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TOOLS, FRAMEWORKS AND CASE STUDIES

Bioregional Community Dialogue: The *Worldviews Network* Toolkit for Educators

Jessica Sickler and Donnelley Hayde

ABSTRACT

Planetarium spaces offer many opportunities for inspiring learning about the cosmos, but they more rarely offer other science content or topics with specific local relevance. The Worldviews Network is comprised of institutions using an innovative approach to interpret topics related to human-induced global change. As a case study, the Worldviews approach provides a model that combines data visualizations with systems-based narratives that tell a story of social-ecological issues through cosmic, global, and local perspectives. Drawing from summative evaluation of the project's eight institutional case studies, this article shares key insights about the Worldviews programming model, including how the process of adopting the model led to skill development for museum staff members and, in some cases, unprecedented community partnerships. For practical application, the article also outlines a toolkit of key factors and available resources for institutions interested in producing issue-based earth science presentations for their own immersive "bioregional community dialogues."

KEYWORDS

Data visualizations;
planetariums; public
engagement with science;
systems thinking;
partnership; museum
education; evaluation

Background

From 2010 through 2013, the Worldviews Network project (www.worldviews.net) assembled a group of interdisciplinary advisors and informal science institutions (ISIs) working to develop an innovative approach for interpreting human-induced global change. The project sought to leverage the power of immersive environments (planetariums or portable domes) within eight ISIs to create compelling stories about social-ecological issues. The programs would use scientific data visualizations and storytelling to demonstrate the limitations of a habitable Earth environment (or "planetary boundaries") through cosmic, global, and local perspectives.¹

Partner sites ranged from large ISIs known for their planetariums and research to smaller ISIs more focused on local outreach; sites included California Academy of Sciences, Denver Museum of Nature and Science, American Museum of Natural History, Minnesota Regional Planetarium Network, University of Michigan Natural History Museum, Renaissance Computing Institute, Journey Museum, and Perot Museum of Nature and Science. This network convened around a set of common goals: creating data visualizations and storyboards for dome presentations, providing pro-

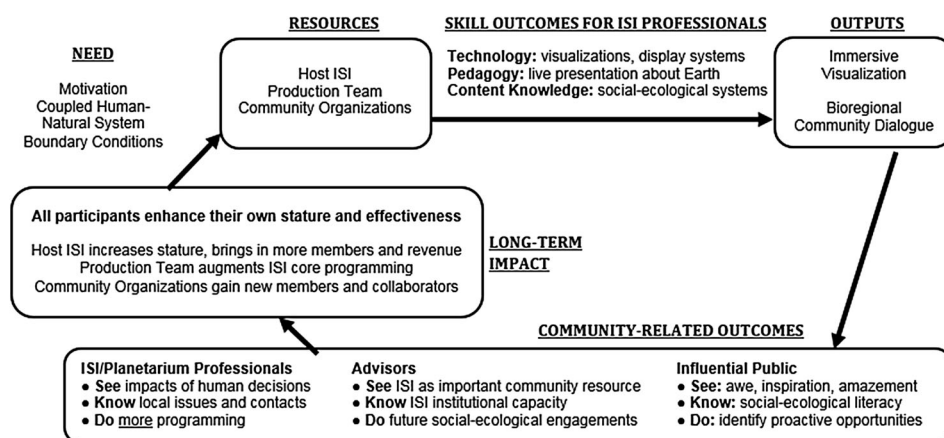
fessional development for informal science educators, producing a Bioregional Community Dialogue (BCD) event at each ISI, and building partnerships with external organizations to promote future action.²

The driving feature of the Worldviews approach is the BCD, a model which the project leadership developed in response to a field-wide call for the “use of new visualization technologies that reveal Earth’s processes in powerful ways,” particularly through inquiry-based learning and systems-based approaches.³ Through this model, the Worldviews team hoped to take full advantage of visualization technology to illustrate concepts of scale, to promote understanding and meaningful participation among audiences, and to foster sensitivity and personal stake in local ecological issues.⁴ Previous evaluation of Science On a Sphere programs has indicated that large-scale data visualization is a viable tool for achieving both attitude and learning outcomes associated with Earth systems.⁵ Meanwhile, visitor studies from team members’ previous project work with Uniview dome software have suggested that planetariums offer “a powerful potential to dramatically enhance and accelerate public comprehension of complex, multi-scale geospatial phenomena.”⁶ These data also suggest that the Digital Earth technology (used in these dome environments) has been associated with audience engagement, interest, and desire to learn more about topics presented.⁷ In the Worldviews model, a BCD event usually consisted of a dome presentation (data visualizations paired with live narration by one to three presenters), followed by some type of post-presentation segment. Each ISI offered some type of audience engagement after the presentation, with formats ranging from question and answer sessions to more intimate facilitated community dialogues.

Summative evaluation of the Worldviews Network aimed to understand the unique attributes and complexity of each site’s process, while also systematically assessing change across the Network and among visitors, personnel, and institutions. Evaluators used a multiple-case study approach, collecting qualitative and quantitative data about project process and outcomes through a variety of methods, including interviews (with the project co-PI Leadership Team, ISI staff at the partner sites, and external advisors), web surveys (of ISI staff and advisors), questionnaires at events, event observations, and document analysis.⁸ The case study approach allowed for the presentation of findings at two levels: (1) a portrait of unique variation in what occurred at each site, and (2) a cross-case analysis, resulting in generalizable conclusions about the efficacy of the Worldviews model.⁹ In this paper, we present the top-level conclusions from this cross-case analysis, as they provide guideposts and recommendations for other museums seeking to engage visitors with similar programming.

Implementation and the process model

Implementation of the Worldviews Network was an iterative process. Given the Network’s ambitious goal of combining sophisticated technologies with community partnership and discussion-based audience engagement, the project sought to continuously learn from and adapt in response to prior sites’ experiences, successes, and challenges. Midway through the implementation cycle, the project leadership and evaluators constructed a detailed program logic model, reflecting the collective mid-course learnings, and added an additional layer to represent the project’s overarching theory of change (Figure 1). This



Over time, Worldviews Network seeks to contribute to large-scale changes in how individuals and society deal with environmental challenges, and in how Planetariums/ISIs take a central role in facilitating that new landscape.

Figure 1. Worldviews network theory of change model.

depiction represents the theoretical vision of the cyclical production process and the literature that informed the project's theory of change.¹⁰

The Worldviews Network model, as conceived by project leadership, drew from several core theories in its professional development and its approach to storytelling for events. One important influence was the Technological Pedagogical Content Knowledge Framework (TPACK), from formal education, which articulates three overlapping domains of knowledge needed for instruction in a technology-rich environment.¹¹ This framework was used to identify the skill outcomes that ISI/museum professionals at Network sites would need to develop in order to produce effective BCD events.¹² Another key theory was the Seeing-Knowing-Doing framework, drawn from sustainability education.¹³ This framework presents overlapping aspects of individuals' worldviews: (1) Seeing, or perception, defined in terms of how people feel about the world; (2) Knowing, or conception, defined as how people conceptually understand the world; and (3) Doing, or practice, defined as how people interact with the world.¹⁴ This informed the construction of BCD events (narratives, visualizations, and subsequent dialogue sessions), with the theory that the events would support issue-specific shifts in perspective across these three domains for attendees.¹⁵ A final organizing idea was a narrative structure that examined a single ecological issue from three perspectives: cosmic, global, and local. Although connected to the Seeing-Knowing-Doing framework, this was a narrative approach to achieve these goals.¹⁶ This synthesized theory of change acted as a touchstone for project work and was the foundation for the analytical framework used in summative evaluation.

Throughout the project, a generalized production process emerged and solidified, which was revealed and articulated through review of the project's document archive, which provided evidence of process, involvement, and roles of key players within each team. Each site began with support from the Leadership Team and defined a social-ecological topic that was relevant to its mission and community. From here, the Leadership team and ISI staff outlined a presentation narrative using the "cosmic-global-local" framework, identified scientific advisors and data resources in the wider community, and began

to create visualizations for the narrative.¹⁷ The external advisors (individuals associated with community organizations or scientific research related to the production topic) worked with ISI staff to develop the narrative, provide fact-checking or background information, and/or locate additional data for dome visualization. Document analysis revealed that the extent of involvement by external advisors varied greatly between ISI sites.

Overall, ISI staff was responsible for the various efforts involved in producing their BCD events. However, an important role of the Leadership Team was applying its expertise to identify and fill gaps for each institution. This support most often took the form of technical troubleshooting in creating or adapting visualizations for dome projection, but in some cases included support with scientific content, aiding in event coordination, or providing logistical support.

Outcomes and impact on ISIs

The development of skills, collaboration, and capacity among ISI/museum professionals and institutions was a significant goal of the Worldviews Network project. Specifically, intended outcomes (derived from the theory of change model) included: increased technical skills; increased skills at teaching live and/or with the dome; increased knowledge of local ecological issues; increased connections with community; increased programming about ecological issues. Evaluation showed it was achieved in several key ways. When discussing the impact of the project, ISI staff most often reported that it fostered new collaborations with outside partners (mentioned by five of the eight sites). These collaborations were with external scientists and community groups who advised on the productions and with Leadership Team members who mentored sites. In addition, two sites noted achieving unprecedented internal, cross-departmental collaboration, a particular interest for larger institutions with often siloed departments for planetariums, education, and scientific research.

Seven of the eight sites reported at least one area of longer-term, institutional impact at the museum/ISI (survey and interview data were collected 1–3 years after their first event for most sites; only one site had recently completed its first event). The most common was achieving some degree of buy-in to the Worldviews approach. Examples of this included wider institutional commitment to telling Earth stories in the dome or planetarium, which often took months or years to achieve after the first BCD event. In addition, five of the ISIs had already reused or repurposed their Worldviews-created digital visualization files for new audiences or programs. These Worldviews Network sites repurposed materials for internal professional development, school groups or teachers, and other outreach with new audiences or venues. Another two sites reported continuing to use the Worldviews narrative approach in *other* shows produced since their BCD events. Finally, half of the sites reported they had worked with a BCD advisor or attendee since the event, able to describe outside relationships that developed as a result of the Worldviews project. While no ISI reported that it had begun new collaborations with community partners, four reported plans to do so.

While the evidence of institutional and longer-term change was profound, the project also focused on the professional development of staff at museums, planetariums, and ISIs. The sites involved in the Worldviews Network each arrived with experience in one or more areas of the TPACK framework (technical skills with the dome, pedagogical

skills for live presentation, and/or content knowledge of the social-ecological issues), but no site was expected to be an expert in all areas. The collaborative production of a BCD event brought together team members' diverse strengths with Leadership's specific expertise, and the development of a show included needs-driven, one-on-one mentorship in critical skills, such as locating and preparing data sets, steering presentations in Uniview, and using storyboards. In follow-up surveys, staff from seven ISIs reported significant gains across their technological, pedagogical, and content knowledge. Table 1 shows that professionals' greatest gains were in technological knowledge/skills, shifting from very low skill-levels (median ratings of one to three out of seven) to moderately high skill-levels (5 or 6 out of 7). ISI staff had higher levels of incoming preparedness in content and pedagogical knowledge; however, some growth was also reported in these areas.¹⁸

A critical finding from summative evaluation was that certain factors about the ISI's institutional context were associated with the type and extent of outcomes achieved. For example, institutional challenges at the larger museums reflected the structure of such institutions toward more siloed responsibilities for departments and individuals. This context sometimes made engaging internal science researchers in the production process more difficult. We found that sites able to make multiple attempts at internal collaboration sometimes found an easier path over time. In contrast, smaller ISIs tended to struggle with more limited resources to implement an ambitious vision. Again, while it was not insurmountable, productions in these contexts were most successful when staff made strategic accommodations related to event size, presentation complexity, and allocation of staff time.¹⁹ In the end, data showed that the project tended to create greatest gains in those areas where there were contextual barriers; in other words, the project helped sites make headway at achievements beyond traditional capacities. In cases where institutional-level interest grew alongside staff-level outcome achievement, there was generally strategic alignment of the program with a larger institutional goal, such as connecting to internal research or a particular interpretive priority.

Table 1. Median ratings of knowledge and skills among ISI professionals in the Worldviews Network (retrospective-pre and post, $n = 9$); results of statistical comparison of paired ratings (Wilcoxon signed rank test for significance).

Skill or knowledge area	Pre Median	Post Median	Sig.* p -value
TECH: Using the full technical capabilities of Uniview in the dome	3	6	.018
TECH: Creating visualizations for the dome	1	5	.027
TECH: Preparing Earth datasets for Uniview	1	5	.011
TECH: Using WMS and other layers in Uniview's Geoscope	3	6	.016
PEDAGOGICAL: Delivering a live presentation to an audience	6	7	.034
PEDAGOGICAL: Delivering a presentation about Earth science content	4	6	.016
CONTENT: Understanding of ecology in general	4	6	.039
CONTENT: Understanding of local or regional ecological issues that were the focus of my BCD event	5	6	.014
COMMUNITY: Awareness of the work people are doing to effect change on this issue	4	6	.011
COMMUNITY: Awareness of who are key people/organizations in my community working to address this issue	5	6	.041
COMMUNITY: Using the dome for issue-focused discussions in my community	2	6	.007

*A p -value < 0.05 indicates a significant difference between ratings of pre- and post-program skills.

Lessons for application

Given the ambitious goals of the Worldviews Network model, partner sites experienced a steep learning curve in the first stages of the project. Their experimentation and reflection on what worked and what could improve was essential to operationalize Leadership's early vision into a concrete and defined process. The evaluation of this accumulation of process, understanding, and resources across the Network showed several guideposts that we feel can facilitate the development of new Worldviews-style programming at a wider range of museums, planetariums, and ISIs.

One key lesson was that carefully planning a BCD event was important to program success and audience experience. In particular, pre-defining an intended audience and understanding their connection to the topic should drive story and program development. The eight sites studied used a mix of audience strategy – some focused on audiences of invited stakeholders connected to the topic; others focused on mostly public audiences. Results showed that audience reaction and dialogue dynamics could be greatly affected by this audience composition. This included the contrast of audience members who reported feeling show content was “over their heads” (general public) with others who requested greater depth in the content (often noting their own expertise). Audience composition also influenced the quality and depth of post-presentation dialogue sessions. Network-level data suggest three main factors associated with successful dialogues: having enough knowledgeable attendees in the room to ensure conversation (rather than defaulting to Q&A, more common for general audiences); having an experienced facilitator to initiate and support the format; and ensuring the facilitator is comfortable with the Worldviews model of design-oriented dialogue.

Above all, evaluation showed that the incoming strengths and assets of a museum/ISI partner affected its approach to production. In each case, staff started from a set of institutional constraints and opportunities, building on strengths, and receiving project support to compensate for weaknesses and to build new skills. The TPACK framework was found to be a useful organizing device because it can help organizations identify and leverage their most relevant resources and skills as well as identify gaps that may be filled by partnerships, existing templates, or targeted professional development. As other ISIs consider trying the Worldviews approach, we encourage new sites to use this framework as a tool for self-assessment in order to apply the Network's lessons and create a custom strategy for their program development. To illustrate this self-assessment, a museum that finds itself with internal strengths in each major area (technical knowledge of Uniview, pedagogical knowledge of presenting and storytelling, and Earth science content knowledge) may have enough resource flexibility to create its own custom BCD event nearly from scratch. For a museum with just one or two major areas of strength, self-assessment may lead to external partnerships or resources to compensate for gaps. For example, a site with lower technological skills might make use of the “plug-and-play” visualization files available on the project website (www.worldviews.net) to adapt existing data visualizations to their local story. A site with limited Earth science expertise might look to local universities or researchers to serve as external content and story advisors on an event narrative. In fact, the project's website has been developed as a repository of digital assets, storyboards, how-to guides for the production process, self-assessment tools, and technical resources to help museums

leverage unique strengths and institutional priorities to create new BCD events (www.worldviews.net/process/).

Finally, evaluation found that the Worldviews Network approach pushed against some traditional boundaries and ideas about the kinds of stories that could be told in a planetarium. While sustained change occurred at a number of the museums, the findings showed that patience and efforts to engage colleagues, as well as strategic alignment with larger institutional goals, were necessary to effect a large-scale institutional buy-in. Where the Worldviews approach has gained a foothold, it came through the time investment and energy of one or two staff advocates willing to experiment with new models, demonstrate proof-of-concept programs, and to engage colleagues over time by highlighting the unique value of the medium to storytelling, audience engagement, and mission.

Notes

1. Yu et al., “Planetariums for Ecological Literacy” and Rockström et al., “Safe Operating Space.”
2. Yu et al., “Planetariums for Ecological Literacy” and Yu et al., Worldviews Network.
3. Hoffman and Barstow, Revolutionizing Earth System Science Education.
4. National Climatic Data Center, *Climate Timeline Information Tool*; Hamilton et al., “Worldviews Network” and O’Sullivan, *Transformative Learning*.
5. Goldman et al., *Science on a Sphere*®.
6. Yu, “Digital Planetariums for Geology and Geography Education.”
7. Yu et al., “Immersive Digital Earth Visualizations.”
8. Sickler and Hayde, *Bringing the Planetarium to Earth*.
9. Yin, *Case Study Research*.
10. Sickler and Hayde, *Bringing the Planetarium to Earth*.
11. Mishra and Koehler, “Technological Pedagogical Content Knowledge.”
12. Yu et al., “Planetariums for Ecological Literacy.”
13. Sterling, “Transformative Learning and Sustainability.”
14. Sterling, “At Variance with Reality.”
15. Yu et al., “Planetariums for Ecological Literacy” and Yu et al., “Digital Earth.”
16. Yu et al., “Digital Earth.”
17. Ibid.
18. Due to small samples, non-parametric statistics were used to calculate the significance of differences between retro-pre and post ratings. However, these results should be interpreted conservatively and generalizations beyond this group limited.
19. Sickler and Hayde, *Bringing the Planetarium to Earth*.

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Donnelley Hayde, a Research Associate with COSI's Lifelong Learning Group, has a background in applied social science, market research, classroom teaching, and museum evaluation. She works with a variety of science centers, art museums, and other informal learning programs.

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