exhibit relate to how they talk about learning in general or to their own views of what they were doing in the exhibit.

Imagination's role in the project:

Imagination as a tool for doing science:

- Researchers imagined what children do as they were designing the study and outcomes measures.

Imagination as a tool for building understanding:

- Participants might have been imagining during their exploration (e.g., what a dinosaur would look like; that they were paleontologists at a dig site).

Suggested Citation (APA 7th Edition):

Weisberg, D. (2022). Dinos and GoPros Project Page. In *Imagination in STEM: A Project Index* (pp. 59-60). Museum of Science, Boston.

Imaginative Ways of Thinking:

Visualizing

Participants use their imaginations to fill in the details when confronted with bones or other objects in the exhibit.

Wondering

Researchers and participants ask and reflect on open-ended questions (e.g., "What will the data look like?" "What would a dinosaur look like?" "How would paleontology tools be used?")

Navigating Inconsistency

Participants put together new information from the museum with things that they already know, which might conflict.

Researchers expect one set of results and then have to envision new ideas for how things could go based on actual experiences.

Image credit: Deena Weisberg

Ready Set Go Engineering

Project Description:

In partnership with Metropolitan Family Service (MFS)—a community-based organization that serves low-income, racially and ethnically diverse communities across the Portland, Oregon metro region—the team conducted a 3-year design-based research study to better understand how the characteristics of hands-on family engineering activities influence the ways preschool-age children and their parents and caregivers engage in the engineering design process at home and in classroom-based parent-child play settings.

Project Format:

Design-based research study

Imaginative Ways of Thinking:

Creating

Improving

Expanding

Institution:
University of Notre Dame
TERC
Metropolitan Family Service

Funding:
National Science Foundation
(EEC-1930848)

Project Contact:
Gina Navoa Svarovsky
gsvarovsky@nd.edu
Associate Professor of Practice
University of Notre Dame

Scott Pattison
Scott_pattison@terc.edu
Research Scientist
TERC

Project Dates:
2019-2023

Project Resources:
InformalScience.org Project Page
Head Start on Engineering project website

Ready Set Go Engineering

Project Audience:

- Pre-K children (3-5 years) and their families

Project Goals:

- Goal 1. Build on prior research and existing partnerships to create a context for research on activities that productively engage young learners (ages 3–5) and their families in elements of the engineering design process
- Goal 2. Use a design-based research (DBR) approach to simultaneously and iteratively improve the activities and advance theory about strategies to support engineering design engagement for parents and children
- Goal 3. Disseminate study findings, frameworks, and other project deliverables to communities beyond the traditional scholarly audiences, with a specific focus on sharing findings with study participants, parents, and early childhood educators

Imagination's role in the project:

Imagination as a family asset:

- Imagination is a strength and asset that young children and their families bring to their engineering experiences.

Imagination as a catalyst:

- Families use their imaginations and playful approaches to the activities to deepen and extend the engineering engagement.

Imagination as transformational:

- The imaginative and playful ways young children and families approach engineering design opens up new ways of thinking about engineering as a discipline.

Suggested Citation (APA 7th Edition):

Svarovsky, G., Pattison, S., Corbett, A., Quijano, M., Ramos Montañez, S., & Wagner, C. (2022). Ready Set Go Engineering Project Page. In *Imagination in STEM: A Project Index* (pp. 61-62). Museum of Science, Boston.

Imaginative Ways of Thinking:

Creating

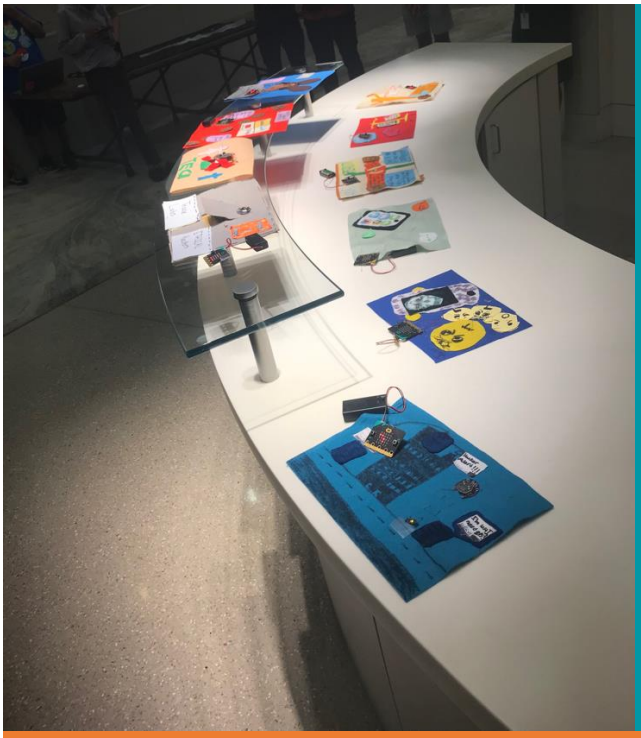
Young children and their families use their imaginations to create a compelling context for engineering design experiences.

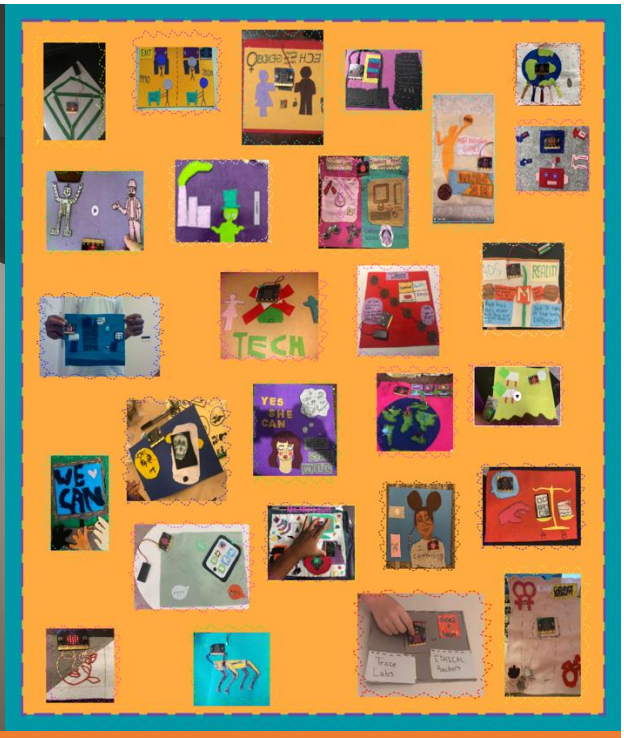
Improving

Young children and their families evaluate and revise their engineering designs based on real and imaginary success criteria.

Expanding

Young children and their families expand the goals and constraints of engineering design challenges based on their own imaginations and interests.





Restorying Quilts

Project Description:

Youth designed interactive, electronic textile-based quilt patches that "restory" dominant narratives about computing and our relationship to technology. Design-based research was used to explore how engaging in restorying practices supported youth's understanding of the sociopolitical and ethical dimensions of computing technologies.

Project Format:

Design-based research project

Imaginative Ways of Thinking:

- Storytelling
- Identity
- Restorying
- Connecting

Institution:

Partnership between University of Pennsylvania Graduate School of Education and The Franklin Institute

Funding:

Ford Foundation

Project Contact:

Mia Shaw
Mshaw12@gse.upenn.edu
PhD Candidate
University of Pennsylvania Graduate School of Education

Project Dates:

May 2021 – July 2021

Project Resources:

https://www.miasshaw.com/research
https://www.yasminkafai.com/

Image Credit: Mia Shaw

Restorying Quilts

Project Audience:

- High school youth from historically marginalized communities

Project Goals:

- Understand that there are codes (sociocultural and computational) that uphold power structures that benefit some people while harming others.
- Understand that marginalized communities have "hacked" these codes by using computing technology, art, and storytelling to resist oppression.
- Use computing technology and restorying practices as tools for interrogating and reimagining dominant narratives about the computing field.

Imagination's role in the project:

Imagination as a vehicle:

- Youth examine how computing systems are connected to systems of oppression and reimagine alternate visions and uses of technology.

Imagination as a process:

- Part of imagining is being able to identify sociocultural codes, break the codes to imagine alternatives, and author new understandings of self and community.

Imagination as a perspective:

- This work draws from Black Feminist/Womanist perspectives, specifically African-American quilt-making and how Black women have reimagined identities and created culture.

Suggested Citation (APA 7th Edition):

Shaw, M. (2022). Restorying Quilts Project Page. In *Imagination in STEM: A Project Index* (pp. 63-64). Museum of Science, Boston.

Imaginative Ways of Thinking:

Storytelling

Storytelling was the prominent process for this work, and the way we examine or unearth sociocultural codes; we told stories every day through brainstorming, designing circuits, icebreakers, and creating quilts.

Identity

Youth developed deeper awareness of themselves and others; through designing interactive restorying quilts, they crafted new identities.

Restorying

Youth reimagined dominant stories across history and in popular culture in a way that reflected marginalized or silenced perspectives.

Connecting

Youth connected and related to each other through designing and storytelling, fostering the ability to imagine by realizing how others see the world.

Image Credit: Mia Shaw

Project Indices

Projects by Contributor / Contact and Affiliation

Projects by Audience Served or Addressed

Projects by Imaginative Ways of Thinking Categories

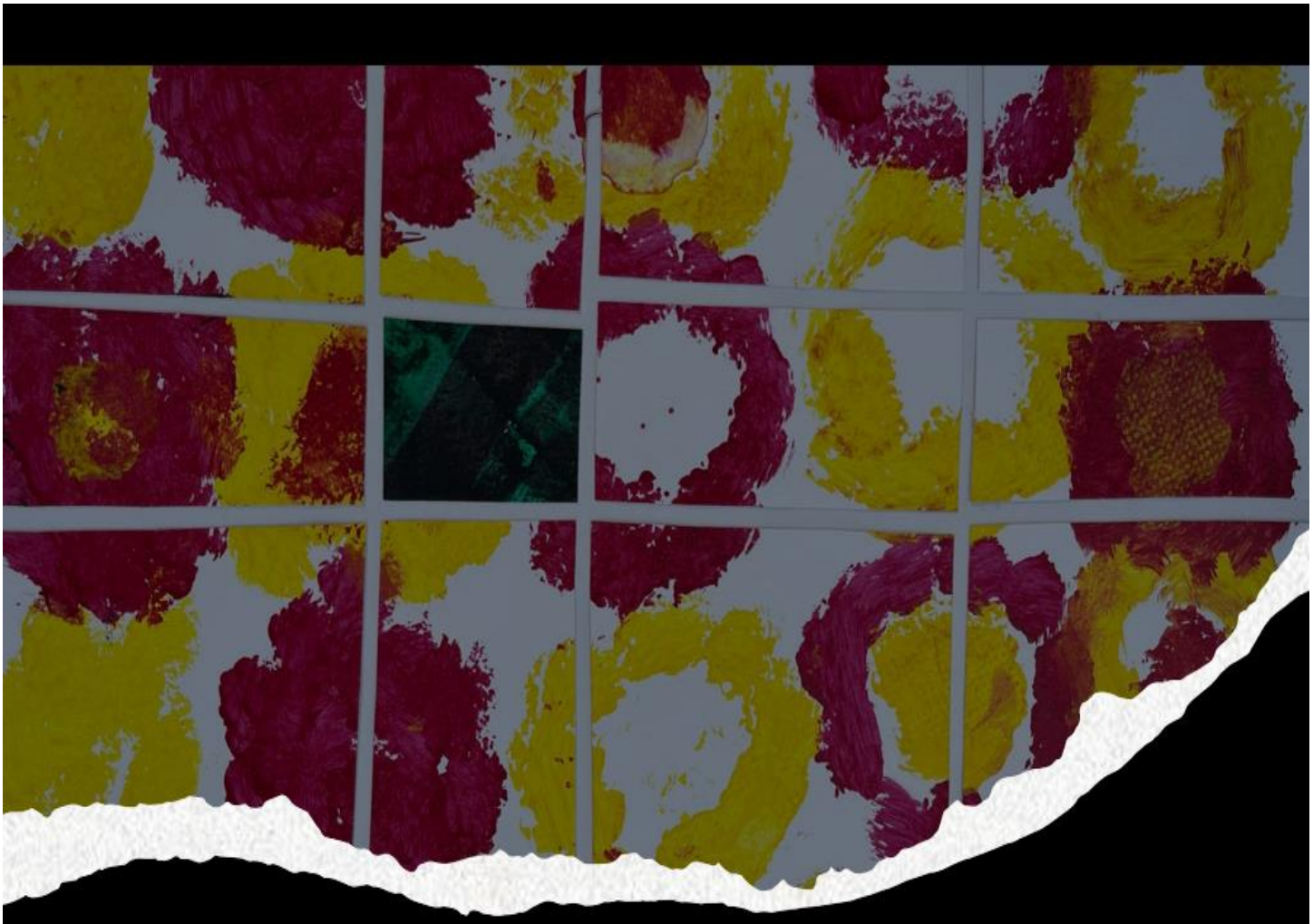
This index lists ***categories*** of imaginative ways of thinking, as well as the ***specific*** way of thinking listed in each project, the associated project title, and page number. Note that some specific ways of thinking may appear in multiple categories, because they were categorized by the contributor's *intended* meaning rather than by the common meaning of the word.

Projects by Imaginative Ways of Thinking Categories (cont.)

Category	Specified Way(s) of Thinking	Project Title	p.
Problem-solving	Addressing challenges	Fabric Science Curriculum	49
	Improving	Engineering at Home	47
		Ready Set Go Engineering	61
	Innovating	Tennessee Rural Impact Project	31
	Testing	Engineering at Home	47
	Problem-solving	Discovery Project	35
		Engineering with Empathy	17
		Frankenstein200	19
		Go Carbon Neutral	21
		Imagining Mars	51
		Mission Mars	23
	Prototyping	Discovery Project	35
		Mission Mars	23
Possibilities Thinking	Expanding	Ready Set Go Engineering	61
	Future Dreaming	West Side Stories	53
	Futures Thinking	Fairytale Engineering	43
		Go Carbon Neutral	21
	Possibilities Thinking	Engineering with Empathy	17
		Go Carbon Neutral	21
		Life on the Edge	9
		Out of this World Aliens	25
		Staying in Science	27
		SubSpace	29
		Tennessee Rural Impact Project	31
	Synthesizing	Imagining Mars	51
	Thinking	We are Water: Connecting Communities	11
Relating	Associating	Arctic Adventure	7
		Out of this World Aliens	25
Self-identifying	Empowering	Ready Set Go Engineering	61
	Identity	Restorying Quilts	63
	Owning	Ready Set Go Engineering	61
	Self-identifying	Life on the Edge	9
		Staying in Science	27
Sensing	Noticing	Arctic Adventure	7
	Observing	Out of this World Aliens	25

Projects by Imaginative Ways of Thinking Categories (cont.)

Category	Specified Way(s) of Thinking	Project Title	p.
Socializing	Connecting	Restorying Quilts	63
	Collegiality	West Side Stories	53
	Perspective-taking	Action Reaction	15
		Applying Imagination to Foster Empathy and Collaboration	57
		Engineering with Empathy	17
		Staying in Science	27
		SubSpace	29
		Through My Window	39
Storytelling	Narrative	West Side Stories	53
	Reflecting	DNA Mutations: STEAM Work	37
	Restorying	Restorying Quilts	63
	Storytelling	Fairytale Engineering	43
		Restorying Quilts	63
		We Are Water: Connecting Communities	11
Understanding	Cultivating Knowledge	Fabric Science Curriculum	49
	Translating	DNA Mutations: STEAM Work	37
	Understanding	Fabric Science Curriculum	49
		Through My Window	39
		TEEMS	41
Visualizing	Representing	DNA Mutations: STEAM Work	37
	Visualizing	Applying Imagination to Foster Empathy and Collaboration	57
		Dinos and GoPros	59
		Discovery Project	35
		DNA Mutations: STEAM Work	37
"What if?"-ing	Speculating	Arctic Adventure	7
	Wondering	Dinos and GoPros	59
		Out of this World Aliens	25



"when we reinvent the way we educate
when we encourage thinkers to think
and give dreamers a place to explore and create
we unlock a place in the mind of the child
that tells them they are equipped to be great"

An excerpt from **seeing is deceiving**

By **Alondra Bobadilla**
Boston's first Youth Poet Laureate and
Imagination Convening Contributor

Image credit: Mary Brooks