



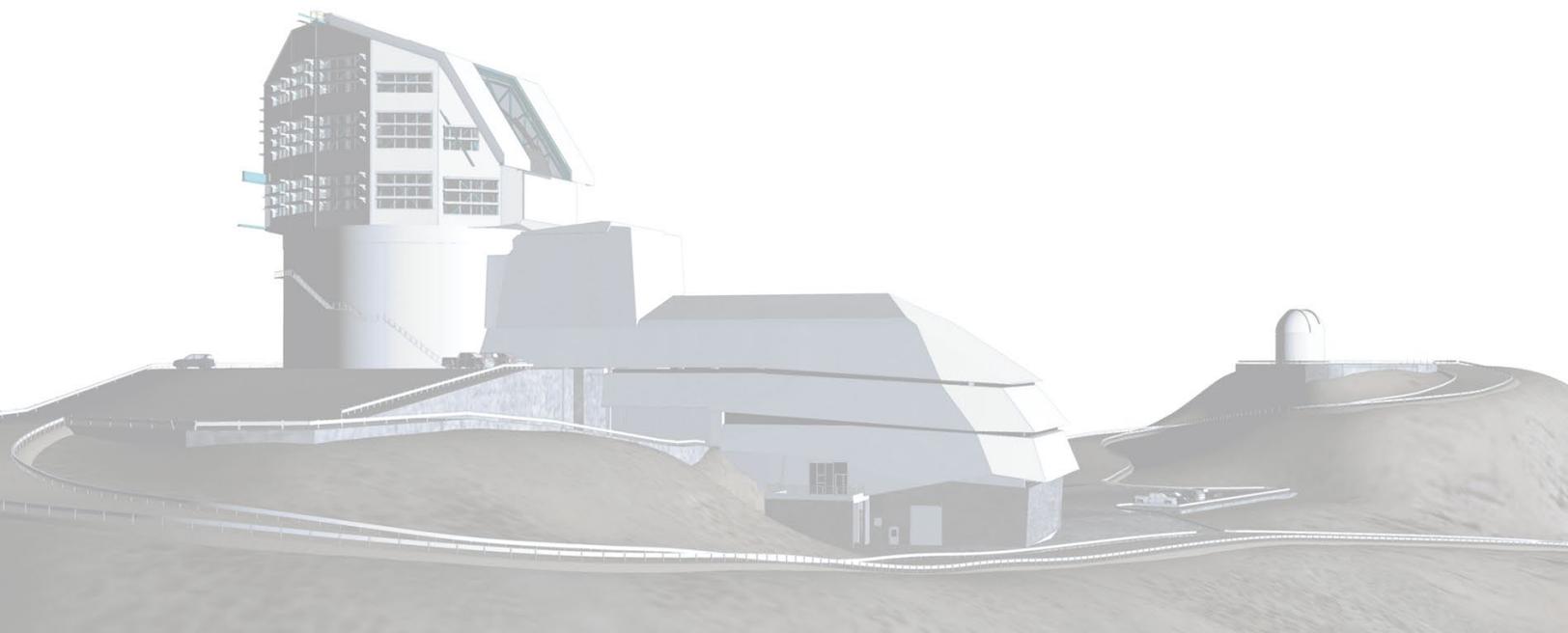
## EPO Design

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# EPO Design

## Executive Summary

The mission of the Rubin Observatory Education and Public Outreach (EPO) program is to offer accessible and engaging online experiences that provide non-specialists access to, and context for, LSST data so anyone can explore the Universe and be part of the discovery process.

Rubin Obs EPO will serve four main categories of users:

1. **general public** (with an emphasis on science-interested teens and adults),
2. **content developers at informal science centers,**
3. **principal investigators with Rubin Obs data rights leading citizen science projects,** and
4. **formal educators** teaching astronomy content at the advanced middle school, high school, and undergraduate college levels,

We will capitalize on positive trends in digital literacy, the increasing use of mobile devices, and a discovery space shaped by social media by building data-driven activities for non-specialists using modern web technologies that are accessible, interesting, engaging, and effective at scale. We will employ a robust communications strategy to engage with the public and help people find our activities, and be purposeful about building and testing educational and outreach activities that consider the input, needs, and desires of minoritized populations.

EPO will create a website to highlight and contextualize the scientific power of the Rubin Observatory and the Legacy Survey of Space and Time (LSST) for non-specialists and host all online resources. Where possible, EPO products will be available in both English and

Spanish.

The website will feature:

- news about exciting astronomical advances from Rubin Obs,
- stories of people involved with Rubin,
- updates from the survey’s “Alert Stream”,
- options to interact with LSST images and science (Skyviewer and widgets),
- a suite of online investigations for classroom use, including instructional support materials,
- opportunities to participate in citizen science projects that use LSST data,
- videos about Rubin Obs, and
- free multimedia resources about Rubin Obs and its science for planetariums and science centers.

Core features of the website will be unique widgets that allow users to interact with LSST imagery and science discoveries in intuitive, interesting ways. These widgets will be used independently throughout the website, and as interactive features within educational investigations.

The data-driven, interactive classroom investigations will be developed for students in advanced middle school through college. They will feature LSST data as it becomes available and will cover commonly taught principles in astronomy and physics, as well as highlight Rubin Observatory’s strengths. Investigations will be aligned with the Next-Generation Science Standards (NGSS)<sup>1</sup> in the USA and the Curriculum Nacional in Chile, and will follow best practices for college level students. Rubin Obs EPO will also provide instructional materials and professional development training opportunities for educators

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<sup>1</sup> <https://www.nextgenscience.org/>

to successfully engage their students with the investigations.

The website will provide opportunities for visitors to contribute directly to science research via citizen science projects. EPO will work with Zooniverse<sup>2</sup> to add LSST data compatibility to their Project Builder tool, allowing Rubin Obs Users to easily create citizen science projects that help them accomplish their research goals and engage with a global community. Rubin Obs EPO will provide support to researchers creating citizen science projects using LSST data.

Underlying all EPO programming is critical infrastructure that responds quickly to varying levels of demand. A foundational component of Rubin Obs EPO is the cloud-based EPO Data Center (EDC), which allows for scalable, on-demand computing best suited to EPO audiences.

A priority during construction is building prototypes and performing user testing, which continually improves the user experience, usability of interfaces, and lowers the risk of not achieving our main goals.

Finally, Rubin Obs will engage the science community in developing and distributing its products, fulfilling the NSF's Broader Impact requirements, and strengthening the link between LSST scientists and EPO audiences.

This document provides an overview of the EPO program for Rubin Obs. It defines specific EPO program elements that shape the cost, schedule, and scope detailed in the Rubin Obs Project Management Control System (PMCS) - WBS 5.0 for the construction of the Rubin Obs EPO program, to be delivered at the close out of the Construction project.

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<sup>2</sup> <https://www.zooniverse.org/>

## Reference Documents

At the highest level, the need for an EPO program is established in the Rubin Obs System Requirements Document (LSE-29) and flows down to the Rubin Obs Observatory System Specifications (LSE-30). From there, full implementation requirements are detailed in EPO Subsystem Requirements (LSE-89) and DM/EPO Interface (LSE-131). Details related to EPO Commissioning are included in the Rubin Obs Commissioning Plan (LSE-79) and details for EPO Operations are included in the Rubin Obs Operations Plan (LPM-181).

This technical system-level documentation is under Change Control within the Rubin Obs Project and the work within is subject to Compliance and Verification Procedures (LSE-160) as defined by the Rubin Obs Systems Engineering Team.

### Rubin Obs Documents

- Rubin Obs System Requirements (LSE-29)
- Observatory System Specifications (LSE-30)
- EPO Subsystem Requirements (LSE-89)
- DM/EPO ICD (LSE-131)
- Rubin Obs Commissioning Plan (LSE-79)
- Rubin Obs Operations Plan (LPM-181)
- Glossary of Abbreviations (link)

### External Documents

- Ivezic et al. (2008) “Rubin Obs: From Science Drivers to Reference Design and Anticipated Data Products” eprint arXiv: 0805.2366  
<http://arxiv.org/pdf/0805.2366.pdf>

# EPO Design

## 1 Goals

These goals describe the desired results of the Rubin Obs EPO program, drive the overall scope, and support achieving our Requirements:

- Bring awareness of Rubin Obs to our audiences
- Develop innovative ways to present the large LSST database and dynamic universe (alert stream) to the public
- Support and promote citizen science projects that use LSST data
- Provide web-based educational investigations that bring real LSST data into classrooms
- Develop multimedia resources for content developers at informal science centers
- Involve the Chilean community in Rubin Obs science and discovery
- Proactively engage with audiences historically minoritized by science
- Provide evidence-based evaluation of the Rubin Obs EPO program and publicly report findings

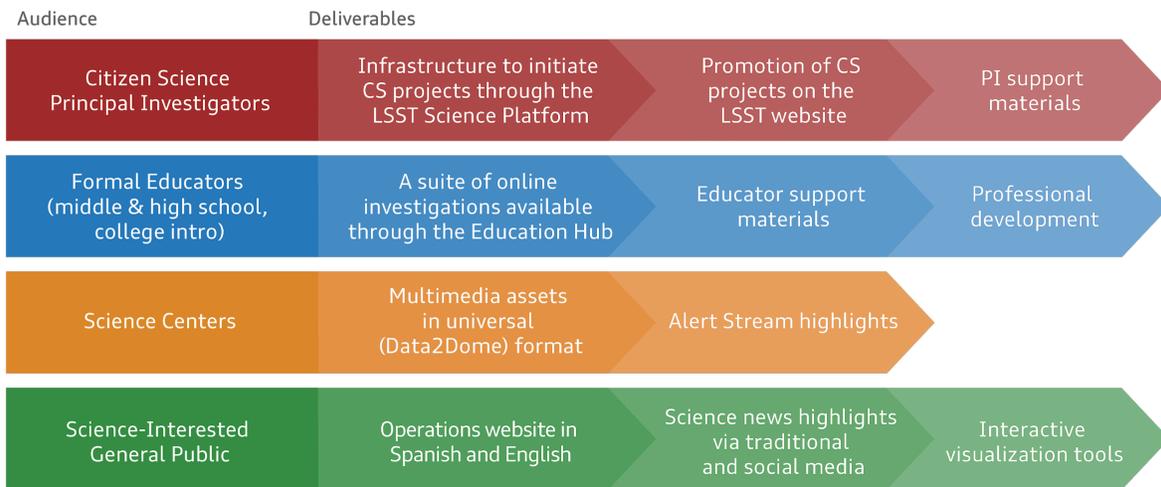
### 1.1 EPO Program

User needs assessments that occurred during an early phase of EPO Construction revealed the necessity for mobile-friendly interfaces, a clear path toward learning objectives through narratives, and educators needing no new software to download in order to introduce classroom activities. This has shaped the vision for Rubin Obs EPO.

In developing accessible online resources for the general public to engage with LSST data and discoveries, EPO will capitalize on upward trends in digital literacy, use of mobile devices, and use of social media to share discoveries. This section starts by identifying

audiences and estimating reach, highlighting features of the website, and then details some of the major EPO program components: multimedia gallery, formal education, and citizen science (see Figure 1).

## LSST Education and Public Outreach Deliverables



### 1.1.1 Audiences

Four primary audiences for Rubin Obs EPO are listed below with estimates of the number of users in each group and the relevant deliverables. We have analyzed user behavior by audience group and learned from related projects to determine the anticipated number of users for Rubin Obs. Note that EPO will reach some participants directly and others indirectly, for example, "content creators" at informal science centers; products they create will then indirectly reach very large audiences.

1. General Public (with an emphasis on science-interested teens and adults)

Users will engage with the project through social media outlets and the EPO website. We estimate 1 million visitors to the website and 5 million reached through social media over the course of Operations. User needs research shows that this is

the primary way the general public who self-identify as “science-interested” interact with astronomy and expect to interact with our materials in the future.

2. Formal educators teaching astronomy content at the advanced middle school, high school, and undergraduate college levels

We estimate 1000 users a day will log into the educational resource part of the website to use online investigations in their classrooms in the US and Chile.

3. Principal Investigators with LSST data rights leading citizen science projects

We estimate that 100-200 Citizen Science projects using LSST data will be launched by researchers over the 10 years of Operations. We estimate up to 10,000 Rubin Obs Citizen Science users based on the history of Zooniverse users.

4. Content developers at informal science centers.

In addition to content developers at planetariums and science centers who receive very large numbers of in-person visitors to their locations, major hardware and software vendors are an audience for our multimedia products. We anticipate 12 vendors receiving annual updates of Rubin Obs content and 100 content providers using multimedia products to integrate into their live, ongoing, or new programs.

### 1.1.2 Website

The EPO website is the heart of the EPO program—it is the place where our other channels will direct people to experience and enjoy Rubin Observatory science. A significant portion of EPO resources will be dedicated to creating and updating fresh, engaging content and interactive opportunities. We anticipate that the science-interested general public will make up the bulk of our website traffic, but educators, science center content creators, and citizen science principal investigators will all find the resources they are looking for on the EPO website. The entire site will be mobile-friendly, reflecting the technology most members of the general public use to access the internet.

The website will highlight:

- News about astronomical advances from Rubin Obs,
- Stories and profiles of people involved with Rubin Obs,
- Updates from the telescope's Alert Stream,
- Updates of what's happening at the telescope site,
- Free multimedia resources, including both planetarium assets and introductory science videos in standard format (see Section 2.3)
- Opportunities to participate in citizen science projects using LSST data (see Section 2.4)
- Classroom Investigations and supplemental educational resources (see Section 2.5)

In addition to this expected content, we will construct novel tools to enable a general user to interact directly with LSST data. No other project has designed such tools explicitly for this audience; rather they have shared tools designed for professional researchers with the public. This allows us to uniquely provide an interactive and engaging experience where a non-specialist can explore astronomy data and be involved in the process of discovery. The results of these discoveries will be shareable on social media.

Interactive tools include:

- **Web-Based Widgets:** Current tools that encourage a general user to interact with data typically require detailed knowledge of the data set, SQL queries to gather data, or programming skills to modify plots. In contrast, our tools are web-based and designed around functionality familiar to the typical web user. A visitor will be able to investigate relationships between images and data points, create their own color images, and visualize 3D structures in the universe among other functionalities. The goal is to embed these widgets in the content described above to transform a passive experience, like reading an article, to an interactive one where the user can explore LSST data themselves.
- **Skyviewer:** The Skyviewer presents wide-field astronomical images, object

information, and time domain highlights as it guides users through to other website features. It will be explicitly designed to be intuitive to an average member of the public, both in terms of functionality (clicking, scrolling, etc.) and content (featuring lists of objects, new articles, alert stream highlights etc. that they would find interesting). Users will be provided with a series of well-defined objectives and uses for the Skyviewer while also being offered the ability to explore the sky as they please. Crucially, the user interface will be simple and streamlined to be as accessible as possible for all audiences. The goal is that this self-guided experience will encourage any site visitor to explore the content of the website more fully.

The rest of this section is dedicated to describing EPO Program components intended for specific audiences that will be hosted on the general website: multimedia, citizen science projects using LSST data, and formal education resources.

### 1.1.3 Multimedia

Rubin Obs EPO is developing a library of digital multimedia assets (See Table 1) during Construction to be used in Operations on the website as well as at science centers, planetariums, and media outlets. Assets include:

- Visualizations of astronomical phenomena related to Rubin Obs science
- Images and videos of progress on the construction of telescope components, including the camera assembly, the mount structure, the dome and telescope facility on Cerro Pachón
- Video interview footage of the broad range of people involved in the Project, from those who brainstormed its early design to the scientists, engineers, and other experts making Rubin Obs a reality
- A virtual tour of the telescope facility
- Introductory videos on main Rubin Obs science and technology topics
- Promotional videos

EPO will contract with external multimedia specialists, video production firms, and visual effects consultants to develop multimedia assets over time. We will not be developing a full-length planetarium show, and will instead deliver short video clips ranging from 30-90 seconds in addition to some short introductory films on the Project up to a few minutes in length.

Rubin Obs EPO will provide multimedia in accepted standards for formatting. Planetarium fulldome video footage will include Domemaster frames to maximize compatibility with various dome styles, projection systems, and software products. Image assets and flat-projection video footage (such as panoramas, sunset/sunrise, day/night time lapse, and aerial drone) will support the Astronomy Visualization Metadata (AVM)<sup>3</sup> standard for images to facilitate easy searching, cataloging, and distribution via Rubin Obs's digital asset management system and the International Planetarium Society's Data2Dome<sup>4</sup> standard.

Throughout Construction, EPO is collecting video footage of various hardware delivery milestones and interviews of members of staff and the science collaborations. Some footage is collected by our team during the annual Project and Community Workshops at voluntary "StoryTime Domain" sessions. In 2018, we conducted 20-minute video interviews of 21 people involved in the Project. Most were in English and 6 were recorded in Spanish. These sessions will continue each year, as appropriate.

EPO will develop a set of short videos introducing main science and technology topics. These will be roughly 2 minutes in length and might cover topics like the 4 science pillars of Rubin Obs, data transfer and processing, the biggest digital camera in the world, and more.

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<sup>3</sup> [https://www.virtualastronomy.org/avm\\_metadata.php](https://www.virtualastronomy.org/avm_metadata.php)

<sup>4</sup> <http://www.data2dome.org/>

Deliverable	Number	Format	Milestone	Completion	Length
Planetarium videos	20	Full dome 4K	Start 2017	March 2019	30-90 sec
Rubin Obs Promo video	1+	YouTube	Start 2017	September 2019	120 sec
Virtual tour	1	Web / 360	Prototype 2019	July 2022	
Construction Footage	N/A			ongoing	
Science and Technology Introductory Videos	up to 6	YouTube	Storyboard 2020 Develop 2021	2022	120 sec

### 1.1.4 Citizen Science

Citizen science is research made possible by volunteers from around the world assisting professional scientists with projects that would otherwise be impractical or not possible. Because of the size of the LSST dataset, some research projects may be too big or complex for individual researchers and their teams to handle, even with the assistance of machine learning technologies - computers simply cannot perform certain tasks required of astronomical data. The goal of Rubin Obs EPO’s citizen science program is to enable anyone with Rubin Obs data rights and access to build citizen science projects using LSST data through a seamless process.

Rubin Obs citizen science will be delivered in partnership with Zooniverse.org, a popular online platform with tools that allow scientists to create and run such projects. So far,

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almost 100 peer-reviewed articles have been published using data derived from Zooniverse-approved projects over Zooniverse's 10-year lifetime. We envision that hundreds of projects and even more publications could be achieved as the result of using LSST data for citizen science projects.

As a result of the integration between Rubin Obs and the Zooniverse, professional researchers will be able to create and run citizen science projects themselves, which enables far more projects than EPO could run by itself. Additionally, EPO has supported Zooniverse to offer language translation within individual projects so there is now the capacity to create a new project or translate an existing project to Spanish.

Rubin Obs Users interested in starting a citizen science project with LSST data will access the Rubin Obs Science Platform and use the tools available there to define and create their citizen science data set. The researcher then uses an EPO-developed package to transfer suitable data to the Zooniverse Project Builder tool, where they go to build and test projects.

Rubin Obs EPO will design and create templates for Rubin Obs citizen science projects that principal investigators will be encouraged to use to maintain an identifiable and consistent look and feel of Rubin Obs projects.

To boost public participation in citizen science projects, EPO will promote current Rubin Obs-related projects hosted on Zooniverse, throughout the website, encouraging site visitors to participate in projects they find interesting.

To assess the effectiveness of the Rubin Obs citizen science infrastructure, EPO will work with two researchers to initiate and run two citizen science projects during Rubin Obs Commissioning. The principal investigators will be asked to document their project-building processes during Commissioning, and provide EPO with feedback, which will be used to make improvements.

To assess the success of the citizen science program, we will use feedback forms and analytics collected by Zooniverse on the participation rates and demographics of citizen scientists over time.

### 1.1.5 Formal Education

The EPO team will produce online, data-driven classroom investigations for students in advanced middle school through college. The topics cover commonly taught principles in astronomy and physics, and each investigation is designed for use with Next Generation Science Standards (NGSS) in the United States and the Curriculum Nacional in Chile.

The Rubin Obs education program takes advantage of opportunities that exist within the modern web ecosystem, recognizes the necessity for mobile-friendly interfaces, offers a clear path toward learning outcomes, and uniquely develops activities that require no software to install or data to download in order for educators to introduce these activities into their classrooms. These characteristics combine to lower the barrier to access these state-of-the-art classroom activities and increase inclusivity within the growing number of schools that have internet connectivity. As of 2019, 99% of K-12 school districts in the US, urban and rural, had internet access at the 100 kbps level, which is appropriate for digital learning<sup>5</sup>.

EPO will develop investigations around six themes (see Figure 2), merging the main Rubin Obs science pillars and the most commonly taught topics in astronomy in the US and Chile. Each investigation will feature authentic LSST data accessed through interactive online widgets that are intuitive to use.

Investigations will be designed to implement effective classroom teaching practices that

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<sup>5</sup> <https://stateofthestates.educationsuperhighway.org/#national>

support student's critical thinking, data analysis skills, and complex problem-solving abilities. Investigations will include a Teacher Guide, introductory videos, and assessment materials. All investigations will be available in English and Spanish.

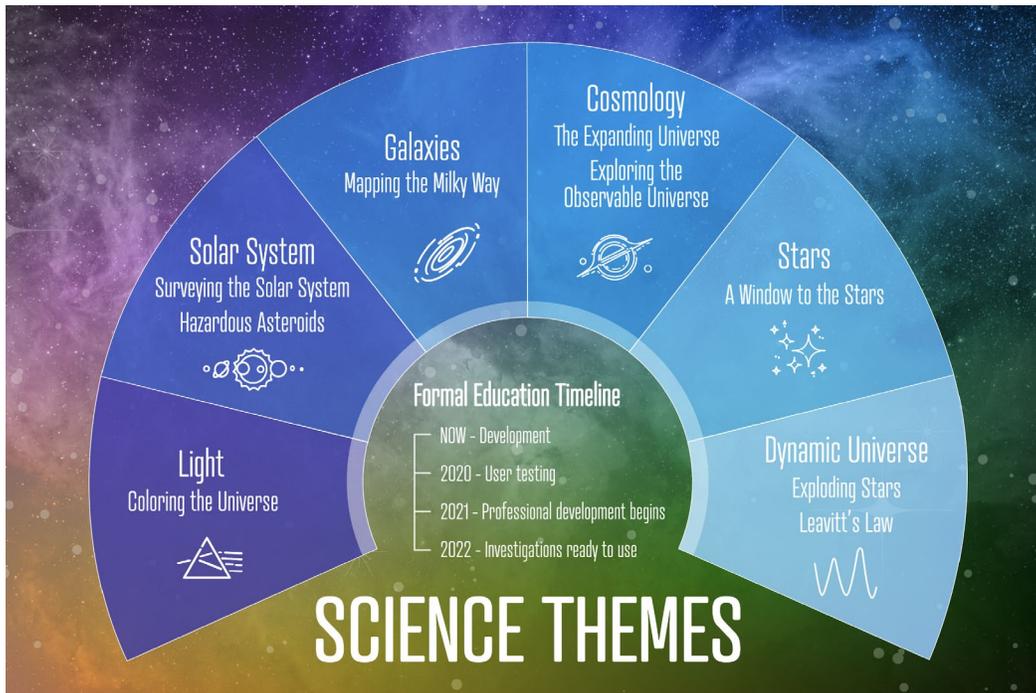


Figure 1: Science Themes of Rubin Obs EPO Formal Education Investigations

All investigations will use LSST data as it becomes available. Extensive field-testing with a diverse range of educators will be conducted throughout Construction using simulated data, pre-cursor data sets, and Rubin Obs commissioning data (as it becomes available). Field-testing is important as it allows us to iteratively improve the design of the online investigations and support materials, as well as improve the ease of use for instructors and accessibility for different types of classrooms.

To increase adoption and encourage sustained use of EPO investigations in classrooms, EPO will offer professional development and support options for educators. Professional development options to be evaluated include holding workshops at professional society

meetings and educator conferences, providing training materials online, and facilitating sessions at strategically selected regional venues.

## 2 Rubin Observatory Science Community

In the initial design and prototyping phases of EPO Construction, the EPO team focused on clearly defining the scope of the content that could be created and the technological resources that could be developed given our staffing and time frame. With this framework in place, the input and participation of the scientific community can begin to expand.

EPO will provide opportunities for members of the Rubin Obs Science Community to participate in education and outreach. These opportunities, while aligned with NSF Broader Impacts criteria, will be available for the entire Rubin Obs Science Community.

Examples include:

- Contribute to interactive widget design and development
- Assist with the assembly of precursor data for user testing during Construction
- Expand EPO's network at strategic conferences/events
- Provide scientific input for EPO deliverables
- Prototype citizen science projects with Rubin Obs, pre-cursor, or simulated data
- Prototype EPO's professional development program

EPO will prepare the following resources for scientists to use during Rubin Observatory Operations:

- visual resources to use in their own outreach and presentations
- opportunities to do outreach
- ways to contribute to ongoing EPO activities
- incorporation and improvement of their visualizations/graphics, etc.
- Science communication/visualization training

Moving forward in Constructions and into Operations, EPO will rely on scientists to share their scientific discoveries and resulting derived data products that will form the basis of new EPO content. This sharing will be facilitated by the direct link between the Science Platform and the EPO Data Center. As we transition into Operations, EPO will work to be a trusted conduit to the general public and media for scientists. In turn, EPO will work with scientists to help facilitate their own outreach efforts.

### 3 Diversity and Inclusion

While respecting the rich traditions of astronomy, Rubin Obs EPO is committed to recognizing and taking action to disrupt the dominant cultural norms of STEM. In practice, this means creating and fostering a culture of belonging that actively invites the participation of all people. We will be purposeful about building and testing educational and outreach activities that consider the input, needs, and desires of minoritized populations.

Throughout Construction and program evaluation, Rubin Obs EPO commits to working with individuals, groups, and organizations including those from:

- Economically disadvantaged areas
- Latinx communities
- African American and Black communities
- Indigenous populations
- People with disabilities, including neurodiverse individuals

Acknowledging intersectionality, we will strive for a balance among genders and gender minorities in user testing.

This commitment has led to specific decisions in building components of the program described above. Some examples of general decisions: care has been taken in designing

diverse animated characters in educational videos; diverse scientists will be highlighted on the website; citizen science projects will be available in Spanish; and multimedia will be available in standard formats such that planetariums with fewer resources can easily use them.

A specific example is within the formal education program. We have been working with a consultant who specializes in inclusivity-driven course designs with the aim to:

- incorporate students' personal experiences and perspectives
- provide students with opportunities to make their own value judgements and connections
- cover both science content and the human story of understanding the Universe.

A sample implementation is within an educational investigation that explores the life of stars. We incorporate the following open-ended prompt:

*Once a star is formed, much of how its life unfolds is based on its initial conditions. Describe a circumstance or event early in your life that has strongly influenced who you have become.*

This prompt encourages connections between the key astronomical concepts introduced in the investigation and students' own experiences. Evidence-based design decisions around diversity and inclusion will be documented in EPO evaluation reports and we will continue to highlight detailed examples within this document.

We will also build websites and online interactives that meet the Web Content Accessibility Guidelines<sup>6</sup> (WCAG) through the World Wide Web Consortium (W3C) process<sup>7</sup>. These

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<sup>6</sup> <https://www.w3.org/WAI/standards-guidelines/wcag/>

<sup>7</sup> <https://www.w3.org/2019/Process-20190301/>

guidelines have been created to help make the web accessible to all people, with particular consideration for people with disabilities. To achieve this, we carefully choose attributes such as text size, color contrast, screen-reader text, interactive element sizes, etc. that meet or exceed the Level A requirements of the WCAG. To ensure success, we are incorporating tests into our development process that alert us to infractions related to those guidelines. In addition, we are taking care to employ semantic HTML, utilizing technologies that perform consistently across most modern browsers and devices, observing best practices of Universal Design, and we are actively innovating data visualization strategies for screen readers.

## 4 EPO Data Center (EDC)

All parts of the EPO program described above depend on making data available in a way that is responsive to requests and easy for non-specialists to use. Therefore, a foundational component of the EPO program is a scalable data center tuned to unique EPO audience needs.

User load and usage varies significantly throughout each day and during different parts of the year. Spikes in web traffic will follow references to Rubin Obs in media, science results, media references to citizen science projects, and social media references by popular individuals or organizations to a feature of the website.

To accommodate these patterns, the EDC will follow best practices popularized by cloud computing: leveraging containers, infrastructure-as-code<sup>8</sup>, and scalable architecture.

The EPO data set hosted in the EDC will not exceed 10% of the full LSST data set, will be obtained from the Data Access Centers (DAC), and will be transferred to the EDC as defined

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<sup>8</sup> [https://en.wikipedia.org/wiki/Infrastructure\\_as\\_code](https://en.wikipedia.org/wiki/Infrastructure_as_code)

in the interface requirements document (LSE-131).

By designing an agile, scalable infrastructure, EPO can meet the challenging and unique needs of our audiences while efficiently minimizing cost. As we develop these creative solutions, we anticipate that our contributions and insights can benefit future EPO programs associated with big data astronomy projects like the Square Kilometre Array (SKA), thirty-meter class telescopes, and the National Optical-Infrared Astronomy Research Laboratory (NOIRLab) as well as the open-source community.

## 5 Evaluation

During Construction, EPO will engage in iterative prototype testing and evaluation to improve Program design. As individual components of the EPO Program are developed, we will recruit people to interact with, test, and provide feedback. Testing may be moderated, where EPO or contractors engage with participants in real time, or unmoderated, where they interact with programs online. Feedback from user testing sessions will be incorporated into ongoing development and design, adding improvements to the user experience and EPO deliverables. By regularly testing with representatives of our main audiences, including our Spanish-speaking Chilean audience, we can ensure the goals and outcomes of the EPO program are more likely to be achieved when Operations begins.

Evaluation during Rubin Obs Construction will focus on answering questions such as:

- To what extent do users find deliverables intuitive and relevant?
- To what extent are deliverables and the website accessible to our core audiences?
- To what extent are audience needs being met?
- What are short-term user outcomes as a result of using EPO deliverables?
- To what extent are activities sustainable through Operations?
- How can we improve deliverables to be more appropriate, efficient, effective, and

sustainable?

User feedback and iterative testing during Construction offers an opportunity to test and refine evaluation questions for use during Operations.

Analytic tracking will be built into technical components of the program during Construction. For example, the website will use an analytic tracking system to determine user dwell time and click paths. These data will be delivered to an external evaluator who will be contracted to evaluate the impact of the EPO Program on our core audiences during Operations.

Outcomes for the main program components are being defined during Construction and are detailed in Table 2. Evaluation will be organized and performed at the program component-level on the premise that if each component is successful, then EPO has successfully fulfilled its mission. Planning for evaluation in Operations is an ongoing process throughout the Rubin Obs Construction and Commissioning periods.

<b>Program Component</b>	<b>Audience</b>	<b>Desired Outcomes</b>	<b>Evaluation Methods</b>
Website	Science-interested teens and adults	<ul style="list-style-type: none"> <li>• Awareness of Rubin Obs</li> <li>• Increased awareness of having access to LSST data</li> <li>• Awareness of the diversity of people working on Rubin Obs</li> <li>• Awareness of the main science themes of Rubin Obs</li> <li>• Awareness of scientific research methods</li> </ul>	<ul style="list-style-type: none"> <li>-Web surveys</li> <li>-Web analytics</li> <li>-Focus groups</li> <li>-Interviews</li> </ul>
Multimedia	Content creators at informal science centers	<ul style="list-style-type: none"> <li>• Awareness of Rubin Obs and its multimedia offerings</li> <li>• Perception that Rubin Obs multimedia resources are easy to adopt</li> </ul>	<ul style="list-style-type: none"> <li>-Web analytics</li> <li>-Surveys</li> <li>-Focus groups</li> <li>-Login requests</li> <li>-Data2Dome-Gallery</li> </ul>

		<ul style="list-style-type: none"> <li>• Perception that Rubin Obs multimedia assets are useful for programming</li> </ul>	exchange
Formal Education	Educators in advanced middle school, high school, and undergraduate college classrooms	<ul style="list-style-type: none"> <li>• Awareness of Rubin Obs and its educational offerings, particularly among underserved groups</li> <li>• Increased confidence using online science investigations with students</li> <li>• Use one or more formal education investigations over multiple years</li> <li>• Use of professional development opportunities</li> </ul>	<ul style="list-style-type: none"> <li>-Surveys</li> <li>-Focus groups</li> <li>-Login requests</li> <li>-Documentation of feedback from EPO team</li> <li>-Pre/post professional development surveys</li> <li>-Online feedback form</li> <li>-Forum monitoring</li> </ul>
Citizen Science	Principal investigators of citizen science projects using Rubin Obs data	<ul style="list-style-type: none"> <li>• Awareness by the Rubin Obs Science Community of the opportunity to build citizen science projects using LSST data via the Rubin Obs Science Platform</li> <li>• Awareness by the Rubin Obs Science Community that they can use citizen science as a tool to achieve their science goals</li> <li>• Increased skills by citizen science principal investigators in developing citizen science projects</li> </ul>	<ul style="list-style-type: none"> <li>-Surveys</li> <li>-Focus groups</li> <li>-Online feedback form</li> <li>-Project Builder analytics</li> <li>-Documentation of feedback from science community</li> </ul>

Needs assessments, focus groups, interviews, and prototype testing sessions have and will continue to have concentrated effort around recruiting for diverse individuals and viewpoints. Through this work, EPO will create deliverables that are interesting, accessible, engaging, and relevant to as many people as possible and learn about the diverse ways people engage with astronomy.

Periodic summaries of evaluation findings will be made publicly available. This could be through published journal articles, presented talks at conferences or the Rubin Obs Project and Community Workshops, and/or publicly posted reports.

## 6 Communications Strategy

Rubin Observatory’s LSST is an astronomical survey for the modern era that requires a forward-thinking communications strategy. Using a traditional framework for communicating is not enough when it comes to helping define the future of astronomy; instead, Rubin Observatory seeks to find new ways of communicating science that welcome and inspire broader audiences. Rubin Observatory plans to capitalize on social media and other innovative online channels to welcome and inspire broader audiences than traditional communications frameworks have allowed.

Through its outward-facing channels, Rubin Observatory will establish meaningful connections between scientists and our key audiences, and will provide context that makes science accessible and impactful.

Rubin Observatory EPO is unique among astronomy education and outreach programs in that it is almost exclusively online. Anyone with internet access will be able to fully engage with EPO products, and EPO will focus most of its communications resources on the various online channels. This will enable EPO to reach a broad audience, and to streamline its resources towards maintaining a vibrant, active online presence. There will, however, be occasional opportunities for meaningful in-person communications interactions; these are also described in this section.

### **Social Media**

Social media provides a channel (distributed over several distinct platforms) for EPO to distribute text and visual content widely, and to direct people back to our website for deeper engagement with Rubin Observatory. However, more importantly, social media is a mechanism for meaningful two-way engagement with our audiences. In addition to posting visuals, news, and links, EPO will use social media during Operations as a means of encouraging ongoing conversation about Rubin Observatory science and building

substantive, long-term relationships with members of its four key audiences. In its Operations staffing plan, EPO has accounted for the staff time and expertise needed to closely monitor social media platforms, respond promptly to questions, and encourage sustained dialog. A social media strategy will be developed in FY21 and will further describe EPO's plan to introduce and manage campaigns and capitalize on popular events and trends in order to maximize this two-way engagement. This strategy will focus on deliberate and strategic engagement with each of EPO's main audiences.

### **Email**

The EPO website will feature an option for guests to submit their email addresses, which will be added to a set of community email lists. Website guests will be asked to choose from a menu of interests to ensure they receive only news and updates that align with their interests. EPO will use the resulting email lists to share updates as appropriate, while being mindful not to overuse this channel. (No spam!)

### **Press releases**

Historically, press releases have been one of the main avenues by which observatories communicate their science to the public. With the support of NOIRLab's Community Engagement and Education (CEE) group, Rubin Observatory will generate and distribute press releases highlighting significant scientific advancements made with Rubin Observatory data. When press releases are issued, EPO will also distribute these science stories via other channels (e.g., website and social media) to reach the broadest audience possible. EPO also recognizes that many news outlets now watch social media for timely, condensed content, rather than relying on press releases.

In addition to the specific channels mentioned above, EPO will communicate through existing professional education organizations to reach educators who seek professional resources through established e-newsletters, email listservs, and online forums. EPO will

also use opportunities specific to Chile, led by the EPO Chile Coordinator in Operations. One example is the annual Astronomy Summer School program hosted by Universidad de Concepción.

## 7 Timeline for Completion

The Table below shows upcoming milestones.

	<b>Formal Education</b>	<b>Website</b>	<b>Citizen Science</b>	<b>Multimedia</b>	<b>General</b>
FY21	Professional development defined; Education materials hosted on website; Construction Complete	Build core site; Populate website with content; Begin Skyviewer development	Develop pipeline for moving data between Science Platform and Zooniverse	Video storyboards and production workflow created	EPO finishes Construction hiring; Define EPO Data Center schemas and interfaces
FY22		Complete Skyviewer; Site features LSST data where possible; Website Launches; Construction Complete	Project Review Panel convened; First Projects created pending data; Construction Complete	Timelapses & Videos completed; Construction Complete	EPO Data Center serving data to all EPO products from USDF; Construction Complete

## 8 Construction Staffing

To achieve these goals during Rubin Obs Construction, EPO will be staffed with content specialists, scientists, educators, and developers. Most team members will be based in Tucson at Rubin Obs Headquarters and led by the Head of EPO. Rubin Obs EPO will also work with EPO groups within the AURA Observatory group and others in Chile to incorporate effective practices and maximize efficiency.

The education and outreach-focused members of the EPO team will develop structured online Rubin Obs databased classroom activities that reflect national education priorities and are engaging for a diverse audience of educators and students. Members of this group will represent Rubin Obs at events like AAS and the IAU, document project progress as archival footage for use in Rubin Obs Operations, and work closely with the Head of EPO to build and maintain relationships with organizations serving underrepresented groups in STEM.

The technical members of the team are responsible for architecting, developing, and maintaining the EPO Data Center. They also maintain EPO website features like the online investigation infrastructure, widget development, interactive features, and multimedia gallery, taking advantage of modern web technologies. They will coordinate with the Rubin Obs Science Platform development group, the Rubin Observatory Interim Data Facility (IDF), and key technology partners to ensure data integrity, seamless integration, scalability, and fast performance.

## 9 Operational Readiness

There are three major phases of EPO:

1. Construction: EPO will use simulated and precursor astronomy data sets to develop and perform testing of website features before Commissioning data from Rubin Obs becomes available
2. Pre-Operations and Commissioning: EPO will use Rubin Obs ComCam data, simulated data, precursor alert stream data, and then LSST Cam commissioning data to further build out and test website features
3. Operations: EPO will launch the public site at the beginning of FY23. Note that commissioning data and precursor data will be used during the first year of telescope Operations prior to Data Release 1 and the beginning of Alert Stream production.

Commissioning tasks are defined in the Rubin Obs Commissioning Plan (LSE-79). We include some EPO highlights here for reference:

- Test network bandwidth and load between the IDF and EDC
- Test loading the public subset of annual catalog data (the EPO Data set) into the EDC database
- Test loading the color co-add images from the IDF into the EDC and converting to image tiles for interactive web display
- Test robustness of educational investigations using EDC data
- Test education investigations and supporting professional development materials with educators
- Test integration of Zooniverse Project Builder with Rubin Obs data sources
- Test website at full load using simulated users
- Verify Data2Dome-compliant software at informal science centers can access EPO multimedia
- Validate key use cases with small groups of actual users:
  - Usability testing of graphical user interfaces
  - Citizen science using two prototype projects
  - Classroom investigations
  - Professional development for educators
  - Data2Dome multimedia search and fulldome display
- Review cybersecurity as defined in the EPO security plan (LEP-21, LEP-22)

Rubin Obs EPO will be declared ready for Operations at the successful completion of an EPO Operational Readiness Review, signalling the formal end of Construction for EPO.

Rubin Observatory Operations is a part of NSF's NOIRLab. NOIRLab is a matrix organization supporting the programs of MSO and CSDC as well as Gemini Observatory and Rubin Observatory Operations. In particular, Rubin Obs EPO program is carried out from

within NOIRLab's CEE group starting FY23.