Science Community Engagement Best Practices

A white paper from the observatory best practices/lessons learned series

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Executive Summary

Community engagement is a central component of many large science initiatives and observatories. For the purposes of this paper, community engagement refers to the engagement of other research scientists, it does <u>not</u> refer to the engagement of the general public or for educational purposes. This paper specifically focuses on community engagement in the context of building a strong scientific user base, supporting new research, and/or synthesizing scientific findings across a set of questions or themes.

Community engagement builds awareness of the observatory as a scientific opportunity, generates trust in shared goals and processes, supports users in accessing and utilizing the observatory, and ensures the long-term relevance of an observatory through an ongoing two-way dialogue with the user community. There are no one-size-fits-all tactics when undertaking community engagement. Each program or observatory has different goals, needs, and resources available to it for community engagement. Understanding this context is important for determining the strategies and activities most suitable to the observatory.

In order to assess the state of the industry in community engagement, research was conducted including both a literature review and review of websites of eight major observing systems and two data aggregators. Once this was completed, the best practices and best practice self-assessment tools were validated through interviews with staff from two relatively mature observatories.

Each of these best practices are discussed in detail, accompanied by context and literature references in the remainder of the white paper. Additionally, these best practices have been organized into a best practice Self-Assessment Tool that enables an existing or new organization to assess their current community engagement capabilities and maturity level. See Appendix.

BP 1: Create and maintain a Community Engagement plan.
A community engagement plan should be developed and maintained that strategically connects program goals to a set of activities and provides metrics for success for each activity.

BP 2: Employ at least one staff member with dedicated community engagement responsibilities.
Community engagement can be undertaken under a range of staffing scenarios from being the partial duties of one or multiple individuals to having a team of full-time community engagement managers. It is our recommendation that an observatory should have at least one staff member with dedicated community engagement responsibilities in order to ensure community engagement related duties remain a priority. A dedicated community engagement manager has been shown to facilitate more strategic and innovative thinking around community engagement,

leading to more regular and diverse activities and points of connection with the community being served. The community engagement manager should create, implement, and manage the annual community engagement plan.

BP 3: Solicit feedback from the community during the program's formation process.
Engaging members of the community as part of the planning and development of an observatory not only provides an early start to building awareness of an observatory and its opportunities, but allows the observatory to learn from and respond to community research and data needs. Early engagement also helps to lay the foundation for the community's overall perception of the observatory in terms of their ownership and sense of belonging within the program. We recommend a hybrid approach that includes obtaining targeted and deep input through workshops or working groups and allowing for broad community feedback on draft plans and documentation.

BP 4: Engage external community members in observatory governance using open and transparent mechanisms.
Similar to the need to make sure the community is heard in the planning of the observatory, the community should continue to have a voice throughout the development and operation of the observatory. An observatory's governance--steering or oversight committee--can serve the role of connecting with the community or representing the community voice. We recommend designing observatory governance to include external community members. External community members provide a less conflicted or biased perspective on the direction of the observatory that may be more representative of the larger community's interests. These community members should be selected via clear and transparent processes, for example, through an open call for nominations and a selection criteria that balances gender, race, geography, discipline and career level to ensure a diversity of perspectives.

BP 5: Utilize conferences to facilitate engagement opportunities.
Conferences present numerous ways to engage with your target audience, including through exhibit booths, oral or poster presentations, town halls, or workshops. They are an opportune time to connect with the user community because of the number of people who attend, making them productive and cost-effective opportunities for community engagement. We recommend conference activities focus on active engagements that allow for two-way dialogue, such as town halls and workshops.

BP 6: Hold in-person or online events to engage new users.
While conferences provide opportunities for broad reach, meaningful training and collaboration-building learning experiences occur through targeted workshops, whether held in-person or online. We recommend utilizing both in-person and online formats as they offer different benefits in terms of potential participation, cost-effectiveness, and educational or peer-networking experiences. Regardless of format, the experience should be designed with the

user and adult-learning principles in mind. Effective and successful engagement must benefit both the program and its end users and researchers.

BP 7: Hold in-person events to connect existing users and foster a community of practice.

An observatory should employ strategies to connect existing users in a collaborative setting. Bringing users together in small, targeted workshops or in large "all program" type of events has a positive impact on science and the observatory by building relationships, trust, and collaboration among researchers. Consider "all program" convenings if the observatory has a goal of scientific synthesis that aims to integrate data and results across users. Larger "all program" type of events build a sense of community among disparate researchers and research projects and facilitate knowledge sharing and building of new collaborations. The observatory should also take advantage of and design these engagement opportunities to learn from user experiences and adapt to their needs.

BP 8: Utilize online social mechanisms to communicate to a broad user base and keep users informed of engagement opportunities.

Frequent communication to users through social media, as well as other electronic means such as direct email or newsletters, can work to keep users informed of opportunities, new data or findings, updates, and other important information that may impact their research. We recommend utilizing social media and online communication platforms as a complementary effort to other engagement mechanisms. A diversity of activities provides the broadest reach and highest return on investment in community engagement.

Scope

This Science Community Engagement Best Practices white paper examines industry performance metrics, identifies and describes best practices, provides a best practice ranking, and ranking questions that enables an existing or new organization to assess their current performance metrics ranking level and identify their desired or aspirational next ranking level. This white paper is intended to provide a tool to identify and plan for organization people, process, and technology improvements.

This paper will discuss community engagement surrounding observatories. For the purposes of this paper, community engagement refers to the engagement of other research scientists, it does not refer to engagement of the general public or for educational purposes. Users are defined as individuals either using data from the observatory or generating data or data products in some way that are integrated into the observatory.

Background

Community engagement in science is used in a number of contexts, such as in building public stakeholder interest and citizen science participation in a science program that will have an impact on or in a specific community. Many large science initiatives and observatories utilize the term to seek to build a community of participants and users through "community engagement" activities. In the context of this best practices paper, community engagement has the goal of establishing and growing a community of academic or other scientific users of an observatory, facility, or instrumentation, for example toward an end goal of being able to address major scientific questions or challenges.

According to a recent study conducted by the American Association for the Advancement of Science (AAAS), individuals whose roles and responsibilities in a scientific organization focus on research community engagement are often self-taught or learned on the job through mentoring and networking.[1] This may be due to the lack of literature on specific strategies for science community engagement and the overall lack of study in this area. As there is no manual or text book for how to effectively conduct community engagement, to determine best practices alternative sources knowledge must be utilized, such as, principles of successful community engagement[2] designed for other audiences (e.g., citizens and stakeholders). These principles encourage your community to co-create knowledge and understanding, by creating opportunities for the community to engage with one another, and that ensuring engagement opportunities are a regular and ongoing component of a program. Additionally, there is much to be learned from adult learning principles in how to effectively communicate and engage

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[1] https://blog.cscce.aaas.org/scientific-community-managers-often-self-taught-with-a-science-phd/
[2] aese.psu.edu/research/centers/cecd/engagement-toolbox/engagement/guiding-principles-of-effective-community-engagement

members of the scientific community. Lastly, many of the best practices in this document are derived from the authors own experiences as community engagement managers.

While the best practices are good general principles to follow, there are no one-size-fits-all tactics when undertaking community engagement. Each program or observatory will have different goals, needs, and resources available to it for community engagement, and this context is important for determining the strategies and activities most suitable to its needs. Here are a few of the things to consider when planning community engagement activities:

- **What is the target user audience?** The audience will not be the same for every program or observatory. For example, global versus regional or national programs may need to consider cultural and capacity building perspectives into engagement strategies. Academic users may have different incentives or goals for using infrastructure or observatory data than resource manager users. Successful community engagement strategies and processes should be sensitive to the specific community context to which it is targeted[3].

- **What are the goals of engagement?** Ultimately, the goals of community engagement will dictate which strategy is used for that engagement. For example, does the observatory seek to demonstrate need and value through a large user base and number of scientific publications? Does it seek to facilitate collaboration and scientific synthesis across users? How important is building a sense of community to accomplishing the goals of the program?

- **How are individuals funded to use the observatory or program?** The mechanism by which users are funded to participate in a scientific program or to use observatory data (e.g., funded directly by the program or observatory versus external and unrelated sources of research grants) may influence how much emphasis is needed on engaging users versus sustaining the existing funded users. The strategies that best address each goal may differ.

- **How much funding can be allotted to community engagement?** The level of funding available for community engagement activities may constrain the number or types of strategies that one can undertake, as well as the staffing that can support these activities.

This white paper presents a synthesis of industry best practices in community engagement, examines current methods used by observatories, and provides a framework across which an observatory could identify their current level of maturity. Best practices described in this white paper are based on an extensive survey of existing observatory best practices. They represent an idealized world of achievable best practices, which are recognized to be challenging to

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[3] aese.psu.edu/research/centers/cecd/engagement-toolbox/engagement/what-is-community-engagement

implement. Each observatory has its own priorities and available resources, as such, the best practices described are aspirational. The best practice white papers objective is to provide a simplified, easy to understand and apply guide for self-assessment and planning. They do not represent guides for technical assessments or implementation.

Methodology

This white paper is one of four in a series of best practice white papers. Other best practices white papers are: Data Product Quality, Observatory Performance Metrics, and Data Citation, Identification, and Tracking. Similar methodology was used in each best practice white paper.

Best Practices Research and Synthesis

Community Engagement best practices identification, research and synthesis was an iterative building process. As best practices were identified, they were researched, refined and validated using extensive literature reviews and website reviews of eight major observing systems and two data aggregators. While other best practice white papers in this series examined nine major observing systems and nine data aggregators, these authors chose not to include observatories with a clear operational audience and no apparent community engagement. Once this was completed, the best practices and best practice self-assessment tools were validated through interviews with staff from two relatively mature observatories. Due to the sensitive nature of research findings, the organizations examined during research are not identified. Literature review references are included.

The authors focused on the following research objectives while conducting secondary research:

- Determine mechanisms and strategies used for community engagement
- Determine organizational structures enabling community engagement
- Determine current state of research in community engagement best practice

Best practice research information was synthesized from this research to identify and define best practices. As needed, secondary research was revisited to refine, test, and validate best practices. The goal of this research was to provide a high level overview of the current state of the industry in implementing these best practices, this research is not meant to be a detailed technical assessment.

As best practices were identified and defined, a best practice self-assessment tool was developed. The best practice self-assessment tool was inspired by the Capability Maturity Model (CMM) developed by the Software Engineering Institute (SEI) at Carnegie Mellon University in 1986 (Paulk et al., 1993). The self-assessment tool creates a ranking of best practices, providing questions and scoring methodology. The tool ranking levels were validated

through secondary and primary research. The scoring methodology provides flexibility for best practice variations across organizations. The self-assessment tool is intended to provide a structure for internal assessment and to identify aspirational improvements that can be implemented to increase maturity levels. It also provides context based on current industry wide best practice maturity levels.

The best practice tool enables an existing or new organization to assess its current community engagement capabilities and maturity level. This tool can also be used to identify steps to achieve the next aspirational level. The best practice self-assessment tool and usage instructions are included in the Appendix.

Figure 1 displays one potential combination of capabilities, which results in maturity levels for a hypothetical observatory. Each observatory will have different combinations of capabilities, which should be aligned with their individual goals, that aggregate to a certain maturity level. For example, one observatory may excel at building new users through trainings, whereas another may require and excel at building a strong network through collaborative meetings. A simplified capability scoring method is described in the Appendix.
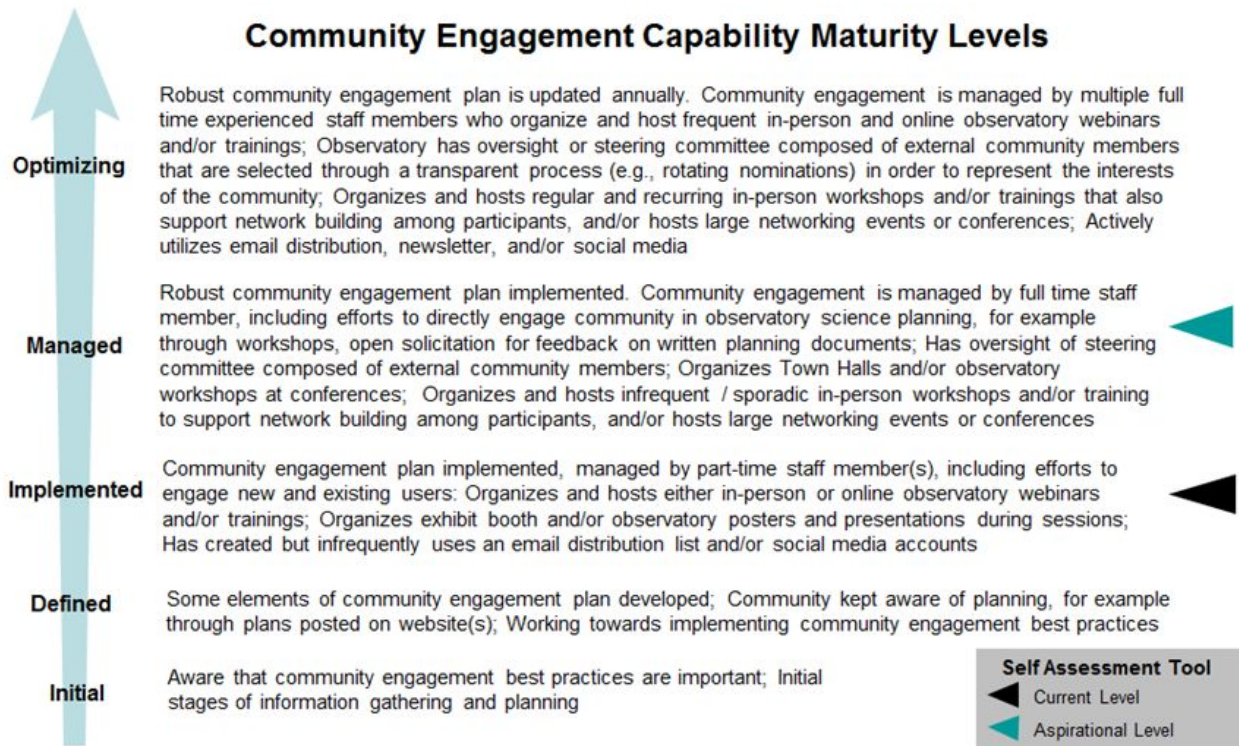
Community Engagement Capability Maturity Levels

Optimizing
Robust community engagement plan is updated annually. Community engagement is managed by multiple full time experienced staff members who organize and host frequent in-person and online observatory webinars and/or trainings; Observatory has oversight or steering committee composed of external community members that are selected through a transparent process (e.g., rotating nominations) in order to represent the interests of the community; Organizes and hosts regular and recurring in-person workshops and/or trainings that also support network building among participants, and/or hosts large networking events or conferences; Actively utilizes email distribution, newsletter, and/or social media

Managed
Robust community engagement plan implemented. Community engagement is managed by full time staff member, including efforts to directly engage community in observatory science planning, for example through workshops, open solicitation for feedback on written planning documents; Has oversight of steering committee composed of external community members; Organizes Town Halls and/or observatory workshops at conferences; Organizes and hosts infrequent / sporadic in-person workshops and/or training to support network building among participants, and/or hosts large networking events or conferences

Implemented
Community engagement plan implemented, managed by part-time staff member(s), including efforts to engage new and existing users: Organizes and hosts either in-person or online observatory webinars and/or trainings; Organizes exhibit booth and/or observatory posters and presentations during sessions; Has created but infrequently uses an email distribution list and/or social media accounts

Defined
Some elements of community engagement plan developed; Community kept aware of planning, for example through plans posted on website(s); Working towards implementing community engagement best practices

Initial
Aware that community engagement best practices are important; Initial stages of information gathering and planning

Self Assessment Tool
◄ Current Level
◄ Aspirational Level

Figure 1. Best Practice Self Assessment Tool Example

Results & Discussion

Community Engagement Best Practices

With so many resources available to scientists and so little time to devote to learning a new system, the model of "if you build it they will come" is not enough to draw in new users to observatories and facilities. Observatories need to make conscious efforts to build and maintain a community of users. As discussed earlier, the idea of community engagement focused within the scientific community is not a field of study with documentation, as such there is no manual for how to do this effectively. As ultimately the goal of community engagement is to "teach" scientists or upper level students (college/graduate) about the observatory or a specific tool/dataset provided by the observatory, the principles of adult learning can help provide insights into the most effective way to engage members of the community. In this way, understanding adult learning helps an observatory to understand its users.

Malcolm Knowles, seen by many as the father of adult learning, outlined four key assumptions about adult learners (Knowles 1970), paraphrased below:

1. **Adults have a deep psychological need to be self-directed.** Adults need to feel accepted, respected, supported, and heard in their learning environment in order to be open to learning. As such, they learn best in a collegial and informal atmosphere where they feel they are at the same level as the teacher or facilitator. For example, a podium on a stage can make adults feel talked down to and sitting in rows creates an atmosphere of passive learning associated with being a child. Small groups sitting around circular tables is more conducive to adults, particularly when the adults have a choice of which problems to work on or topics to address.

2. **Adults come into learning with a reservoir of experience.** Adults have accumulated a large background of experience that defines who they are as unique individuals. Bringing these experiences into their learning environment means that a) they have a wealth of knowledge and experience to contribute to the learning process and b) they have fixed habits and patterns of thought that can make them less open minded. Tapping into these experiences are key to adult learning, for example utilizing group discussions.

3. **Readiness to learn is motivated by the need to know something.** Given this principle, capturing a "teachable moment" with adult learners does not happen until they have discovered their need to know something. As such, materials need to be presented in such a way that the learner can connect how learning these materials will help them solve real-life tasks or problems.

4. **Adults are oriented toward learning via problem-solving issues immediate in their lives.** Whereas children often learn things with postponed application (e.g., to prepare for college or a future job) adults engage in learning with the perspective of immediate application. With this problem-centered frame of mind, it is important to organize teaching around immediate problems and concerns.

In short, the ideal learning environment for an adult is one in which they come to the table because they want to learn, they feel appreciated and heard by the instructor/facilitator, they can add to the learning of the group with their own experiences, and materials are presented in such a way to provide solutions to problems/issues with immediate application to their lives.

"Individuals are motivated to engage in learning to the extent that they feel a need to learn and perceive a personal goal that learning will help to achieve." (Knowles 1970)

These assumptions have led to the four key principles of adult learning[4]:

1. Adults need to be involved in the planning and evaluation of their instruction.
2. Experience (including mistakes) provides the basis for learning activities.
3. Adults are most interested in learning subjects that have immediate relevance to their job or personal life.
4. Adult learning is problem-centered rather than content-oriented.

Using these principles as a framework, observatories and other facilities can examine how they interact with members of their community in terms of teaching them about the observatory or how to use a certain tool or dataset. The basic guidelines gleaned from these principles in the context of an observatory's community engagement are that simply talking to people about the observatory will not make them want to learn more about it or be an active part of its user community. Instead, the observatory needs to understand its target audience, their needs, and specific motivations. The community needs to be engaged and allowed to share their knowledge and experience. Community input should be sought and then it should be shown how that input was applied to the observatory and that observatory can meet its community's expressed needs. Additionally, when trying to teach the community, for example, how to use a data portal, simple demonstrations are not sufficient, it is important for participants to see how using this tool can directly help their research, teaching, or other aspects of their work. The training needs to be tailored to specific needs or questions of the individuals present.

Seven best practices for Community Engagement were synthesized from the research and experiences of the authors. They were formed based on the principles of the creation of trust and a sense of community and the principles of adult education. Preferred engagement strategies described within each best practice are those that maximize learning potential.

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[4] https://www.instructionaldesign.org/theories/andragogy/

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BP 2: Employ at least one staff member with dedicated community engagement responsibilities

BP 3: Solicit feedback from the community during the observatory formation process

BP 4: Engage external community members in observatory governance using open and transparent mechanisms

BP 5: Utilize conferences to facilitate engagement opportunities

BP 6: Organize and staff in-person or online events to engage new users

BP 7: Organize and staff in-person or online events to engage existing users and foster a community of practice

BP 8: Utilize online social mechanisms to communicate to a broad user base and keep users informed of engagement opportunities

Each of these best practices are discussed in detail, accompanied by context and literature references. A best practice Self-Assessment Tool is presented in the Appendix.

Development of a Community Engagement Plan

BP 1: Create and maintain a Community Engagement plan

A community engagement plan should be developed and maintained in order to strategically focus community engagement efforts against a set of goals, for example, increasing the number of data users or expanding facility awareness in a particular user group. The community engagement plan describes the events and initiatives to be conducted by the organization, the target audience for each, and measurable metrics to determine the success of each part of the plan. A community engagement plan should also incorporate mechanisms to evaluate audience or participant feedback to facilitate continuous improvement to the engagement activities and, therefore, the participant experience. None of the observatories or data aggregators researched published a community engagement plan on their website. This is not an indication that they do not have or maintain one, but perhaps an indication that community engagement planning is viewed more as a "behind the scenes" administrative function than a public facing program aspect such as science planning. One observatory did publish an assessment report of community engagement activities.

Community Engagement Staffing Structure

The staffing structure for community engagement depends on an observatory's community engagement goals, as well as the financial resources available to undertake community engagement. The AAAS Center for Scientific Collaboration and Community Engagement is studying the field of scientific community engagement and seeks to support and institutionalize the role of community engagement in science. It refers to this role or staff position as the

"community engagement manager[5]"; however, the responsibilities can be embedded in any position or number of positions.

BP 2: Employ at least one staff member with dedicated community engagement responsibilities

An observatory can be effective in one or a few activities regardless of having assigned community engagement staff if they are focused and goal-oriented. Having a dedicated staff member, however, ensures the prioritization of community engagement tasks amidst the other work required by the observatory. According to an ongoing study by the AAAS[6], having a dedicated staff member does not seem to dictate whether an organization can engage in traditional types of engagement activities, such as conference calls, generating newsletters, and conferences. However, having staff resources dedicated to community engagement will result in more frequent, more diverse (especially in non-traditional, online mechanisms), and more strategically-planned activities. The community engagement manager should create, implement, and manage an annual community engagement plan that strategically connects program goals to a set of activities and provides metrics for success for each activity.

None of the observatories or data aggregators included in the websites reviewed used "community engagement manager" as a staff title, though one observatory listed clearly related titles including user engagement and user services. In the absence of clear titles, descriptions of job responsibilities were examined, where available, for key words and phrases such as training, synthesis, or network coordination to identify staff undertaking community engagement duties. Three of the eight observatories listed multiple community engagement staff members. One observatory listed one dedicated staff member with a clear community engagement role, and another listed three staff members with partial responsibilities related to community engagement. For the remaining three observatories and both of the data aggregators, there were no staff listed with titles or roles that were clearly related to community engagement. It should be noted that this is not necessarily evidence that these programs have no staff support in this area, simply that they did not describe these staff positions or responsibilities on their website.

It was evident from the research that observatories that had dedicated staff also held a number of workshops, supported working groups, and attended conferences. Two of them held regular, non-traditional activities such as webinars. One of the observatories that did not list community engagement staff did organize a regular "all program" workshop; however it is notable that these events are relatively infrequent (every three years). These findings seem to follow a consistent and predictable format in line with AAAS findings that dedicated staff have more flexibility for more diverse activities.

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[5] https://www.aaas.org/programs/center-scientific-collaboration-and-community-engagement
[6] https://blog.cscce.aaas.org/how-scientific-community-managers-shape-activity-planning/

Engaging the Community in Planning the Observatory

Engaging potential users and participants, especially early in the development of a scientific program, is important for building awareness of the observatory as a scientific opportunity, generating trust in shared goals and processes, and for ensuring the long-term relevance of a program or major infrastructure (Penman et al. 2011). Reaching out to the community from the beginning allows the community to feel their voices are heard and become invested in an observatory they helped design. Early engagement also helps to lay the foundation for the overall perception of the community in terms of their ownership and sense of belonging within the program. The goal is to make a good first impression through community engagement, in lieu of later combating a perception of isolation from, or disinterest in, the community. Additionally, depending on what activities are conducted to engage the community at this stage, researchers may find others at these planning events with similar interests and form new collaborations around their shared interest in the program.

BP 3: Solicit feedback from the community during the observatory formation process

There are several ways in which the community can be engaged in the initial planning. First, a core group of individuals planning the observatory can write an initial draft (e.g., science plan) of the proposed observatory or project. This is in some cases referred to as a consultative draft. This document would contain the core, foundational structure of the observatory - e.g., mission/vision, goals, science objectives, societal relevance, strategic road map, concepts for development and implementation. That draft is then posted online and widely distributed through the community for comment. After a set time period, comments are adjudicated and the document is finalized as the observatory's foundational document. Assuming strong communication around the comment opportunity, this scenario allows for the greatest reach into the community and the greatest chance for involvement. A downside with this approach, however, is that the community can only comment on what has already been written; they did not have the opportunity to be a part of the creation of the core mission or scientific scope of the program. Additionally, it is important that after soliciting feedback from the community that the observatory provides a response to that feedback in someway so community members who took the time to contribute feel that their suggestions were heard. This can range from a web post thanking contributors and broadly describing how comments were incorporated, to providing individual responses to community submissions.

Alternatively, the core group planning the observatory can host a series of in-person working groups and workshops with the goal of defining the core foundational structure, scope, and/or requirements of the observatory. The series of workshops could include an overarching workshop to define the core mission and objectives and then a series of workshops focusing on specific disciplines or geographic/ecological regions covered by the observatory. The advantage

of this approach is that community members are involved from the beginning and can help to shape the full vision of the observatory. Individual voices and ideas may be better amplified through open discussion. The downside of this approach, though, is that it limits the breadth of the community that can be involved. Workshops can only have a limited number of attendees and lesser known scientists, for example from smaller more teaching focused institutions, early career scientists, or postdoctoral scholars may not receive invitations to these events though they may be very interested in contributing.

Lastly, members of the community could submit proposals to develop and assist in the operation of portions of the observatory. Using this model, the community as a whole would have the opportunity to submit proposals, but only a few ideas would ultimately be selected. As such, only a limited number of community ideas feed into the overall observatory development as opposed to the other broader, more democratic mechanisms for incorporating ideas.

In reviewing the eight observatories and two data aggregators, inferences were made based on the history and planning documentation available on most of these websites about the engagement of the community in the planning process. Past calls for feedback on a written plan were generally unavailable, but many documented processes that involved workshops, meetings, and working groups were noted on the website. Only two - one observatory and one data aggregator - did not describe or provide enough information to infer community engagement in their planning processes. Two of the studied observatories are proposal driven in terms of the specific scope of science to be incorporated; one of those had democratic community-based mechanism for high level structure and plans for the observatory while the other took a top-down approach for that phase of planning. Three other observatories and one data aggregator were defined through a series of workshops or working groups. One data aggregator indicated that it provides opportunity for community members to provide input on its regular operational renewal proposals, and one observatory was developed without any level of community input but is notably a much smaller-scale initiative than others studied.

Engaging the Community in Observatory Operation

Similar to the need to make sure the community is heard in the planning of the observatory, the community should continue to have a voice throughout the development and operation of the observatory. Depending on what happens during installation and development - timeline delays, descoping of infrastructure, changing science priorities - the community can feel uninformed or left out of decision making that may lead to (perceived or real) deviations from the community's agreed upon path. Having broad scale community feedback on daily operations, however, is not feasible.

Most large scientific programs and observatories establish a governance, oversight, or steering committee (nomenclature varies) to maintain a connection to the scientific community. That steering committee, in parallel with or supported by observatory community engagement staff,

could serve as a way to continue to involve and inform the community. Steering committees can be generalized into two main forms: those created by taking a top level person from each component of the observatory (i.e., an internal committee) or those elected or appointed from the broader community in order to represent those voices and needs.

BP 4: Engage external community members in observatory governance using open and transparent mechanisms

Having representatives from the broader community elected to a steering or oversight committee can provide that larger community perspective and help to keep community members feeling involved in the process, continuing their sense of ownership. These representatives are ideally selected via clear and transparent process, for example, through an open call for nominations or an open community election to ensure they represent the interests of the community.

The committee can utilize additional community engagement strategies to further maintain community involvement in the operation of the observatory. At a minimum this involves keeping the community updated and informed of changes. It may also include solicitation of community input in instances where challenges arise during construction, implementation, or initial operations, for example, that may require descoping of the science capabilities. Communication, dialogue, and community feedback can be achieved through town halls, workshops, or subject matter expert evaluations.

Three of the observatories and one data aggregator studied utilize steering or oversight committees comprised of community members. Two of these have an open selection process consisting of applications or elections, one has members appointed by the funding agency and U.S. state governments, and one's process is not clear from the research. Five observatories studied utilize internal committees comprised of operators or principal investigators. Of those, two also utilize advisory committees comprised of community members which can serve as that connection to the community.

Building a User Community

BP 5: Utilize conferences to facilitate engagement opportunities

There are several mechanisms through which an observatory can engage new users. At a minimal level this would involve attending a conference and either having presentations and posters or a booth in the exhibit hall. These, however, are passive tools and rely on potential new users seeking out one presentation amongst the hundreds or thousands at the conference or stumbling upon the observatory at an exhibit hall. More active mechanisms, like hosting a town hall or a workshop during a conference would play more to the strengths of the adult learners in attendance (Knowles 1970) as users would be able to conduct self-directed, problem-oriented tasks.

Conferences in general are great tools for an observatory to meet new scientists and engage new community members as a wide range of people attend conferences. Additionally, conferences are cost effective as scientists will have all traveled there using their own means.

BP 6: Organize and staff in-person or online events to engage new users

All of the observatories and data aggregators studied attend conferences for the purposes of community engagement and communication. Additionally, all of them use conferences to present papers or posters, though in some cases these presentations may be submitted by the individual research participants rather than the observatory staff. Four of the observatories took advantage of conference opportunities to organize more interactive events such as town halls, workshops, and network meetings.

Outside of conferences, observatories can host in-person workshops or trainings. These provide the same ideal learning environment for adult learners, but provide the potential for more focused attendance and a multi-day event. Often workshops at conferences are limited to only a half day. Unlike with conferences, however, observatories may be responsible for the costs of participant travel which can limit their ability to conduct these events. In-person training can be particularly useful as they focus on problem-oriented tasks where the learners can address an immediate need in their research (Knowles 1970). Trainings also provide the opportunity to not just discuss skills and knowledge, but to have the participants perform the skills being described in the class (Russell 2006).

Another cost effective way to engage the broader community is through offering online webinars or training sessions. This can be enticing to scientists as they are typically relatively short time commitments, do not require travel time or funds, and are often archived online so a scientist can watch it at a later time as well. Online software used for these webinars and trainings can often accommodate more live viewers than in-person workshops (i.e., for both cost and space reasons) and have the ability for participants to ask questions either verbally or through an online chat feature. However, they are not conducive to participants practicing skills and exercises during the webinar period. The AAAS study[7] noted that organizations with dedicated community managers were most likely to organize online events.

Given the different costs and benefits of in-person and online events, as well as the different levels of accessibility and participant involvement that each allows, an ideal tactic would be to provide a mix of both events throughout the year.

Three of the observatories and one of the data aggregators hosted in-person workshops to engage and/or train new users. The data aggregator additionally held webinars for this purpose. Two additional observatories held in-person workshops; however, it is not clear whether these

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[7] https://blog.cscce.aaas.org/how-scientific-community-managers-shape-activity-planning/

have a goal of building the user community (i.e., engaging new users). Two observatories have training workshops and webinars for researchers who are newly engaged in the program, but are not aimed at that initial engagement. Interestingly, both of these observatories are built through dedicated calls for proposals, which likely decreases their need for grassroots engagement through workshops. One observatory and one data aggregator studied had no clear indication of workshops or trainings for new users.

Connecting Current Users

BP 7: Organize and staff in-person or online events to engage existing users and foster a community of practice

An observatory should employ strategies to connect existing users in a collaborative setting. Bringing users together in small, targeted workshops or in large "all program" type of events has positive impact on science by building relationships and trust among researchers and improving collaboration and the development of new project/proposal ideas, as well as on the program or observatory by building a sense of community that keep users engaged (Penman et al. 2011; Alexander et al. 2011). These convenings should consider the participants needs and goals, as well as the program's, and even allow for participant-driven content and agendas[8]. This facilitates the integration of user experiences to defining the problem, expanding the body of knowledge, or developing the most useful tools and applications, all key components of adult education (Knowles 1970).

BP 8: Utilize online social mechanisms to communicate to a broad user base and keep users informed of engagement opportunities

These gatherings, however, can be costly to the observatory and may not be feasible for all programs. Virtual mechanisms such as telephone and online meeting services can effectively support targeted convenings aimed at fostering collaboration among researchers, such as across funded projects or cross-cutting scientific topics. Online workshops have been shown to enable broader participation--importantly, from developing countries and early career researchers--in interdisciplinary, collaborative research (Arslan et al. 2011).

Similar to connecting new users, to engage a broad array of current users, it is recommended to utilize a suite of both in-person and online events.

Collaborative research-focused workshops are a common community engagement strategy utilized by the programs included in the secondary research. Only one of the programs studied (a data aggregator) does not appear to utilize meetings or workshops to engage with or connect existing users. Eight of the observatories and one of the data aggregators regularly hold some type of targeted science or synthesis workshop among users. Of those, two observatories also

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[8] https://www.instructionaldesign.org/theories/andragogy/

organize "all program" meetings or conferences at regular and predictable intervals. Notably, these observatories also stand out in that they are currently building networks through directly-related research funding and calls for proposals. These programs also appear to place more emphasis on scientific synthesis, which strategically supports the need for these much larger and inclusive community-building meetings (Alexander et al. 2011). A third observatory, which also has directly-related calls for proposals, has established numerous technical working groups and appears to be planning an initial program-wide meeting to collaboratively connect users.

Using Online Tools to Connect Users

Most researchers use some form of social media or online collaboration platform[9]. Frequent communication to users through social media, as well as other electronic means such as direct email or newsletters, can work to keep users informed of opportunities, new data or findings, changes, and other important information that may impact their research. There appears to be a positive relationship between research citations and the use of social media to communicate research[10], which also supports a benefit for observatories and research programs that actively use social media and online tools to increase use and citation of their data and research results. As social media and the online environment have a rapid pace of change, a social media strategy needs to be nimble to adjust to the platform used by the target community at a given time.

All of the observatories and data aggregators studied utilize social media; however, in one case, the social media accounts were not dedicated to the observatory but to the umbrella organization under which it resides. Six of the observatories and one data aggregator also utilize newsletters or direct email subscriptions to connect with their user communities. One additional observatory had a newsletter archive but no indication that it is currently, actively utilized as a communication mechanism. And another observatory employed a distribution list that allowed users to directly post information rather than receive from the observatory.

Measuring Success

Metrics for community engagement activities include measurement of "reach". Example metrics include:

- The number of workshops, trainings, conferences attended, and other events.
- The number--and growth in number--of participants (new and repeat) in community engagement activities, including geographic location of participants/users as it relates to a program's target audience and diversity

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[9]http://blogs.nature.com/ofschemesandmemes/2017/06/15/how-do-researchers-use-social-media-and-scholarly-collaboration-networks-scns

[10] https://phys.org/news/2018-04-social-media-scientists-message.html

- Numbers of comments on draft documents posted for community feedback. Where possible, some data (state, country, etc.) around individuals responding.
- Number of website hits, unique visits, and downloads
  - Number of new and repeat users (User adoption metrics)
  - User visit frequency and website pages visited (path taken, links clicked, etc...).
- Size of newsletter distribution list
- Number of social media followers as well as active engagers on posts
- Degree of social influence based on social media signals using Klout score (Budden and Michener 2018).
- Number of engaged users on online forums
- Impressions in the press and popular media.

While these metrics can provide a picture of how much awareness has resulted from community engagement activities, they do not necessarily indicate an outcome of meaningful engagement with the observatory in terms of usage of its data or resources. Quantifying actual use and uptake of the data and findings comes through traditional tracking of the number of scientific publications acknowledging the data and their associated citation factors, such as the *h* index (Hirsh 2005). These metrics signify when an observatory or findings based on observatory data were used to help further scientific discovery.

Other metrics of success, that are harder to quantify include participation by community members in cruises and other observatory maintenance activities and proposal submissions to utilize observatory resources or data.

Conclusion/Recommendations

In the absence of a body of literature around when and how to undertake scientific community engagement, organizations strategize their own approaches. Many scientific programs and observatories take advantage of similar opportunities and activity types, which, when considered with direct experience and the practices of adult learning lead the authors to the best practices and recommendations identified in this paper. In general, a program's scientific and user-oriented goals seem to drive strategies for community engagement. For example, programs that have a clear focus on synthesis across individual research projects or themes approach community engagement in a very inclusive way that creates a sense of belonging across the user community. As a result of our research and analysis, we propose the following recommendations for what guidance in community engagement should entail.

Recommendation #1: Create an annual community engagement plan that strategically connects program goals to a set of activities and provides metrics for success for each activity. (Best Practice 1)

Recommendation #2: Observatories should employ at least one staff member with dedicated community engagement responsibilities. Having a dedicated staff member demonstrates a commitment to community engagement and ensures duties related to this are not overtaken by other roles and responsibilities in unrelated task areas. A dedicated community engagement manager is shown to facilitate more strategic and innovative thinking around community engagement, leading to more regular and diverse activities and points of connection with the community being served. The community engagement manager should create, implement, and manage the annual community engagement plan. (Best Practice 2)

Recommendation #3: In engaging the community in the planning of an observatory, a hybrid of scenarios is recommended to ensure both wide reach and a deep sense of investment from the community in an observatory that it believes addresses its research interests and needs for data. For example, an ideal approach may be to host a series of in-person working groups and workshops in order to generate the initial framing of the observatory with strong community input. The draft document resulting from these workshops and consultations can then be distributed to the community for feedback and further input. This approach does not limit an observatory from applying a project-oriented (i.e., proposal based) model to developing its network as the process of soliciting proposals may still be tied to an overarching science plan or set of basic requirements that has been developed and/or refined with community input. (Best Practice 3)

Recommendation #4: Design observatory governance to include external community members to ensure connections are maintained to the user community at all stages of development and operation. External community members provide a less conflicted or biased perspective on the direction of the observatory that may be more representative of the larger community's interests. These community members should be selected via clear and transparent processes, for example, through an open call for nominations and a selection criteria that balances gender, race, geography, discipline and career level to ensure a diversity of perspectives. (Best Practice 4)

Recommendation #5: Utilize a diversity of approaches to both build and sustain a user community. A multi-faceted approach provides the broadest reach and return on investment in community engagement. For example, use of social media, newsletters, and conferences are low cost ways to generate initial awareness and interest in an observatory on which to build deeper connections and dialogues to the user community through workshops and trainings. Workshops and trainings can be done in-person to build peer-networks and collaborations and to practice skill building. These events align most closely with the principles of adult learning. Online workshops and trainings can broaden the reach and may be more effective for small group projects and discussions or for large demonstrations and questions and feedback sessions. (Best Practice 5,6,7,8)

Recommendation #6: Consider "all program" convenings when the program or observatory has a goal of scientific synthesis. Workshops and meetings are a widely used strategy for engaging and connecting existing users with the goal of improving and increasing scientific collaboration. The type of workshop should support the program's goals for community engagement. Programs and observatories that aim to integrate data and synthesize results across users benefit most from larger "all program" type of events, which build a sense of community among disparate researchers and research projects, facilitating knowledge sharing and building new collaborations. (Best Practice 7)

Recommendation #7: Utilize engagement strategies where users can be self-directed and learn skills focused on problem solving for their direct and immediate research needs (Knowles 1970). Effective and successful engagement must benefit both the observatory or program and its end users and researchers. Design engagement opportunities where the program also learns-from and adapts-to the needs of its users and where users learn from one another. (Best Practice 6, 7)

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Appendix

Best Practice Self-Assessment Tool

The best practice self-assessment tool enables an existing or new organization to assess their current community engagement capabilities and maturity level. This tool can also be used to identify steps to achieve the next aspirational level. This white paper is intended to provide a Self Assessment Tool for an organization to identify and plan for improvements in people, process, and technology that support community engagement.

For the purposes of this self-assessment tool, community engagement refers to engagement of research scientists, it does <u>not</u> refer to engagement of the general public or for educational purposes

Steps for Using the Self-Assessment Tool

1. Review Best Best Practices List
2. Review Figure 1: Example of a completed best practice self-assessment
3. Determine Self Assessment Capability Scoring
4. Determine Maturity Levels

1. Best Practices List

CE BP 1: Create and maintain a Community Engagement plan
CE BP 2: Employ at least one staff member with dedicated community engagement responsibilities
CE BP 3: Solicit feedback from the community during the observatory formation process
CE BP 4: Engage external community members in observatory governance using open and transparent mechanisms
CE BP 5: Utilize conferences to facilitate engagement opportunities
CE BP 6: Organize and staff in-person or online events to engage new users
CE BP 7: Organize and staff in-person or online events to engage existing users and foster a community of practice
CE BP 8: Utilize online social mechanisms to communicate to a broad user base and keep users informed of engagement opportunities

2. Example Of Completed Best Practice Self-Assessment

The example below displays one potential combination of capabilities, which results in maturity levels for a hypothetical observatory. Each observatory will have different combinations of capabilities, which aggregate to a certain maturity levels. For example, one observatory may

excel at tracking and reporting data citations, whereas another may excel at providing data citation guidance. A simplified capability scoring method is described in the next step.
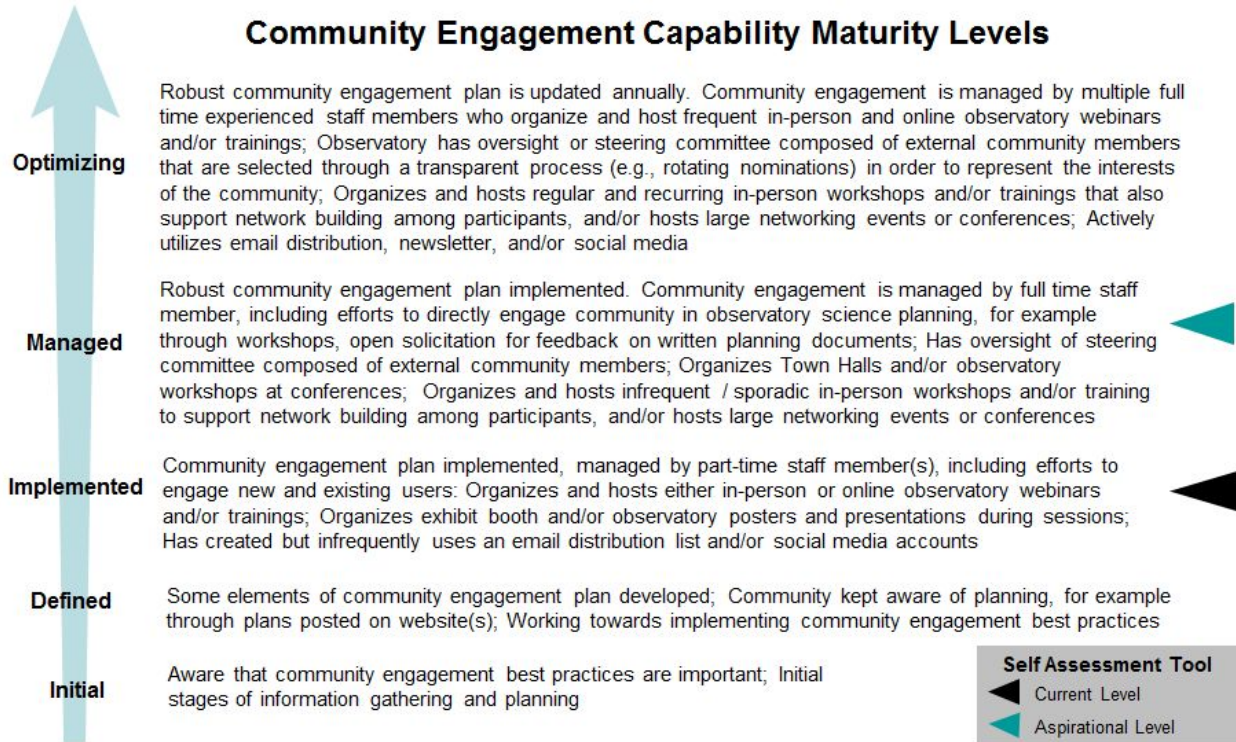

Figure 1: Best Practice Self Assessment Tool Example

3. Self Assessment Capability Scoring

For each best practice, determine the capability score for your observatory. Only select one capability score per best practice. It is assumed each capability score is inclusive of prior score.

CE BP 1: Create and maintain a Community Engagement plan
- Some elements of community engagement plan developed – 1 point
- Robust community engagement plan that includes performance metrics is developed and maintained – 2 points

CE BP 2: Employ at least one dedicated staff member for community engagement
- A staff member(s) has funded, part-time responsibilities related to community engagement – 1 point
- One staff member has funded, full-time responsibilities related to community engagement – 2 points
- Multiple, full-time staff members have funded responsibilities related to community engagement – 3 points

CE BP 3: Solicit feedback from the community during observatory formation process
- Feedback from the community is sought through passive means, such as posting a draft science plan on the website for review – 1 point
- The community is directly engaged in observatory science planning, for example through workshops, and continued opportunities to provide feedback. – 2 points

CE BP 4: Engage external community members in observatory governance using open and transparent mechanisms
- Oversight or steering committee composed of external community members or project leaders appointed internally. – 1 point
- Oversight or steering committee composed of external community members that are selected through a transparent process (e.g., rotating nominations) in order to represent the interests of the community. – 2 points

CE BP 5: Utilize conferences to facilitate engagement opportunities
- Organizes conference exhibit booth and/or observatory posters and presentations – 1 point
- Organizes Town Halls and/or observatory workshops – 2 points

CE BP 6: Organize and staff in-person or online events to engage new users
- Organizes and hosts either in-person or online observatory webinars and/or trainings – 1 point
- Organizes and hosts frequent in-person and online observatory webinars and/or trainings – 2 points

CE BP 7: Organize and staff in-person or online events to engage existing users and foster a community of practice
- Organizes and hosts infrequent or sporadic in-person workshops and/or trainings that also support network building among participants, and/or hosts large networking events or conferences - 1 point
- Organizes and hosts regular and recurring in-person workshops and/or trainings that also support network building among participants, and/or hosts large networking events or conferences – 2 points

CE BP 8: Utilize online social mechanisms to communicate to a broad user base and keep users informed of engagement opportunities
- Has created, but infrequently uses, an email distribution list and/or social media accounts – 1 point
- Actively utilizes email distribution, newsletter, and/or social media – 2 points

4. Determine Maturity Levels

Add up your capability score points to determine your current maturity level:

Initial Level	0 points
Defined Level	1-3 points
Implemented Level	4-6 points
Managed Level	7-9 points *
Optimizing Level	10+ points **

Identify your aspirational maturity level by selecting a desired best practice capability score. Add up your desired capability score points to determine your aspirational maturity level.

Notes:

*Score must include at least one staff person with part-time dedicated responsibilities for community engagement

**Score must include at least one staff person with full-time dedicated responsibilities for community engagement

The staffing requirements included in Levels 3 and 4 reflect the finding that dedicated staff are necessary for a well-developed community engagement strategy and consistent activity. Therefore, capabilities and maturity must take into account organizational staffing.