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PLUS: THE CREATION OF PLANET WORD, WHAT WE'RE MISSING IN
MUSEUMS AND HOW TO GET IT BACK, AND MORE!

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BRINGING LANGUAGE TO LIFE: THE CREATION OF PLANET WORD

By Emily Gref

Planet Word, a free museum dedicated to the language arts, opened in Washington, D.C., in October 2020. Conceived as a space to inspire and renew a love of words, language, and reading in people of all ages, the museum eschews the typical museum approach of a collection of artifacts, and instead engages its visitors through unique, immersive learning experiences. As the world's first voice-activated museum, the high-tech, interactive nature of Planet Word provides unique opportunities for informal learning; likewise, developing and curating the content for these exhibits necessitated innovative approaches to audience engagement.



Figure 1: Planet Word is housed in the historic Franklin School Building in Washington, D.C. Photo by DuHon Photography, courtesy of Planet Word.

WHAT IS A MUSEUM OF WORDS AND LANGUAGE?

The idea for a museum of words and language came to founder Ann B. Friedman, a former teacher, when she read an article about the Museum of Mathematics in New York City. It struck her that if a museum about math could make numbers and equations fun and interactive for its visitors, why couldn't a museum about words do the same thing?

Thus Planet Word was born. It would be a space where visitors could explore words and language through exhibits grounded in a solid understanding of language arts and science.

Driven by a deep love and appreciation for words and how they form our identities and connect us to each other, Ms. Friedman's vision for Planet Word is rooted in the belief that a literate population is the foundation of a strong

modern democracy. By offering experiences that spark curiosity about the written word and verbal communication, Planet Word hopes to set its visitors on a lifelong path of reading and learning, and, by extension, participation in civic life.

As a former teacher, Ms. Friedman knew that the best way to engage students in learning was to provide hands-on, interactive activities. She defined six core values to guide the development of Planet Word's exhibits:

- **FUN:** Planet Word offers unique, participatory, changing, and innovative experiences with language and words.
- **PLAYFUL:** Planet Word engages participants in physical, social, and cognitive play to increase understanding of language.
- **UNEXPECTED:** Spontaneous learning takes place around every corner.
- **MOTIVATIONAL:** Planet Word builds confidence and encourages a lifelong interest in words and language.
- **MEANINGFUL:** Planet Word strives to have a measurable impact on literacy outcomes.
- **INCLUSIVE:** Planet Word strengthens community by celebrating and valuing all types of linguistic diversity.

By embracing these six core values, Planet Word aims to be a space where words and language in all their infinite variety are celebrated in all their forms: spoken or signed, written or sung. The museum's approach to language is descriptive, rather than prescriptive. By focusing on how language is used rather than dictating grammar rules, Planet Word emphasizes that it is for *everyone*, regardless of their education or what language(s) they speak.

DESIGNING THE PLANET WORD EXPERIENCE

Once the mission and values of Planet Word were defined, the first step was securing a location. In January 2017, the District of Columbia selected Ms. Friedman's proposal to rehabilitate the 150-year-old Franklin School, a historic landmark located in the heart of the nation's capital, and turn it into a museum. The next step was to develop the exhibits that would deliver the type of interactive, immersive experiences that would give visitors the opportunity to learn new, surprising, and meaningful things about words and language. To help bring this vision of the museum to

life, Planet Word hired Local Projects, the award-winning exhibit design firm behind the National September 11 Memorial & Museum and the Equal Justice Initiative's Legacy Museum in Montgomery, Alabama. Supporting the exhibit designers and Planet Word's content team was a board of advisors with a breadth of expertise in the language arts and linguistics, including lexicographers, authors, poets, and singer-songwriters.

To determine which experiences and concepts were ultimately included within the museum, Planet Word and Local Projects used a rubric of 10 factors:

1. **Important Concepts:** The exhibits should focus on key concepts that stakeholders felt must be included if the museum were to be taken seriously as an institution about words and language.
2. **Interactivity:** The key concepts should be transmissible without relying on reading didactic labels; through showing, not telling.
3. **Diversity:** The experiences should reflect the diversity of the human experience, and not rely on an unrepresentative "canon" of literature and music; other languages and modes of expression should be represented.
4. **Descriptivism, not prescriptivism:** None of the experiences should prescribe a "right" or "wrong" way to use words and language; instead, the experiences should celebrate all forms of language use.
5. **Age-Appropriate:** Planet Word's target audience was defined as 10- to 12-year-olds; experiences should be accessible and engaging to this age group.
6. **Embodies the Six Core Values:** The experiences should exemplify most, if not all, of Planet Word's six core values: fun, playful, unexpected, meaningful, motivational, inclusive.
7. **Physical Space and Accessibility:** Given the limited space of the Franklin School, the exhibits had to utilize the available space efficiently and be accessible to disabled visitors.
8. **Duration:** Based on the typical time visitors spend in a museum, the exhibits should not tax visitors' attention spans, but experiences should take as much time as needed to convey the important information—without requiring too much time be spent on any one exhibit.
9. **Attainable Content:** Where the experiences required the licensing of intellectual property, such IP licenses should be available and affordable to the museum.
10. **Mix of Modalities:** The overall museum experience should use a mix of language modalities: some reading, some writing, some listening, some speaking and some visual interpretation.

Using this rubric, and in consultation with the advisory

board, Planet Word and Local Projects mapped out a museum experience comprising 10 galleries, each covering a distinct topic within the language arts. Using the Franklin School's architecture as a starting point for determining the physical location for each gallery, a narrative arc—as well as a pathway for the visitor experience—for the museum emerged: starting on the third floor, visitors would begin their Planet Word journey with "**Our World of Words**," three galleries devoted to the origins of language and linguistic diversity; going down to the second floor, "**Inspired by Words**," they would explore five galleries that showcase all the creative ways people use words; and finally, on the first floor, the theme would be "**The Power of Words**," where the last two galleries would focus on how to be critically aware of the power of words and language on both the individual and societal level.

Within this overarching framework, the exhibit design team created curatorial briefs for each of the 10 galleries that also tied to the Common Core curriculum, in part to ensure that the material within the galleries would be valuable to one of the museum's core audiences: middle school teachers looking for field trips for their classes. The final 10 galleries are as follows:

First Words

The Topic: Child language acquisition

The Experience: The only truly passive experience within the museum, this three-minute montage showcases the milestones of child language development, using real home videos sourced from family, friends, and YouTube. With short, pithy captions, the experience helps to confront biases about "baby talk," which has real benefits for children, and spotlights a multilingual toddler and a Deaf baby babbling with his hands.

Where Do Words Come From?

The Topic: The history of the English language

The Experience: This gallery features a stunning 22-foot-high wall composed of over 1,000 3-D words, upon which the animated story of the history of the English language plays out via sophisticated projection mapping. The experience relies on visitor interaction to advance, inviting the audience to shout out the answer to questions, or choose which word story to hear next (choosing from portmanteau, onomatopoeia, borrowed words, or neologisms).

The Spoken World

The Topic: Linguistic diversity

The Experience: The Spoken World gallery is situated in the Great Hall of the Franklin School and takes advantage of the soaring ceilings to accommodate a 12-foot-diameter globe chandelier composed of 4,800 LED lights. Surrounding the globe are 15 iPads, each displaying videos of "lan-



Figure 2: The word wall in *Where Do Words Come From?*
Photo by DuHon Photography, courtesy of Planet Word.



Figure 3: Young visitors paint with their words in Planet Word's Word Worlds gallery." Photo by DuHon Photography, courtesy of Planet Word.

guage ambassadors" that invite visitors to stop and learn about their language through interactive prompts. There are 30 languages from all around the world represented, including all the major languages of the world, languages specific to the D.C. immigrant population, Indigenous languages, and two sign languages.

Unlock the Music

The Topic: Techniques of songwriting

The Experience: A twist on the classic karaoke lounge, disco ball included, visitors select one of 23 songs (representing a diverse range of genres, performers, and time periods) from an iPad, and then are encouraged to sing along to their selection as they learn about the techniques (such as alliteration, slant rhyme, and anaphora) that helped make the song such a memorable hit.

Joking Around

The Topic: Humor and wordplay

The Experience: There are two main experiences within this gallery: "Don't Make Me Laugh!", a game conducted through linked iPads where a pair of people take turns telling corny jokes (one laugh equals one point), and a "selfie wall," where visitors can pick up a prop that illustrates a common idiom or pun and pose in a framed cut-out so their partner can guess the idiom and take a photo.

Word Worlds

The Topic: Imagery with words

The Experience: Using "smart" paint brushes, visitors can literally paint with their words by dipping their brush into a "bucket" labeled with a scene-setting adjective and waving it over the projected landscape, creating fall foliage with "autumnal," rainstorms with "tempestuous," and enchanted castles with "magical."

The Library

The Topic: Celebrating literature

The Experience: Planet Word's "magical library" comprises three separate experiences: Story Tables features a long reading table with eight special cradles: set one of 50 different books (selected for a diversity of genres, target audiences, authors, and stories) into the cradle, and the book will come to life with a bespoke animation projected over the pages, and a narrator (who could be the author, or someone whose life was impacted by reading the book) describing what makes the book so special. Visitors are also encouraged to find the Secrets of the Stacks—nine dioramas illustrating scenes from classic books, hidden behind framed mirrors that reveal themselves when a passage from the scene is read aloud. There's also a secret room hidden behind one of the bookshelves; visitors who find it are welcomed into an intimate Poetry Nook, a meditative space where they can listen to 50 poems read aloud, as poetry was meant to be experienced.



Figure 4: The Library gallery comprises three separate experiences. Photo by DuHon Photography, courtesy of Planet Word.

Lend Me Your Ears

The Topic: Techniques of oratory

The Experience: Visitors deliver an excerpt from eight famous speeches, including President Barack Obama's career-making speech at the 2004 Democratic National Convention and Malala Yousafzai's Nobel Peace Prize acceptance speech. Before trying their hand at reading from a teleprompter, they learn about some of the key rhetorical techniques that made those speeches resonate through history.

I'm Sold!

The Topic: Techniques of copywriting

The Experience: Visitors enter a "media spiral" composed of 25 screens, showing an endless stream of print advertisements, all aimed at persuading the reader to buy a product or support a cause. Through a series of five rapid-fire games, visitors learn about different techniques copywriters use to influence their audience, and at the end of the spiral visitors can create their own advertisement to add to the stream using the techniques they've learned about.

Words Matter

The Topic: The power of words

The Experience: In the museum's capstone gallery, visitors have a chance to reflect on how words impact us all, in ways both big and small. Four plinths within the room feature videos of people with stories about how words matter to them, with topics ranging from gender-neutral pronouns to the power of nicknames. In the center of the gallery is a recording booth where visitors can contribute their own story of how words matter to them.

In each of these 10 galleries, the interactive, immersive nature of the experiences is foregrounded. The high-tech nature of the galleries captures visitors' attention, and the compelling content pulls them in. In every experience, there is something new or surprising to be learned about words and language, and visitors are encouraged to have fun and play with their words.

WORDS SPILLING OUT OF EVERY CORNER

The opportunities to be delighted by words and language—and learn something new in the process—are not limited to the main experiences within Planet Word's galleries, however. Part of the founding vision for the museum was to have words "spilling out of every corner," and to include auxiliary experiences within the galleries that would allow visitors to dive deeper into the topic of the galleries. From top to bottom, the museum is filled with content related to words and language, from the auxiliary experiences to the artwork, from the wall copy to the lockers and even to the lobby floor. No space is wasted in the

mission to inspire visitors.

In six of the 10 galleries, there are framed interactive screens that can be activated with either touch or voice. These interactive screens introduce visitors to 19 topics related to the main gallery themes, covering subjects such as word formation techniques, endangered languages, how to tell a joke, the role of rhythm in poetry, animal communication, news literacy, dialects, and the power of words to harm others.

Throughout the museum, visitors encounter fun facts, quotes, and clever quips illustrating the endlessly creative nature of language painted on the walls—everything from maps of unexpected etymological relationships to Tom Swifities to literary quotations. In the lobby, symbols from the world's writing systems throughout history are embedded in the terrazzo floor. Artworks that take language as their focus are displayed in the hallways, and the museum courtyard features a commissioned sculpture by Rafael Lozano-Hemmer: a Speaking Willow tree whose branches emit the sounds of 364 languages when visitors pass beneath them. Visitors can also build their vocabulary in a photo booth built in partnership with the College Board, where they are prompted to pose to show a word's meaning.



Figure 5: Visitors can hear the sounds of 364 languages beneath the branches of the Speaking Willow. Photo by DuHon Photography, courtesy of Planet Word.

DELIVERING ON THE MUSEUM'S MISSION DURING A GLOBAL PANDEMIC

Planet Word was originally set to open in May 2020. Of course, the COVID-19 pandemic necessitated a change in plans; exhibit installation was forced to pause, and the museum team shifted to working from home. As the public health situation evolved, so too did the museum's thinking around how best to deliver on the mission and values that the museum was founded upon. With the museum's doors closed, the Programming and Education departments strategized around how to pivot to meet the moment.

Because Planet Word did not yet have an established visitorship, the Curator of Programming opted to partner with other organizations to run joint virtual programs serving a diverse audience. This included online classes around word-related topics for older adults through Oasis, puzzle nights at the intersection of words and mathematics with the Museum of Mathematics, and beginning a new series of online programming with Shared_Studios called Diver-Cities, where artists from around the world and local to DC talk about poetry, word art, health messaging, and other timely, language-oriented subjects. The partnership model allowed Planet Word to build a more global online following, raise awareness of the museum, and experiment with different models of virtual programming, and to continue operating seamlessly after the museum shut down again in November 2020.

Meanwhile, the Manager of Education Programs began piloting virtual field trips during the summer of 2020, starting with a middle school-aged program based around the content in Planet Word's I'm Sold! gallery about copywriting techniques used in advertising. The virtual field trip proved so popular with teachers both in the D.C. area and elsewhere in the country, filling a need for engaging, curriculum-relevant content in the remote learning landscape, that several more are now in development.

Online programming, while not an engagement stream that had originally been planned for Planet Word's offerings, has turned out to be a rewarding avenue for audience engagement, bringing the museum's mission "beyond the walls" of the physical building. Thanks to the pressures of the pandemic, Planet Word can reach people who might not otherwise be able to visit the actual museum and engage them with the concepts and content that populate the exhibits.

OPENING UP AND LOOKING AHEAD

Planet Word was able to open to the public in October 2020. In support of the safety of the community and staff, visitorship was limited to 35 people an hour, three days a week, with timed tickets available for free online. Even

with the limitations, tickets disappeared as quickly as they were released. Masks and social distancing were enforced, styluses were handed out for the touch screens, and staff regularly cleaned high-touch surfaces to ensure the experiences were safe. Even though the museum was only able to stay open for five weeks before rising case numbers shut the doors again, the museum's unique, innovative experiences made an impact: tickets were in high demand and word of mouth was spreading, particularly on social media. (One TikTok video posted by a visitor garnered over 1 million views.)

When the museum announced it would reopen in April 2021, tickets were once again in high demand. Online programs and virtual field trips continue to grow, attracting audiences from beyond the D.C. area and providing ample opportunity to speak to the issues of language that define our current times, but also be fun, playful, and meaningful with word nerd trivia nights, conversations with authors, and discussions about poetry and songs.

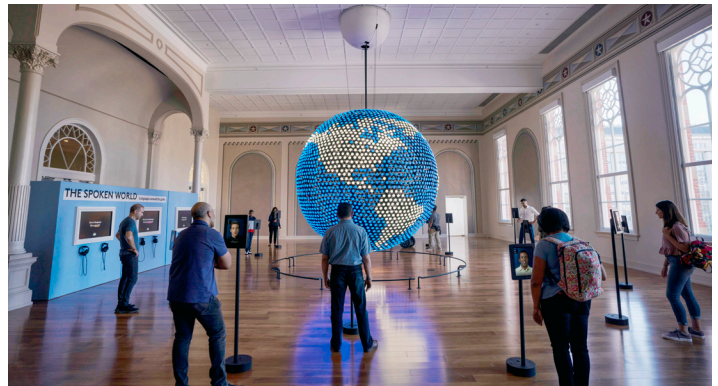


Figure 6: Visitors can learn about 30 different languages in the Spoken World gallery. Photo by DuHon Photography, courtesy of Planet Word.

In the coming months Planet Word looks forward to introducing two more experiences to visitors: a word puzzle adventure room, called Lexicon Lane, and an Immigrant Foods restaurant, whose innovative menu combines the diverse, delicious cuisines of immigrants into something new, not unlike what Planet Word has done to redefine the concept of "museum." Most of all, the museum looks forward to welcoming authors and poets and audiences to the auditorium, students to the galleries and classrooms, and tourists through the doors.

Emily Gref is the Exhibition Content Manager at the Planet Word Museum in Washington, DC. She can be reached via connect@planetwordmuseum.org. Find out more about Planet Word at planetword-museum.org.

STARTING A MOVEMENT TO HELP SAVE UK URBAN BIODIVERSITY: NATURAL HISTORY MUSEUM, LONDON

By Victoria Thomson

Over the past year, many of us have turned to green spaces near our homes to bring us much-needed comfort in challenging times. We have discovered a small patch of green in a concrete jungle, heard birds sing when flights were grounded and witnessed nature's new-found confidence to claim back what was once theirs.

The nature on our doorsteps has never been more important or appreciated. But, in the UK and across the globe it is under threat like never before.

The 2016 State of Nature report showed that between 1970 and 2013, 56% of the 4,000 species for which we have sufficient data declined significantly, with 15% of the 8,000 species assessed considered extinct from Great Britain or threatened with extinction (Hayhow, et. al., 2016).

Globally, the May 2019 UN IPBES landmark report confirmed that the natural world faces unprecedented declines, commenting that 'biodiversity and nature's contribution to people are our common heritage and humanity's most important life-supporting 'safety net'. But our safety net is stretched almost to breaking point.' (Brondizio, 2019).

Today, around 83 per cent of the UK population live in urban areas. That figure is on the rise, which will make it increasingly more challenging for wildlife to thrive, and for people – particularly young people – to have all-important access to green spaces and nature.

In the UK, we have suffered decades of decline in the abundance and distribution of many species, and in urban areas in particular we simply do not know enough about how to mitigate pressing environmental challenges such as climate change and biodiversity loss on top of increasing urbanization.

This means that towns and cities are rapidly becoming key places to conserve biodiversity. It is where most people will experience nature, and why it has never been more important to make our towns and cities healthy and sustainable places to live.

The Urban Nature Project is the Museum's response to these important and urgent challenges.

It is a major UK-wide partnership program that will build our understanding of urban biodiversity, connect the nation with the nature in towns and cities and produce practical tools for supporting the wildlife that lives around us.

It is a transformational project that will not only galvanise people to reengage with the nature on their doorsteps, but building on the Museum's scientific and public work, triggering a movement that will ultimately play a role in helping to safeguard nature's future.

Despite the challenges it faces, the UK is home to an array of wonderful and inspiring nature. However, research paints a worrying picture that young people, especially those from diverse and disadvantaged backgrounds, are becoming more and more disconnected from nature. This impacts their wellbeing, their desire to protect nature in the future and their interest in working in the science and conservation sector.

Through the project we will be creating new ways to connect people to their local urban nature, from the youngest to the oldest, and looking to strengthen and expand the pipeline of scientists from school age to young adult.

We're creating a UK-wide learning program that will provide young people, families, and schools with opportunities to understand and explore urban nature.

The schools program will ask young people to form scientific questions and investigate the issues that urban nature and local biodiversity face. The schools taking part will be from across the UK and facilitated by our partners, with a specific focus on connecting with those identified as having the greatest disconnect from nature; traditionally those from lower socioeconomic and diverse backgrounds.

Throughout the schools program, questions will be submitted to the Museum and these will form the focus of a national citizen science project. For the first time ever, a citizen science project will be led by the interests of young people in this exciting opportunity to act collectively and make a positive difference to urban environments across the country.

Taking that first step to nature can be daunting for some,

so a new online hub will provide a range of ways to support people wanting to take action for nature at home.

Urban environments have been historically overlooked by the nature conservation sector, and it is now recognized that significant collective effort is required to save and manage these important habitats.

In recent years, the abundance of key urban species has dropped significantly (10% between 2002-2013) and of the 529 UK urban species assessed, 37 are considered threatened. Yet these urban areas remain vital for many of the UK's species – London alone is home to almost 20% of known UK species.

To find out more about how nature is responding to and within changing urban environments, scientists from the Museum will be working with partners across the UK to champion an evidence-based approach to conservation.

We have already begun piloting a range of innovative, cost effective technologies in order to revolutionise understanding of biodiversity in urban areas, looking at DNA, eDNA and acoustic monitoring.

We're also working with the London Wildlife Trust to develop new training programs and toolkits around monitoring and managing urban habitats, which, together with the new technology we're developing, will be made available to our partners.

Our goal is to try to make it easier for people to record plants and animals in urban habitats. This cutting-edge science will help us record the whole range of life in urban habitats, from microscopic animals in soil and water to flying insects such as flies and moths. Sharing this knowledge and the scientific methods we've developed will allow others to find out what lives in their urban areas and ultimately help others to help protect urban nature across the UK.

As well as the national focus across to connect people with the nature on their doorstep, we're also looking to our own front garden in South Kensington, London, and how we can make changes to support biodiversity.

The Museum gardens were originally set aside for future expansion of the building. However, a lack of money resulted in a smaller building than planned and a need to landscape the gardens.

The east and west outdoor spaces started as formal gardens, but the addition of winding paths on the west side (now home to the Wildlife Garden) gave it a more natural

feel.

Through the years the two sides of the garden continued to develop independently. Now, for the first time ever, we'll be uniting the east and west gardens with one new design that builds on 130 years of heritage.

The new Museum gardens will be a fully accessible green space in the heart of London. They will be somewhere visitors can learn more about the incredible diversity of life on Earth, and our scientists can develop best practices to protect urban nature. They will take you back in time, and help you look to the future.

In the east garden planting, geological specimens, a timeline wall, large sculptural elements, footprints and representations of animals bring the past to life. In the west garden visitors will get a chance to connect with UK habitats. They will be able to explore the extraordinary diversity of nature that lives in our towns and cities, understand nature's importance, see some of the work being undertaken by Museum scientists to monitor and support nature in urban environments, and (hopefully) become inspired to protect it.

The new gardens will also allow us to introduce more formal and informal learning opportunities. Our schools offer will be able to increase, as well as our volunteer program. We're also looking to introduce opportunities for young people to explore a career in science and nature, providing that all-important first step.

Designing the new gardens has been a huge, collaborative effort. Architects Feilden Fowles and landscape architects J&L Gibbons have worked alongside many experts from the Museum as well as consultants from the conservation and heritage sector. This was to ensure that the designs reflected the five core criteria of: protect and increase the existing wildlife and biodiversity; respect the heritage of the Waterhouse building; improve accessibility across the gardens all year round; create a leading, sustainable design; and provide opportunities to learn about and explore nature.

Building work is due to start this year and the transformed gardens are planned to open in 2023.

In 2031 the Natural History Museum, London, turns 150. We recently launched our new vision which puts the future of people and planet at the heart of all we do. Our mission is to create advocates for the planet; people who feel informed, confident and able to make choices that help both themselves and nature thrive in the future.

The Urban Nature Project is the Museum's most ambitious program of activity to date, building on a heritage of scientific and cultural innovation that will connect a whole new generation with the delights of nature.

WALK THROUGH THE NEW NATURAL HISTORY MUSEUM GARDENS

EAST GARDEN ENTRANCE

Visitors will begin an extraordinary journey through Earth's history in the east garden, emerging via a new step-free ramp. Explore the diversity of life as it evolves and learn about the explosion of life in the seas 500 million years ago.



Figure 1. Visitors will begin an extraordinary journey through Earth's history in the east garden, emerging via a new step-free ramp. © The Trustees of the Natural History Museum, London Credit: Feilden Fowles and J&L Gibbons.

JURASSIC GARDEN

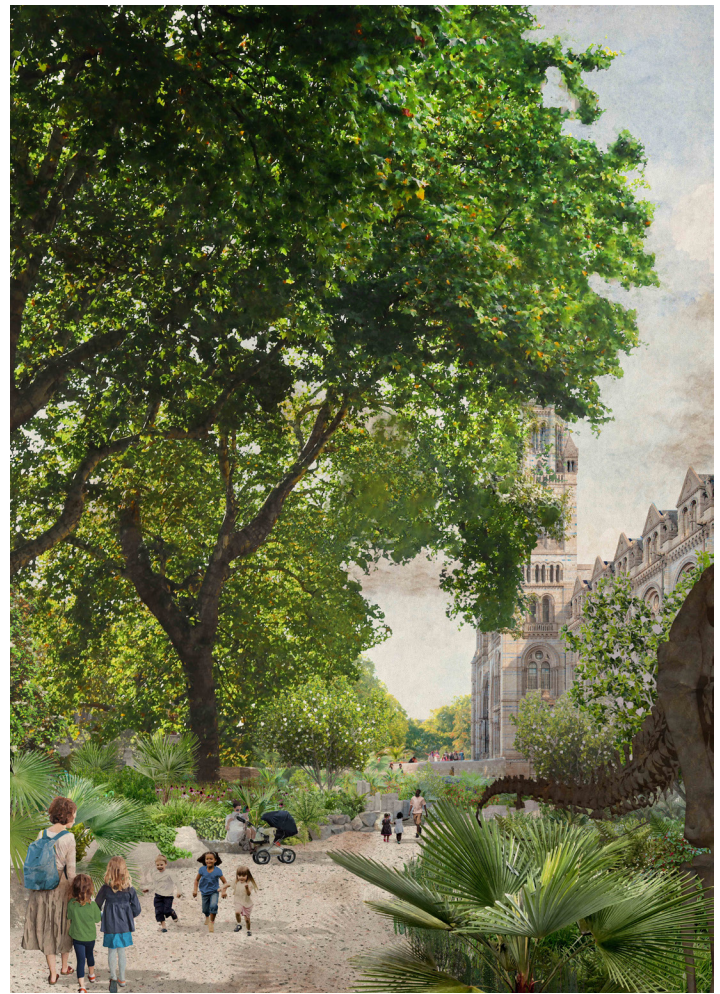
A new weatherproof cast of the Museum's much-loved dinosaur *Diplodocus carnegii*, Dippy, will take center stage in a Jurassic garden filled with tree ferns and cycads, before moving on to track the evolution of our earliest ancestors.

GARDEN BUILDING

A new garden building will provide visitors with a year-round cafe and our garden team with a support space for planting. The focus has been to design a sustainable building that works with the differing architecture styles of the Grade 1 listed Waterhouse building and the Palaeontology building, while developing a piece of elegant architecture in its own right.

WILDLIFE GARDEN

Enter a living research laboratory and an urban space teeming with life. Learn about the changing environment and find out about the extraordinary wildlife right on our doorstep that our scientists are studying.



*Figure 2. A new weatherproof cast of the Museum's much-loved dinosaur *Diplodocus carnegii*, Dippy, will take center stage in a Jurassic garden. © The Trustees of the Natural History Museum, London Credit: Feilden Fowles and J&L Gibbons.*

Figure 3. A new garden building will provide visitors with a year-round cafe and our garden team with a support space for planting. © The Trustees of the Natural History Museum, London Credit: Feilden Fowles and J&L Gibbons.





Figure 4. In the Wildlife Garden, learn about the changing environment and find out about the extraordinary wildlife right on our doorstep that our scientists are studying. © The Trustees of the Natural History Museum, London Credit: Feilden Fowles and J&L Gibbons.

LEARNING AND ACTIVITY CENTRE

A Learning and Activity Centre will combine facilities for scientific work, monitoring, learning, and the volunteer community that is key to the upkeep of the gardens. A combination of methods including utilising glazing, insulation, a green roof, rainwater capture, ventilation, ground source heat pumps and locally sourced sustainable materials will contribute to the creation of a pioneering sustainable building.



Figure 5. Learning and Activity Center. © The Trustees of the Natural History Museum, London Credit: Feilden Fowles and J&L Gibbons.

DARWIN CENTRE COURTYARD

Discover how much biodiversity can thrive in urban areas and how important green spaces are in cities. Learn what we can all do to help make towns and cities more resilient and sustainable for nature and us.

SUSTAINABLE BY DESIGN

Creating a sustainable design that works with the landscape is at the heart of the redevelopment. With an ambitious approach to sustainable construction, the project



Figure 6. In the Darwin Centre Courtyard learn what we can all do to help make towns and cities more resilient and sustainable for nature and us. © The Trustees of the Natural History Museum, London Credit: Feilden Fowles and J&L Gibbons.

aims to have a positive impact the environment. We will aim to deliver a project which removes more carbon from the atmosphere than it contributes; that reduces and limits energy consumption and design energy efficient buildings, using 100 per cent renewable energy during construction and beyond; that creates a zero-waste garden and ensures no waste from the construction of the gardens goes to landfill; that reduces water consumption and is designed to minimize water waste; that sources materials responsibly and aims to use 100 per cent certified sustainable materials from the UK; cares for biodiversity across the garden and elsewhere – we'll grow the plants coming into the garden in the UK as much as possible; and improves well-being for staff, volunteers and visitors by designing spaces with well-being in mind, providing spaces within the garden for reflection and relaxation, and ensuring mental health support is available for all.

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I-WISE: A FOUNDATIONAL CONFERENCE ON INDIGENOUS WORLDVIEWS IN INFORMAL SCIENCE EDUCATION

By Nancy C. Maryboy, Isabel Hawkins, Laura Peticolas, Jill Stein, Shelly Valdez, and Ka'iu Kimura

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INTRODUCTION

Land Acknowledgment

We gratefully acknowledge the ancestral homelands of the Pueblo and Algonquin Peoples on whose sovereign lands we gathered. We also acknowledge the homelands of the Indigenous participants from around the world.

I-WISE—Indigenous Worldviews in Informal Science Education—was a two-part conference in 2015-2016 (<http://iwiseconference.org>) to advance understanding around the convergent margin of Indigenous Knowledge and Western Science in informal STEM education. Indigenous leaders from the 'Imiloa Astronomy Center of Hawai'i and the Indigenous Education Institute (IEI) convened two gatherings to plant the seed for relationship building among diverse worldviews. A first conference in Albuquerque, NM, brought together more than one hundred principal investigators, educators, scientists, tribal knowledge holders, Indigenous youth, education researchers, and Indigenous community grass-roots participants from around the world (Figure 1). Six months later, at a second gathering in Washington, DC, I-WISE conference organizers, strand leaders, and Indigenous youth shared a synthesis of critical issues and emerging research questions with more than thirty federal agency program officers, policymakers, and other stakeholders in science and education. The DC gathering was held over two days at the National Museum of the American Indian and the National Museum of Natural History.

Keynote speakers included Leroy Little Bear, J.D. (Kainai Nation of the Blackfoot Confederacy), Robin Wall Kimmerer, Ph.D. (Potawatomi), and Eric J. Jolly, Ph.D. (Cherokee). Further collaborative synthesis resulted in a list of guiding questions to inform a research agenda to further informal STEM education at the confluence of Western Science and Indigenous ways of knowing. Participants discussed the resulting implications concerning the importance of Indigenous worldviews to enhance public science literacy

and improve STEM education, career opportunities, and lifelong learning for Indigenous youth.



Figure 1: Participants of the Albuquerque conference gather for a photograph.

(Photo by Christopher S. Teren/terenphotography.com)

The goals of I-WISE were to:

- Identify, integrate, and synthesize existing efforts to embed Indigenous worldviews in lifelong STEM learning.
- Strengthen the interchange between Indigenous worldviews and STEM.
- Formulate emerging research questions.
- Establish next steps to improve communication, knowledge access, and leadership.

“INDIGENOUS PEOPLES HAVE THE RIGHT TO MAINTAIN, CONTROL, PROTECT, AND DEVELOP THEIR CULTURAL HERITAGE, TRADITIONAL KNOWLEDGE, AND TRADITIONAL CULTURAL EXPRESSIONS, AS WELL AS THE MANIFESTATIONS OF THEIR SCIENCES, TECHNOLOGIES, AND CULTURES... THEY ALSO HAVE THE RIGHT TO MAINTAIN, CONTROL, PROTECT, AND DEVELOP THEIR INTELLECTUAL PROPERTY OVER SUCH CULTURAL HERITAGE, TRADITIONAL KNOWLEDGE, AND TRADITIONAL CULTURAL EXPRESSIONS.” (ARTICLE 31, UNDRIP 2007)

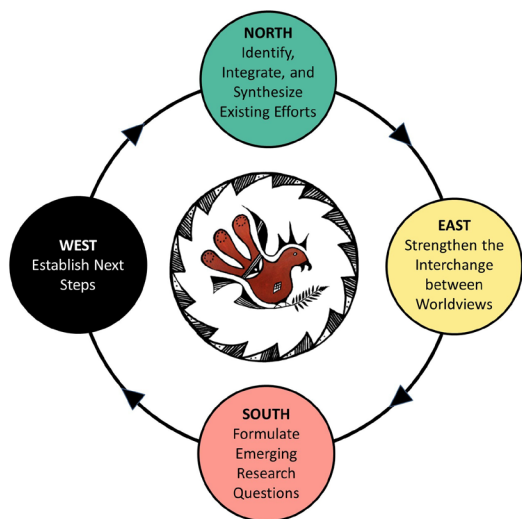


Figure 2: I-WISE goals and logo (developed by Shelly Valdez and Ashley Teren). The center of the image reflects the design of traditional Pueblo pottery. The parrot is a winged relative that unites Indigenous communities and is found within many migration stories, art forms, and community-based knowledge systems including science.

I-WISE goals follow the Diné traditional 4-directional alignment process model (Figure 2). This dynamic model was developed by IEI (Begay and Maryboy 1998), based on nature and Diné Cosmology. The process explicitly acknowledges interrelationships (Maryboy, Begay, and Peticolas 2012) and synergizes with Western systems thinking. The process also aligns with the assertions expressed in Article 31 of the United Nations Declaration of the Rights of Indigenous Peoples (UNDRIP 2007).

RATIONALE FOR I-WISE

Environmental problems related to climate change, declining biodiversity, and sustainability are pervasive throughout our planet, and finding solutions is of high interest and relevance to both the Indigenous and non-Indigenous public. Indigenous Knowledge is rooted in deep relationships with the environment and the sustained permanence of countless generations of Indigenous Nations in their ancestral lands (Barnhardt & Kawagley 2005). Indigenous Knowledge encompasses respectful stewardship and reciprocal responsibilities (Maryboy, Hawkins & Cline 2005) based on a “science of place”—the corpus of long-standing knowledge of the environment in a particular locale (Valdez and Hawkins 2021), where science is rooted in cultural identity and a sense of place, allowing communities to lead healthy lives sustainably for many generations.

Indigenous peoples have been and continue to be gener-

ators of scientific knowledge and many Western scientists have found tremendous value in Indigenous science as an important and complementary resource for solving humanity’s shared planetary problems (Aikenhead and Mitchell 2011). Both knowledge systems deserve recognition, respect, and understanding. It is thus increasingly important for the ISE field to introduce audiences to the perspectives of both Western Science and Indigenous Knowledge (Snively and Corsiglia 2001).

The National Research Council (NRC) has recognized the need for a culturally responsive educational agenda (NRC 2012, p. 307) where worldviews and sociocultural factors are central to the discussion of Indigenous science and to efforts engaging Indigenous students in culturally responsive informal science learning (NRC 2009, p.225). The ISE field has made strides in this field over the past 15 years (e.g., Kawagley 1993; Maryboy, Hawkins, and Cline 2005; Maryboy, Begay, and Peticolas 2012; Stein and Valdez 2016; Augare et. al., 2017; Stein and Valdez 2017; Venkatesan and Burgasser 2017; Stein, Valdez, and Heimlich 2020; Valdez and Hawkins 2021; Peticolas et. al., 2021; Hawkins and Ávila Vera 2021). The I-WISE conference identified and synthesized theoretical approaches, methods, and findings of work to date, and informed an agenda for future research and programming.

CONFERENCE PROCESS

To ground participants in local Indigenous protocols, the experience of the Albuquerque gathering began by honoring Indigenous sovereignty and acknowledging the longstanding relationships with ancestral lands of the Pueblo, Navajo, Apache, and other tribes in the American Southwest. As a pre-conference activity, participants were hosted by the Pueblo of Acoma during their September 2nd annual community Feast. Acoma Sky City is more than 1,000 years old and one of the oldest continuously inhabited cities in North America. The Feast experience allowed I-WISE participants to connect with the land, with Indigenous Knowledge, and with each other. The conference experience was continuously guided by IEI’s principle of Collaboration with Integrity (Maryboy, Begay, and Peticolas 2012), through which the knowledge systems of Western and Indigenous science contribute to a rich dialog and collaborative opportunities grounded in equity and relationship. The conference allowed participants to experience various expressions of Indigenous culture (Figure 3).

Project leadership identified five conference strands stemming from two prior NSF-funded projects that considered the intersection of Indigenous Knowledge and Western Science in ISE—Cosmic Serpent and Native Universe (Maryboy, Begay, and Peticolas 2012; Stein, Valdez, and Jones 2012; Stein, Valdez, and Heimlich 2020). In the Albuquerque



Figure 3: Kyle Swimmer shared a traditional hoop dance at the Albuquerque conference.

(Photo by Christopher S. Teren/terenphotography.com)

que gathering, the discussions within each strand were anchored on tenets of Indigenous Knowledge and Western science, where STEM content lends itself to amplify the sciences found within mainstream academics.

Strand 1. Wholistic¹ Education: discussed general principles to promote culturally based education across both the informal and formal education realms, such as recognizing the importance of Indigenous languages and tribal traditions in supporting Indigenous youth and students in STEM pathways.

Strand 2. Collaboration: considered the attributes of successful relationships among Indigenous communities, STEM academic researchers, and ISE institutions in the planning and implementation of informal STEM learning experiences.

Strand 3. Environmental Sustainability: considered the meaning and worldview of sustainability from the Western and Indigenous perspectives, and how Collaboration with Integrity between the two knowledge systems can contribute toward addressing global environmental challenges.

Strand 4. Next Generation: engaged Indigenous college students and other youth involved in STEM fields in collaborative activities with Indigenous elders and Western scientists to explore and leverage their experiences to strengthen engagement of Indigenous youth in STEM careers.

Strand 5. Evaluation: explored effective strategies in culturally responsive and participatory evaluation models to assess the impacts of culturally based science learning experiences for Indigenous audiences in ISE settings.

Each strand discussion was facilitated, integrated, and

synthesized differently depending on the content and strand leadership, and represented a wealth of diverse backgrounds and experience that was crucial to achieving a cohesive synthesis. The results from each strand, below, were necessarily structured uniquely to maintain the integrity and authenticity of content, participants, relations, and spirit in each strand. Strand leaders and participants had the latitude to dynamically adjust processes within their strand as discussions evolved.

Wholistic Education Strand

Strand Leaders: VerlieAnn Malina-Wright, Ed.D. (Pacific American Foundation, IEI, Native Hawaiian) and Glen S. Aikenhead, Ed.D. (University of Saskatchewan, Canada).

Strand Synthesizer: Amethyst First Rider (University of Lethbridge, Alberta, Canada, Kainai Nation of the Blackfoot Confederacy).

Strand Support: Pam Woodis (National Museum of American Indian, Jicarilla Apache), Leroy Littlebear, J.D. (University of Lethbridge, Alberta, Canada, Kainai Nation of the Blackfoot Confederacy)

The Wholistic Education strand was foundational to the I-WISE conference. An understanding of what Wholistic Education signifies is necessary to most of the recommendations that emerged from the two gatherings. Traditional Indigenous education is significantly different from Western education, since it encompasses a concept of wholeness set in a dynamic Universe of the interrelationship of all things. As they endeavored to define “wholistic,” participants engaged in lively and sometimes contentious discussions throughout the sessions.

Wholeness is not the division of reality into constituent parts to be subsequently synthesized into a working whole. Wholistic education starts from an undivided whole, and as much as possible and from as wide a perspective as possible, teaches from an inclusive and relational approach. This is in contrast with Western education that has been historically taught from a disciplinary, reductionist, and specialization-focused perspective. Wholistic education is not about replacement: it is about continuous and dynamic adaptation and adjustment.

A wholistic approach to education is the utilization of a broad spectrum of pedagogical approaches and methods to engage students in the co-creation of knowledge. According to Indigenous thinking, pedagogy must include ethical and moral reasoning, creative expression, scientific and social inquiry, honoring of ethical space, and a focus on relationship to place.

Wholistic education thrives in the context of place-based learning. The concept of place embraces the emotional, spiritual, intellectual, and physical dimensions of a location where people live. It includes an amalgam of their spoken language, developed knowledge, and accumulated wisdom. In most Indigenous languages, the concept of place is a verb because it is the interacting processes among “all my relations” and “for seven generations².” Place constitutes self-identities: “We are the land, and the land is us.” Although place is associated with what is geographically local, its outer boundaries reach far into the sky, as experienced by that locale. Paradoxically, place includes everything, but is unique to where certain people live on Mother Earth. In short, place is intrinsically wholistic.

Place offers contexts and themes for wholistic teaching and learning aimed at “knowing how to be a good relative in the world.” Living a sustainable life environmentally and culturally nurtures health and healing in Indigenous communities. Wholistic education is local, experiential, transdisciplinary, cross-cultural, and focuses on resiliency, the community’s well-being, and life-long learning. Wholistic lifelong teaching, learning, doing, and refining are preserved through the practices of ceremony, language, and lived cultural experiences.

The Wholistic Education strand built a foundation that gave voice to the need for informal science learning. Strand participants interacted through dialogue and storytelling, sharing cultural examples where Indigenous informal science is context- and place-based. Other reflections included countering these discussions by reporting their observations that existing power imbalances between dominant mainstream institutions and American Indian Nations still occur in mainstream education systems.

In the beginning, discussions about the historical contexts of colonization, and at times domination and oppression, by mainstream institutions were not being collectively understood or accepted. Instead, telling a story of collective histories caused a transitional shift in the dialogue. This shift to support Wholistic Education enhanced direct relationships to Indigenous ways of knowing. These ways were recognized as Indigenous epistemologies of inquiry; thus, Wholistic Education became recognized as equivalent to Indigenous ways of knowing.

Collaboration Strand

Strand Leaders: Marcia DeChadenes (San Juan Islands National Monument) and Paul Coleman, Ph.D. (Institute of Astronomy, University of Hawai‘i, Native Hawaiian)

Strand Synthesizer: Laura Peticolas, Ph.D. (Sonoma State University)

Strand Support: Victoria Coats (Oregon Museum of Science and Industry)

The I-WISE Collaboration strand documented participants’ reflections on their personal experiences and research on co-creation, honoring Indigenous voice and complementary value systems to develop meaningful and sustained relationships. Strand leaders established a collaborative space where the participants were invited to introduce themselves from a place-based perspective. Several participants used their Indigenous languages (e.g., Dakota, Native Hawaiian, te reo Māori) to showcase the unique and often untranslatable concepts embedded within their knowledge systems, while other attendees were invited to practice deep listening with an open mind to enter in a circle of relationships during the gathering. Following Indigenous protocols from Pacific Northwest tribes, strand leaders chose two volunteers to “bear witness” during the discussions so they could identify departure from mutually agreed-upon norms of collaboration. Mini-case studies, or stories, were used to examine ideas of collaboration to better understand what is, or is not, effective in cross-cultural collaborations. Discussion questions included addressing the rationale for collaborating as well as the needs, costs, and benefits of *Collaboration with Integrity*. Participants also acknowledged that, in some instances, it might be inopportune to collaborate, or it might be best *not* to collaborate to honor tribal protocols to protect Indigenous intellectual property.

Participants identified potential benefits of collaboration, such as nurturing enhanced capacities for self-reflection and growth through opportunities to embrace diverse perspectives, and the potential of successful collaborative projects to help heal historical trauma. Other benefits cited included sharing of economic vitality to balance power structures, and increased awareness of both Indigenous Knowledge and Western Science as valid ways of expressing understandings of the Universe from multiple cultural lenses.

Participants recognized that collaboration cannot thrive when groups have conflicting values and cultural approaches that prevent establishing a shared ethical space that honors integrity and fosters mutual trust. Collaboration requires teams and individuals to be willing to “cross borders, rather than patrol borders.” Most participants with successful collaboration experiences agreed that sustained relationships are key to collaboration and that a crucial aspect is being willing to be changed by any good relationship. It is important to be open to being changed; however, under certain conditions, it may be necessary to remain separate to maintain one’s integrity.

Participants also considered the cost of collaboration at the intersection of Indigenous Knowledge and STEM. Several participants felt that cross-cultural collaboration in the context of science can lead to the erosion or loss of deeply held beliefs and cultural practices in favor of compromise to find common ground between worldviews. Other participants spoke about the challenges of collaboration when cultural protocols necessitate protecting knowledge or resources for their Indigenous communities that are explicitly not allowed to be shared with people outside the community. Even when the collaboration leads to positive outcomes for communities, individual stakeholders may struggle with personal feelings of guilt and sadness—people spoke of being split down the middle, losing aspects of their identity, and feeling cognitive dissonance while trying to hold paradoxical views. Some spoke about feelings of “only being allowed to walk on one foot.” Others talked about the danger of potentially creating lasting trauma and “losing the spirit, breath, and soul,” or the integrity, of the knowledge. Most participants, however, felt hopeful that they could engage in new ISE efforts using important aspects of *Collaboration with Integrity*, which needs to be established from the very beginning for successful outcomes.



Figure 4: Acoma Pueblo—the thousand-year-old Sky City, New Mexico. (Photo credit iStock-482727053).

Environmental Sustainability Strand

Strand Leaders: Yvonne Vizina, Ph.D. (University of Winnipeg, Canada, Metis) and David Begay, Ph.D. (IEI, Navajo (Diné))

Strand Synthesizer: David Begay, Ph.D. (IEI, Navajo (Diné))

Strand Support: Ashley C. Teren (IEI, Swedish/Cherokee/Navajo (Diné)) and Clarita Lefthand Begay, Ph.D. (University of Washington, Navajo (Diné))

Participants considered wholistic aspects of Indigenous worldviews, including the physical and place-based manifestation of culture, the sacred and spiritual elements contained within worldviews, and the affective dimensions of worldviews, including ethics and values. Questions were developed to guide the discussion, and strand participants were invited to answer them by considering the intellectual, physical, spiritual, and affective facets of knowledge.

- *What are differences and commonalities of sustainability from Western and Indigenous perspectives?*

Indigenous peoples have understood the concept of sustainability for thousands of years—it is not a new idea—as represented by the Acoma Sky City in Figure 4. Historically, the Iroquois Confederacy first echoed the belief that human actions with respect to the environment need to consider impacts seven generations into the future, a value grounded on sustainability that is shared across Native American tribes.

Indigenous and non-Indigenous participants agreed on the need to address critical environmental issues affecting our planet, with discussions on climate change, global warming, water and ocean pollution and acidification, impacts of mining, social and environmental injustice, land degradation, land and farming reclamation, air quality, resource depletion, mercury and other toxicity in fish, light pollution of the night skies, and many more.

Differences between worldviews were noted in the context of the motivations and intended beneficiaries of environmental policies and actions. From an Indigenous perspective, sustainability maintains the wellbeing of Mother Earth and Father Sky, and the interrelationships that sustain all life in balance. From a Western perspective, the primary motivator for, and beneficiary of, sustainability is the human being. Participants also discussed tensions around the exploitation of the environment to tap energy sources for profit and the shortsighted large-scale industrial agricultural practices at the expense of nurturing biodiversity.

- *What is needed to better understand environmental sustainability?*

Indigenous people have sophisticated experiential ecological knowledge emerging from relationships to place that result in diverse lifestyles. To achieve sustainable wellbeing in Indigenous communities, the Western reductionist approach of considering specific sciences is not required. Sustainable Indigenous values are embedded in Indigenous languages and the cultural ways of life of the people.

Participants recognized the need to collaborate with in-

tegrity to consider Indigenous Knowledge in concert with Western Science as complementary knowledge systems to help sustain healthy environments for many generations during this time of global crisis. Participants also issued a call to action for federal funding agencies to capitalize on this opportunity of collaborative research for the benefit of the planet.

- *How does environmental sustainability impact other community concerns such as health, biodiversity, and gender issues?*

From an Indigenous worldview, everything is interconnected, and the health of all people is a direct reflection of the health of the environment. Indigenous people, including two-spirited, gender fluid people, perceive themselves within nature and interrelated with all things. Living with the land requires an embodiment of sustainability, stewardship for future generations, and responsible caretaking. Indigenous people's experiential knowledge systems, rooted in ancestral tradition, are extremely important to environmental sustainability because they emerge from lifelong experiences and knowledge learned from an intimate relationship with the natural world that surrounds them and makes them unique.

Western Science researchers can learn from Indigenous Knowledge holders who understand how relationships with the environment can yield credible knowledge not easily measured by equations or scientific instruments. Indigenous Knowledge of the environment is largely observation based and experiential, with end results that are often the same as Western Science results, but often emerging over generations at a less accelerated pace.

Governmental policies and funding should recognize the need to prioritize environmental restoration initiatives and reparations for Indigenous lands that have been mined and contaminated with no regard to the wellbeing of the ecosystem that includes tribal communities. Successful ISE projects on environmental sustainability involving Indigenous collaborations should recognize that the foundation of Indigenous worldviews emerges from the heart of their communities and from the principles, behaviors, and respectful interaction with all Creation. Above all, strand participants emphasized that the application of Indigenous worldviews in ISE can contribute to advancing policy and decision-making concerning the environment and long-term sustainability.

Next Generation Strand

Strand Leaders: Kyle Swimmer (Laguna Pueblo, Eastern Band Cherokee, Chippewa-Cree) and Isabel Hawkins, Ph.D. (Exploratorium, Latina)



Figure 5: I-WISE provided many opportunities for intergenerational learning. (Photo by Isabel Hawkins).

Strand Synthesizer: Tim Hecox (Oregon Museum of Science and Industry)

Strand Support: Shelly Valdez, Ph.D. (Native Pathways, Laguna Pueblo)

Elder Mentors: Verlie Ann Malina-Wright (Native Hawaiian), María Ávila Vera (Yucatec Maya), Jesús Martínez, Ph.D. (Chicano), and Richard Horn (Blackfeet)

The Next Generation Strand experience was designed to engage Indigenous young adults by fostering discussions, participatory activities, and cultural exchanges that built on their cultural heritage and allowed them to envision how to reconcile their worldviews with ISE experiences. The strand recognized the key role that Indigenous youth can play in making Indigenous Knowledge visible and valued in STEM fields and careers.

A highlight for the youth was the opportunity to engage in hands-on experiences facilitated by elders (Figures 5 and 6). The cultural and scientific relevance of these activities was emphasized through discussions of cultural continuity and by making explicit the chemistry of natural pigments, the math and science of Indigenous games, and the biochemistry of corn, among other examples. One example of an Indigenous pedagogical approach was the use of a Native Hawaiian “fishpond³” as a tool whereby youth embodied the attributes of the fishpond's biodiversity as an expression of wholistic sustainability. Dr. VerlieAnn Malina-Wright served as facilitator while participants listened to the conversation within this role-played experience. Youth appreciated humor and laughter, and their energy inspired other I-WISE participants.

Strand discussion catalysts included the following points:

- *How can Indigenous Knowledge and Western Science complement each other?*

By recognizing that Indigenous Knowledge is wholistic and that Western Science approaches are a subset of the whole. Science is part of culture and science lives within tradition.

- *Where are your sources of cultural grounding?*

In our homelands, our elders, our ceremonies, and our traditional knowledge that is continually evolving, innovating, and adapting.

- *How can you be the caretakers of Indigenous Knowledge in your communities?*

By having opportunities to learn, teach, and practice STEM in our communities; by honoring our worldviews through reciprocity and collaboration with elders; and by connecting deeply with place.

- *Where are the gaps in your educational experience, K-21?*

Everywhere. There are huge gaps throughout our Western educational experiences, since there are almost no opportunities granted to us to learn in our traditional ways with validation from our teachers, mentors, and non-Indigenous fellow students.



Figure 6: Participants engaging in an Inka engineering hands-on activity highlighting Indigenous ways of knowing. (Photo by Christopher S. Teren/terenphotography.com)

Strand participants discussed STEM and ISE in the context of sovereignty, which allows Indigenous communities to manage their resources, lands, people, and knowledge. The youth envisioned a future where learning science could take place outside of the school classroom in an everyday manner, considering “all our relations.” They suggested more storytelling and kinesthetic learning to allow for experiential activities that activate all the senses, animating human sensibilities that go beyond the biological to include the sense of honor, the sense of ethics, the sense of belonging, and the sense of community identity. The youth appreciated the role of their elders in posing deep questions that delve into traditional knowledge to support lifelong learning and wellbeing. Informal science learning has an opportunity to include the richness of intergenerational education happening in tribal communities today, where youth engage in inquiry at their own pace with elders playing a mentoring role.

Participants agreed that Western education systems cannot tell the youth all that they need to know, and that such systems need to welcome and make room for wholistic learning. The Indigenous youth that participated in the strand are thriving exemplars who have done a stellar job of navigating the Western academic system. However, they considered it important to exert their self-determination and leadership by explicitly questioning the merits of pursuing a graduate STEM education, internships at Federal agencies, and STEM careers that necessarily remove them from their homelands and cultural worldviews and resources. The youth challenged the Western educational system to shatter the colonial frameworks that are grounded on meritocracy and the value of individual achievement in favor of community-based approaches for excellence in education—a new wholistic educational system where Indigenous youth can bring the entirety of their cultural intelligence to bear in humanity’s collective quest to understand our place in the Universe.

Evaluation Strand

Strand Leader: Joe E. Heimlich, Ph.D. (COSI Center for Research and Evaluation)

Strand Synthesizers: Tania Wolfgramm (Auckland University of Technology, Aotearoa/New Zealand, Māori and Tonga), Salvador Acevedo (Scansion, Latino)

Strand Support: Jill Stein (Jill Stein Consulting)

Engaging in cross-cultural evaluation⁴ processes can be challenging and the responsibility to honor different worldviews may seem overwhelming. Professionals choosing to undertake such work are often straddling multiple worldviews and find themselves playing the complex role of

a “bridge person,” which can, at times, be difficult and frustrating. While considering the competing value systems that are both explicit and implicit in evaluation processes, it became important to ask difficult questions. “Whose values and voices are privileged?” and “Whose perspectives are preferentially centered?” The following areas emerged from the discussions and illustrated the importance and benefits of co-creating a cross-cultural evaluation system.

- Improved depth of understanding of Indigenous worldviews, values, and cultures.
- The recognition that Indigenous languages are important and need to be honored.
- The importance of considering Indigenous evaluation models and systems in the design and development of evaluation methodologies and processes to achieve harmony and balance.
- Deeper understanding of community values and protocols to strengthen relationships and foster genuine community engagement and participation.
- Increased awareness of power and politics towards increased balance of power.
- Increased knowledge, skills, and capacities for funders and policymakers who are supporting Indigenous evaluation.

SYNTHESIS AND OPPORTUNITY

I-WISE generated a synthesis to guide opportunities and the future directions of ISE programs focused on Indigenous people. Below is a summary of key questions that emerged across the five strands and policy discussions at the D.C. gathering. The questions serve to inform an emerging research agenda to advance knowledge of Indigenous worldviews in ISE. The thirteen questions honor the thirteen segments on the back of the turtle and the yearly cycles of the Moon from an Indigenous perspective, important to many Indigenous communities.

1. What characterizes effective models of wholistic teaching and learning within an Indigenous worldview that are value-based, culture-based, language-based, and place-based?
2. How can we strengthen the capacities, structures, and processes in both Indigenous and non-Indigenous allies and institutions within the framework of *Collaboration with Integrity*?
3. What are the processes for healing and reconciliation that are necessary to enable *Collaboration with Integrity*?
4. How can ISE and other institutions collaborate with Indigenous communities and Tribal Nations to support the sustainability of Indigenous Knowledge?
5. How can ISE efforts include Indigenous ancestral lands as a key component of a learning model rooted on

sovereignty and place-based learning?

6. What structures, processes, and supports are needed to create a learning pathway in formal education that allows Indigenous youth to pursue STEM fields and careers based in their own Indigenous epistemologies?
7. What STEM learning ecosystems can be developed and managed within the premise of keeping youth engaged and present in their communities while also pursuing higher education?
8. How can the ISE field support Indigenous youth in learning their cultural knowledge, learning from elders, and activating knowledge for the benefit of their communities?
9. What does “evidence-based” mean from an Indigenous epistemology? How can we use community-based perspectives and wellbeing to determine success based on core values rather than external measures?
10. How do we measure the impact of these efforts through cross-cultural evaluation processes that honor Indigenous values and perspectives?
11. How can we support the creation and implementation of a new language of evaluation and research for this work?
12. What structural changes are needed in funding agencies to be inclusive of Indigenous worldviews and Indigenous research processes beneficial to Indigenous communities?
13. What is needed to support a research strand for Indigenous research by Indigenous people themselves (e.g., cultural astronomy, traditional ecological knowledge, etc.) with Indigenous protocols, Indigenous languages, and Indigenous validations?



Figure 7: Strand Leader VerlieAnn Malina-Wright and NSF Program Officer Monya Ruffin-Nash engaged in discussion at the Washington, DC gathering. (Photo by Christopher S. Teren/terenphotography.com)

CONCLUSION

The importance of I-WISE is that it established an interdisciplinary platform for future work, nourishing diverse perspectives in teaching and learning at the intersection of Indigenous Knowledge and STEM and informing policy at the national and local levels. The discussions and outcomes were guided by the lived experience of Indigenous scholars, knowledge holders, and youth in partnership with researchers and practitioners in the field of ISE and Western Science. The two I-WISE gatherings provided a key opportunity for a broad spectrum of stakeholders both within and beyond the field of ISE to share experiential knowledge and evidence-based findings. Participants charted a course for how the synthesis of Indigenous worldviews and informal STEM learning can be stimulated through authentic collaboration. Conference outcomes provide a point of departure for informal science educators investigating the cultural underpinnings of STEM as they strive to co-create new types of public learning experiences. I-WISE informs how NSF-sponsored projects can reconcile Indigenous worldviews and ISE learning experiences that showcase the currency and vitality of Indigenous Knowledge (Figure 7.) The greater impact on society will be new directions for policy and practice that result in authentic collaboration with Indigenous peoples.

ENDNOTES

1. Leroy Little Bear (Kainai Nation of the Blackfoot Confederacy) suggests this spelling, which avoids confounding the sacred “holy” with the secular “holistic.” The English spelling excludes his Kainai meaning of “whole,” captured by the term “wholistic.”

2. The concept of Seven Generations refers to looking beyond the immediate present. It is the idea that what you do today will affect seven generations into the future. When making decisions, almost every indigenous person will responsibly consider the effects on the seven generations ahead of them, as well as the influence of those who came before—the ancestors, the relatives who fought so hard to maintain Indigenous ways of knowing and living.

3. Traditional fishponds (loko i‘a in the Hawaiian language) are an ancestral method of aquaculture practiced by Native Hawaiians, representing an advanced method of fish husbandry among the original peoples of the Pacific.

4. There was considerable discussion around the notion of “cross-cultural” evaluation, which was seen as reinforcing an inaccurate idea of bounded cultures (an “us” and “them” approach) that was not useful. Others felt that “evaluation” should be expanded to “knowledge building” and be inclusive of wisdom from practice, culture, collaboration, and research. This approach moves away from priv-

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ileging Western scientific knowledge in order to embrace multiple ways and forms of knowing.

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PARADISE LOST: WHAT WE'RE MISSING...AND HOW TO GET IT BACK

By David Whitemyer

I am and always have been a passionate museumgoer. My mother likes to repeat the anecdote of the first time she and my father brought me along on one of their weekend museum trips, rather than leave me home with a babysitter. This was in the early 1970s, before plush UPPAbaby strollers and acceptable public temper tantrums. They encouraged me, an energetic four-year-old, through the grandiose lobby and marble halls of Chicago's Field Museum. After a few hours of peering into the many cabinets of curiosity, they said it was time to go. I fell to the floor, refusing to budge, crying, "I haven't seen everything."

Very little has changed, and when I now drag my own wife and children to museum after museum, I still whine a bit if I haven't seen everything.

But, like nearly everyone, I haven't had the opportunity to visit many museums in the last twelve months through the ongoing pandemic, as many have been closed and I've been trying to play it safe from home. This saddens me, as simply being physically inside a museum brings me great joy.

During the last year, through lockdowns, closures, and reduced visitation, museums have been doing incredible, hard work to remain valuable to their communities and to share engaging, informative content. They've been supporting education as leaders in informal learning, providing hours of online resources - from art courses and sociology to science and natural history - to classrooms and home-school students. Museums have been promoting culture and content through virtual tours, online exhibits, and expert-led experiences. Some are giving back to their communities by assisting in COVID response efforts, delivering supplies to elders, and donating masks and gloves to medical facilities. And they're supporting museum professionals through online networking opportunities, idea-sharing and free career courses. While we're all missing museums, they've certainly risen to the occasion.

Of course, it goes without saying: although museums are doing amazing work to support communities and to remain relevant, online experiences just don't come close to giving us what an in-person museum visit does. I recognize that not every museum is currently off-limits, but we're all familiar with the disheartening statistics. According to

Colleen Dillenschneider, of Know Your Own Bone, visits to cultural entities in 2020 are only 40.5% of what they were in 2019 (Dillenschneider, 2020). And an American Alliance of Museums survey performed last year, shows that directors from nearly one-third of U.S. museums worry that they're closed forever (Trepany, 2020).

From this, here are three things we've temporarily lost because of the pandemic and resulting museum closures, along with suggestions on how to consider these experiences more carefully as we plan for upcoming exhibitions and for the post-COVID future of museums.

1. SPATIAL EXPERIENCE

"When designing physical spaces, we are also designing, or implicitly specifying distinct experiences, emotions, and mental states," writes Finnish architect Juhani Pallasmaa, in the book *Architecture and Empathy* (Pallasmaa, 2015). As designers, "we are operating in the human brain and nervous systems, as much as in the world of matter and physical construction." This is true for both architects and exhibition designers, where we strive to do more than fulfill a building program or convey exhibit content, but to create a four-dimensional experience of wonder, awe, and beauty.

Museums and exhibitions provide far more to people than content-delivery - more than artifacts, information, and programs - which cannot be experienced via Zoom. Whether classical or contemporary, museums are a walk-through experience, with an array of textures, finishes, light, shadows, and perspectives. They are experienced uniquely at different times of the day and in different seasons.

As we (fingers crossed) leave our homes and re-enter the world in the coming months, our minds and bodies will be eager for these multidimensional experiences. Curators, exhibit designers, and architects (and landscape architects, and media specialists, etc.) must work together to create holistic visitor experiences and aesthetic harmonization in museums. Our collective goal is not just to give value to the stories being told and to the artifacts being displayed, but to the spaces in which they're shared.

2. ENCOUNTERS WITH STRANGERS

In a 2008 Museum 2.0 blog post, Nina Simon writes about the joy that comes from encounters with strangers - sometimes called accidental interactions - in museums (Simon, 2008). She posits six conditions within which “non-compulsory participation encounters with strangers” may occur: a desperate need for information, an uncertainty about rules, unusual rules, intimate observations of an extraordinary event, doing something aberrant, or carrying something strange. When any of these things occur, it encouragingly allows us to engage with strangers. These encounters can sometimes be uncomfortable or unwelcome, or meant in jest and with warmth, but they have value in museums where participatory experiences can enhance both learning and fun.

With virtual museum tours or live online programs, scheduled through registration and a calendar invite, we miss these accidental opportunities for social niceties and quips. Even informal networking Zoom gatherings and “breakout rooms” with museum colleagues, because of our fairly homogeneous mindsets, don’t really foster rich surprise interactions.

Simon suggests, “Creating a place for participation is not enough.” In order to design museum environments that encourage encounters with strangers, there needs to be a way for visitors to mediate rules and events, and with enough non-uniformity that expectations are twisted. Looking ahead to museum re-openings and new exhibitions, let’s strive to create spaces and experiences that surprise visitors and bend behaviors, giving museumgoers a push to interact with one another.

3. PRESENCE OF GREATNESS

In the early 20th century, famed pianist and Polish Prime Minister, Ignacy Jan Paderewski is said to have visited Beethoven’s home museum in Bonn, Germany. Stopping near the piano where Beethoven composed the bulk of his most notable works, the museum director offered Paderewski the opportunity to play the instrument. He is reported to have declined, with tears in his eyes, claiming that he was not even worthy to touch it. This awe - this opportunity to be in the presence of greatness - is something that, more and more, only museums can give to us. There’s a reason why visitors at the Smithsonian’s National Museum of Natural History flock to the Hope Diamond, one of the most famous, valuable jewels on earth. The crowds at the Louvre don’t swarm Leonardo da Vinci’s Mona Lisa to “appreciate” it, but simply to be next to it. Museums provide us the chance to stand near tangible authenticity and relevance: the first, the last, the most unique, the most famous, the most important or innovative.

YouTube videos and Zoom sessions can’t compete with this. A picture or a film about an object doesn’t provide the same palpable feeling of being within arm’s-length of eminence and status. And say what you will about selfies! Love them or hate them, they add value to museum experiences as many visitors long to share their once-in-a-lifetime encounters with greatness via social media.

Although we (fairly, I believe) hold ourselves in high esteem, museums are competing with numerous other options for people’s leisure time. Museums are competing with movie theaters, malls, wacky Instagrammable pop-ups, and even Netflix. And they can win by promoting what pretty much only museums can provide: real things. When visitors begin returning to museums, and we start developing new exhibitions, highlight what you’ve got. Bring out the good stuff, and woo prospective guests by the invitation to stand in the “only-here, LIVE, in-person!” presence of greatness.

PARTING THOUGHTS

We’ve lost so much more than these three things. We’ve lost people-watching in museums. We’ve lost the joy of simply seeing new things and being amongst art in public indoor spaces. We’ve lost the experiential and hands-on learning opportunities that museums provide so well. And most notably, according to a November 2020 American Alliance of Museums article, we’ve heartbreakingly lost nearly 30% of museum staff (AAM 2020).

Despite these losses, I remain hopeful and optimistic about the future of museums. People will return! And I believe that by thoughtfully considering our losses - with some creativity and forward thinking - we can offer visitors more rich and engaging museum experiences than we have in the past. This is a serendipitous opportunity to press the Reset Button for museumgoers, and a chance to introduce and invite new audiences who rarely - or never - visit our cultural institutions. People will crave in-person experiences and be eager for ways to engage with one another outside of the digital world and away from their homes. As the saying goes, you don’t know what you’ve got until it’s gone. So, when we get it back, post-pandemic, let’s make it better than ever.

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NE STEM 4U: AN 8-YEAR REFLECTION ON BUILDING THE NEXT GENERATION OF THE STEM WORKFORCE VIA PROFESSIONAL DEVELOPMENT EXPERIENCES

By Nikolaus Stevenson, Amie Sommers, Neal Grandgenett, William Tapprich, and Christine Cutucache

The need for an expanded and diversified science, technology, engineering, and mathematics (STEM) prepared workforce continues to remain a major imperative within the United States. Urban, metropolitan universities are uniquely positioned to meet the needs of the STEM workforce pipeline head-on because of their strong partnerships with their surrounding community, including employers. This network of talent generators (i.e. universities) and stakeholders (i.e. corporations, K-12 schools, non-profits, or other employers for college students within the city) serve as an important ecosystem for the support, and enhancement, of a STEM-prepared workforce. Metropolitan areas are supporting the need for undergraduate preparation in STEM disciplines through the development of STEM Learning Ecosystems, comprised of 89 systems throughout the United States that bring together multiple stakeholders (STEM Ecosystems, 2020). These formal Ecosystems bring together school districts, informal and out-of-school time (OST) partners, in addition to philanthropic, business and industry partners (STEM Ecosystems, 2020). The formation of such Ecosystems was presented as the final, distinguishing factor in the "Charting a Course for Success: America's Strategy for STEM Education" document from the White House (NSTC, 2018).

Consequently, the Nebraska Science, Technology, Engineering and Mathematics 4U Program (NE STEM 4U) at the University of Nebraska at Omaha was founded eight years ago, in order to provide a pre-professional training program to undergraduate and graduate students at UNO, while simultaneously supporting the needs of local partners in the OST context in both urban and rural settings. Particularly in urban metropolitan areas, the need for programming in the afterschool time is significant. Within just the city where the hub of this program resides, there are more than 55,000 youth in just one of the school districts, most of which are high need. The value that a program like NE STEM 4U brings is to prepare undergraduates for the workforce, while synergistically filling a gaping community need. For perspective, youth spend approximately 80% of their hours in non-school time and this time can be used to enhance learning (Wherry, 2004). The NE STEM 4U program uses the OST to bring hands-on, minds-on activities with directed mentorship in a sustainable way to youth. This mutually beneficial program design has helped UNO retain more students in STEM through graduation, while also raising awareness of college and STEM career pathways among youth (Cutucache et al., 2018; Leas et al., 2017; Nelson et al., 2018; Nelson & Cutucache, 2017).

STEM outreach programs in the OST context are a unique opportunity for STEM pipeline growth and motivator toward pursuance of STEM careers for youth. However, as has been reported routinely, quality is of greatest impact on student retention. We place relationship building and youth voice as the foundation on which we offer our programming, and we provide programming twice weekly for each of our partner sites, further emphasizing the sustainability and commitment to them.

Herein, we highlight the existing infrastructure of the NE STEM 4U program, to include inputs, outputs, feedback loops, and partnerships within a city to prepare the next generation of STEM talent. The model demonstrates key components, as we intend to provide a program framework model that engages in two-way community partnerships and elevates the STEM pipeline for undergraduate and graduate students, as well as students' interest for STEM in grades K-8.

NEBRASKA DEMOGRAPHICS

We have predominantly worked with Omaha Public Schools (OPS), the largest and most diverse school district in Nebraska with 55,000 students. We partner with schools within the district that are traditionally underserved in the STEM areas, and that include high levels of socioeconomic need as defined by high proportions of students on free/reduced lunch or high-need. Our program increases weekly time spent on science by two hours, a massive leap to address the lack of access to STEM content, and also serves to challenge students and aid in awareness toward STEM careers to include college aspirations.

Mentees within the NE STEM 4U Program

Students who participate in our program range from kindergarten through 8th grade, but the largest cohorts are between grades 4 and 8. We target this age group to capture student interest in STEM at an early age, so that we can take an active approach in helping students prioritize STEM coursework (Dejarnette, 2012), since research supports interventions during this timeframe to cultivate student interest and preparedness in STEM careers (Dabney et al., 2011; Moreno et al., 2016).

How we are working to diversify the STEM Pipeline

The demographics of youth NE STEM 4U participants (mentees) represent groups that are affected by the achievement gap in science and mathematics testing within the state of Nebraska (ECS, 2018). For example, we served 287 youth participants from the 2019-2020 school year in grades 5 through 8, comprising 6.1%, 23.5%, 36.7%, and 21.4% of our population respectively (12.2% did not answer). Over half of the students served are from minority backgrounds: American Indian or Alaska Native (6.6%),

Asian (5.0%), Native Hawaiian or Other Pacific Islander (1.7%), Black or African American (19.8%), Hispanic/Latino (22.3%), and 18.2% did not answer. Additionally, 35.7% of our students are female. Furthermore, 24% of our students in the 2019-2020 school year were retained for longer than one session of programming (students can sign up for a new extracurricular every 8-weeks), thus indicating a desire to continue to learn more about STEM.

NE STEM 4U PROGRAM STRUCTURE

Our program is an undergraduate student led, faculty-guided program that was an intervention embedded into the metropolitan university structure of UNO. The program is designed to dually serve undergraduate and graduate student mentors as a pre-professional training program, regardless of major, while providing an afterschool education experience for K-8 youth using an inquiry-based learning approach. The structure has evolved since inception. For example, prior to year four, we had only undergraduate mentors and faculty advisors (Cutucache et al., 2016); then, we implemented undergraduate leaders as officers. In year five we supported two research assistants/graduate students and in year six we lost a graduate assistant, but instead gained a program coordinator (Figure 1). The program developed quite rapidly. In year one we had one faculty advisor and eight students, year two we had two faculty advisors and 15 students, and by year three we gained our third faculty advisor and have engaged approximately 20 to 35 mentors annually since inception.

A typical year for us is broken into four sessions, eight weeks in duration, with 16 total activities or lessons per session. With each new session, new youth can join the program and/or youth may re-enroll with NE STEM 4U.



Figure 1: A student interacts with an NE STEM 4U activity (Note: photo taken before remote instruction due to the COVID-19 pandemic).

Characteristics of Undergraduate Mentors and Their Professional Development

Our program largely attracts student mentors from STEM disciplines. We define STEM as very inclusionary, and thus we have had students from aviation, business, biology, chemistry, physics, geology, mathematics, teacher education, and pre-health students all participate in the

program. The undergraduate/graduate student mentor population is approximately equal in gender, and mentors are from a variety of ethnic backgrounds, socioeconomic statuses, and declared majors (representative of the UNO student body; Nelson et al., 2018).

Internal and External Evaluation: Program Fidelity and Real-time Feedback

We facilitate ongoing integration in relation to youth programming via assessment of the NE STEM 4U program through focus groups, one-on-one interviews, and small group meetings with mentors. Additionally, the Dimensions of Success (DoS) tool and the Weikart Youth Program Quality Assessment (YPQA) tool (CYPQ, 2020; The PEAR Institute, 2020) are used to gauge the social, emotional, and STEM-related learning components of our programming. We assess the program using these tools on an ongoing basis to continually improve our undergraduate mentor capabilities, components that have been embedded into the structure of the program (Figure 3). These assessments focus on best practices for teaching and help provide objective evidence for addressing our specific research questions intertwined to the program. Feedback is utilized each semester to design professional development experiences for undergraduate mentors. Additionally, real-time feedback with the evaluative tools from both internal and externally-hired assessors provides an immediate perspective on areas needing further development in regards to programming. The utilization of the feedback, often in a rapid feedback loop, is a critical component of maintaining



Figure 2: An undergraduate mentor facilitates a middle school 'Family Night' with a demonstration in STEM (Note: photo taken before remote instruction due to the COVID-19 pandemic).

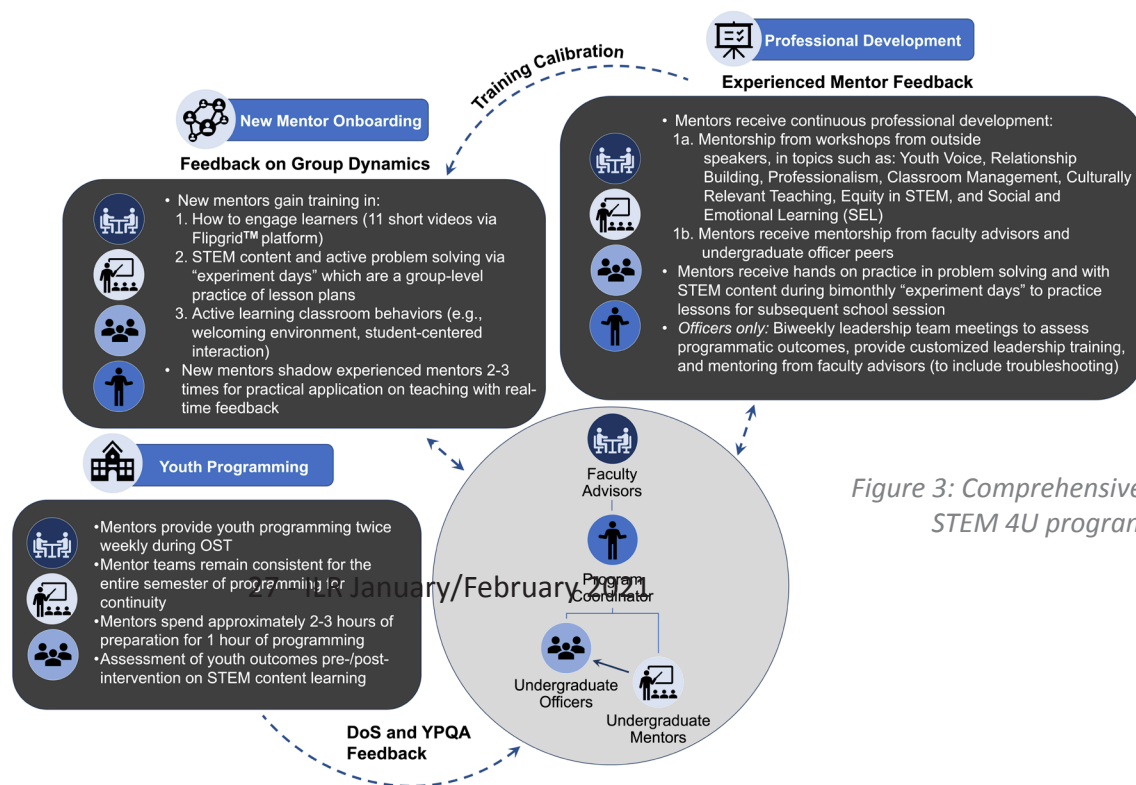


Figure 3: Comprehensive look at the NE STEM 4U program model.

program implementation and integration.

MUTUALLY BENEFICIAL PARTNERSHIPS

We use a two-way approach to engage with the community, where both institution and community partners collaborate to develop and apply knowledge to address community needs. When considering embedding and integration of our program within the community, partnerships at the local and state level have been and continue to be quintessential to program success over the past eight years. These ongoing partnerships are indicative of community “buy-in,” a result of high-quality programming provided by NE STEM 4U to youth. Partnerships also include other Nebraska universities and their nearby school districts to expand the reach of the OST program, potentially suggesting a model suitable for further expansion. These developments are the early steps in developing a potential national model for an OST program that furthers STEM learning experiences and impact.



Figure 4: A mentor interacts with students to facilitate an NE STEM 4U activity (Note: photo taken before remote instruction due to the COVID-19 pandemic).

From the outset, and continuing to the present, the success of our program has benefited from the collaborative support of the city-wide afterschool program leaders in *Collective for Youth*, and the state-wide afterschool program leaders in *Beyond School Bells*. These entities have provided significant intellectual and programmatic support, as well as critical guidance and advice throughout the duration of NE STEM 4U. Similarly, *Beyond School Bells* was a major catalyst for steady expansion of the program state-wide. And, *Collective for Youth* supports not only the NE STEM 4U program, but OST programming for thousands of youth in the Omaha metropolitan area. This includes

support for coaching site directors, OST providers, and also conducts external quality control assessment, mostly utilizing the Weikart Youth Program Quality Assessment (YPQA) tool. These evaluations are important for ongoing evaluation and improvement of programming. Our city and statewide partner needs include providing high quality afterschool programming, and we highlight below some of the comments from our partners in regards to these two-way partnerships:

“Mentors do a great job with interacting with all small groups and the activities seem fun for the youth. We appreciate coaching of site staff to make the introductory portion of the activity more engaging and less similar to a traditional class setting.”

-Elementary Afterschool Program Site Director

“NE STEM 4U college students [mentors] are role models to our elementary, middle school students, and staff. They have peaked the curiosity of our students as well as instilled confidence in our staff to facilitate various components of STEM independently.”

-Support Services Manager at Collective for Youth

As a result of programmatic success in Omaha and partnership with other Nebraska universities, expansion of our NE STEM 4U model has reached both Kearney Public Schools (rural location in Nebraska) and Lincoln Public Schools (urban location in Nebraska). Each of these partnerships are important to the continual success of the program. Additionally, partnering with the Omaha STEM Ecosystem has helped our NE STEM 4U mentors and youth enrolled in the program become familiar with current STEM job openings in Nebraska, contributing to development of individuals to fill STEM workforce needs around the Omaha Community.

“In partnership with NE STEM 4U, we have connected several industrial partners to align education to career pathways for students.”

-Omaha STEM Ecosystem Director

The network of partnerships that exist between our NE STEM 4U program and educational, industrial, and philanthropic stakeholders has helped integrate the program into the community. And, we rely heavily on them as an effective feedback loop for programmatic excellence.

Key Programmatic Elements

When considering sustained success and integration for a STEM program, certain elements of our NE STEM 4U program have been identified as important, culminating in eight years of programming and subsequent, continued expansion. These elements are routinely incorporated into the everyday work and include the use of professional

development activities, experiment practice, an annual retreat, and bi-weekly officer team meetings. Additionally, post-hoc data from participants identify faculty advisors as a pivotal component of the program.

Embedded into the program, faculty advisors provide professional development structures to the undergraduate mentors while being the driving force for continual grant and foundation funding to the program from the local, state, and national levels. Additionally, faculty advisors play an important role in promoting best practices with data collection, analysis and publication of program data as students are encouraged to partake in Discipline Based Education Research (DBER) research affiliated with programming. These advisors also function on a more personal level with mentors by serving as guides for undergraduates to explore various career trajectories.

Also critical to the success of NE STEM 4U, we have identified the need for a day to day program coordinator to assist in relationship building, an important feature built into the program as a result of its integration (Figure 2). For our program in Omaha, we have employed a research technologist to function in content management and relationship building.

Furthermore, we identify the bi-weekly leadership team meetings as an important feature of the program (Figure 3). Synergistic outcomes from these interactions include job placement, internships, and the pursuit of graduate school aspirations due to guidance provided by faculty advisors.

Lastly, professional development is crucially embedded into our program that has promoted success for undergraduate and graduate students. We believe that our STEMinar events function as an important component of undergraduate professional development. These events bring in professionals from a wide array of disciplines to provide an hour-long workshop. Informally speaking, this community of practice of mentors prompts an opportunity for the more senior personnel to guide and assist the newer personnel on difficult or new tasks.

CONCLUSIONS

Our NE STEM 4U program characterizes three important features of impactful OST programs. These features, which have engendered continued program success include: 1) strong community partnerships, 2) positive student and undergraduate mentor outcomes, and 3) a professional development structure for increased success of college students (Figure 3). We provide a potential intervention model for universities to capitalize on undergraduate and graduate enrollment to provide a high-quality STEM

outreach experience for K-8 students and professional development for the workforce. Similarly, employers within metropolitan areas can begin to rely on a talent pipeline given the increased retention to graduation and within STEM demonstrated in the NE STEM 4U program. Since UNO is not unique in facilitating such a pipeline, an intervention that successfully addresses STEM-learning needs in a diverse urban and rural context could serve as a model. Implementation of our NE STEM 4U program intervention should be considered as a potential national model in college student graduation rates, retention within STEM areas post-graduation, and interest in STEM for K-8 youth.

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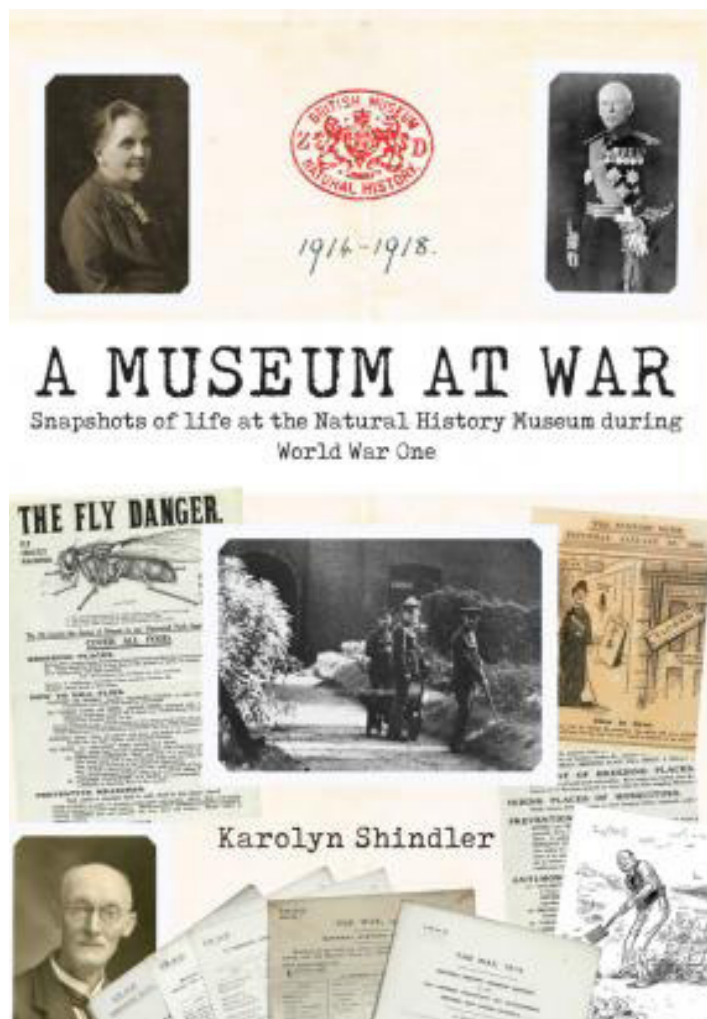
Christine Cutucache is the founder of the NE STEM 4U program and serves as one of the three active faculty advisors, along with Neal Grandgenett and William Tappich. Nikolaus Stevenson serves as the program coordinator of the NE STEM 4U program, while Amie Sommers works as a doctoral student for Christine Cutucache, conducting research on this program among others. The author team resides at the University of Nebraska at Omaha's Department of Biology, STEM Teaching Research, and Inquiry-based Learning Center, and Department of Teacher Education. To get in touch, feel free to reach out to our founder at ccutucache@unomaha.edu.

ILE/TEN TRAVELING EXHIBITIONS ROUNDTABLE/FORUM COMING SOON

WE ARE PLEASED TO ANNOUNCE THAT, FOLLOWING UPON THE SUCCESSFUL SESSION ASSOCIATED WITH THE 2020 ASTC CONFERENCE, INFORMAL LEARNING EXPERIENCES AND THE TRAVELING EXHIBITS NETWORK WILL HOST AN ONLINE TRAVELING EXHIBITIONS ROUNDTABLE ON TUESDAY, MAY 26, AT 3:30PM EASTERN DAYLIGHT TIME. OPPORTUNITIES TO APPLY FOR A POSITION ON THE PRESENTATION SCHEDULE WENT OUT A WHILE AGO, BUT THE FORUM WILL BE READILY (AND AT NO COST) AVAILABLE TO ALL INTERESTED MUSEUM FOLKS. PLEASE STAY ALERT FOR ONLINE ANNOUNCEMENTS OF THE ZOOM ACCESS AND JOIN US FOR WHAT WILL BE AN INTENSE AND INTERESTING 90 MINUTES OF IMPORTANT INFORMATION ABOUT THE TRAVELING EXHIBITIONS WORLD.

A MUSEUM AT WAR: BOOK REVIEW

By Robert Mac West



Publication of this book (2018) came at a very interesting time for the museum world. Here we are, looking at the various ways in which museums can serve and benefit their communities. These include extending and expanding the audiences/clients and broadening their abilities to be a significant resource. And now here is a book with day-to-day documentation of the multiple ways in which London's Natural History Museum served and benefited Great Britain during World War I from 1914 to 1919.

After an introduction the book is a daily accounting of a large variety of museum activities. It is fascinating to read of the ways in which the scientific expertise and collections were put to national and military use during the war. Further, it did not close to the public but rather installed modest exhibitions which pointed out how the museum's collections and scientific expertise were utilitarian. The national museum was indeed a national resource.

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Obviously the war impacted the museum in multiple ways. Staff were summoned to military duty and collections were moved to secure locations. But the facility stayed open and shared understandings as appropriate for the public visitors.

Here are a few carefully dated examples of the museum's contributions to the war effort, looking both to the UK population and to needed information for the military.

Mammalogy: An October 1914 section describes visits to the museum by men from medical units who used horses in various ways. They learned about horse anatomy from specimens on exhibit in what was then a closed area of the North Hall. One specimen, with its human skeletal counterpart, is still on exhibit as shown in the illustration.



Figure 1: Horse and human anatomy exhibit dating back to WWI. Source: Google Images

Entomology: In 1915 it was discovered that insects were responsible for severe damage to military biscuits, an important part of the wartime diets. Museum research showed that the biscuits were infested by moths and beetles. This resulted in recommendations for the biscuit cooling facilities to be modified, resulting in much more healthful food for the army. The resultant exhibit is illustrated on p. 63 (figure 2).

Ornithology: In 1916 an exhibit was prepared for the public to demonstrate the differences among various species



Figure 2: Illustration on page 63 of the exhibit on research into the cause of insect damage to the army biscuit as it appeared in July 1925.

of pigeons. The importance was public recognition of the homing pigeons which were used solely for military functions – and it was illegal to shoot them. The book points out the importance of this as numerous violations of this resulted in fines and even prison sentences. The exhibit was in a part of the museum that remained open during the war.

These are just a few of the fascinating examples of the ways in which the Natural History Museum and its internal resources served the kingdom, both at home and on the warfront. The chronology makes it even more interesting as one can follow certain events and procedures and see how the presumably intellectual and academic resources of the museum were broadly applied and used in so many circumstances.

The relevance of this book to our current world is really remarkable. Today there are vigorous and essential searches for ways that museums of all sorts can better serve their communities and make their resources relevant and useful. It is doubtful that the Natural History Museum intended to

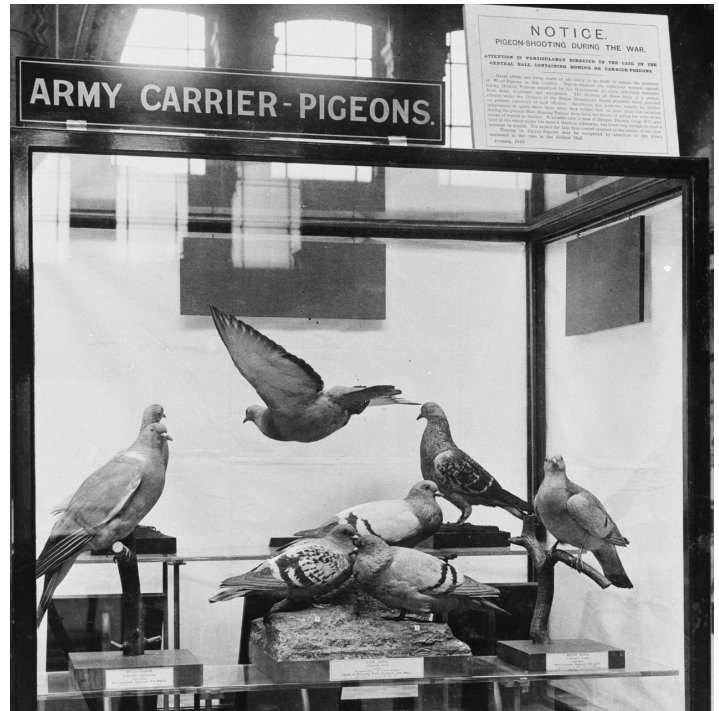


Figure 3: Exhibit in the Central Hall in 1916 showing the differences between the various species of pigeons. P. 113

do that early in the 20th Century but the numerous examples described here certainly do point out how it was able to be responsive in a challenging time.

Shindler, Carolyn, 2018. *A Museum at War, Snapshots of life at the Natural History Museum during World War One*, Natural History Museum, Cromwell Road, London, 319pp.

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THE INFORMAL LEARNING REVIEW

1776 KRAMERIA STREET, DENVER, COLORADO 80220

ON THE COVER:

The thousand year old Acoma Pueblo in west-central New Mexico (near Albuquerque) is home to the Acoma Pueblo Tribe. Its Indigenous Knowledge is central to the ongoing discussions of how STEM education incorporates it as well as Western Science. Read more on page 12.

