

NOAO Community Survey for Astro2020: Survey Results

1. Outreach

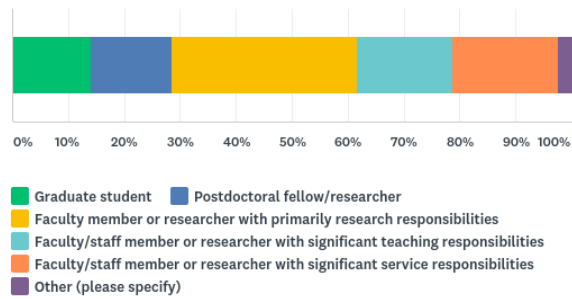
The survey was launched 1 May 2019 and closed on 21 May 2019. Over the course of this period, the survey was advertised to the NOAO Currents subscriber list, recent NOAO proposers, user communities of facilities within and beyond NOAO, recent NOAO-related study and workshop participants, and the astronomical software community. Recipients were encouraged to engage their research and department colleagues in the survey, especially students and postdocs we might not be able to reach directly. A total of 476 people responded to the survey, with an average survey completion time of 13 minutes.

The survey results reported below are summarized in charts generated by surveymonkey. The complete text of the survey, available here: http://ast.nao.edu/sites/default/files/SurveyMonkey_173430737.pdf provides the complete text of each response option, many of which are abbreviated in the charts below.

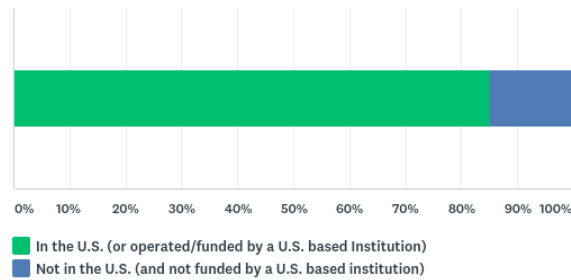
2. Demographics

Of the 476 people who responded to the survey, approximately one-third were students and postdocs (29%), with the remainder split between faculty members with primarily research responsibilities and faculty members with primarily teaching or service responsibilities (Q1). The great majority (85%) are located in the US (Q2). Most (65%) are affiliated with universities or observatories associated with universities (Q3).

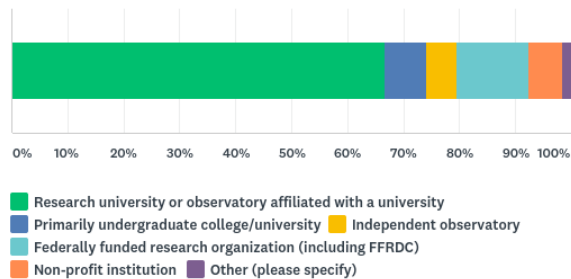
Q1 I am a... (select best match)



Q2 My home institution is

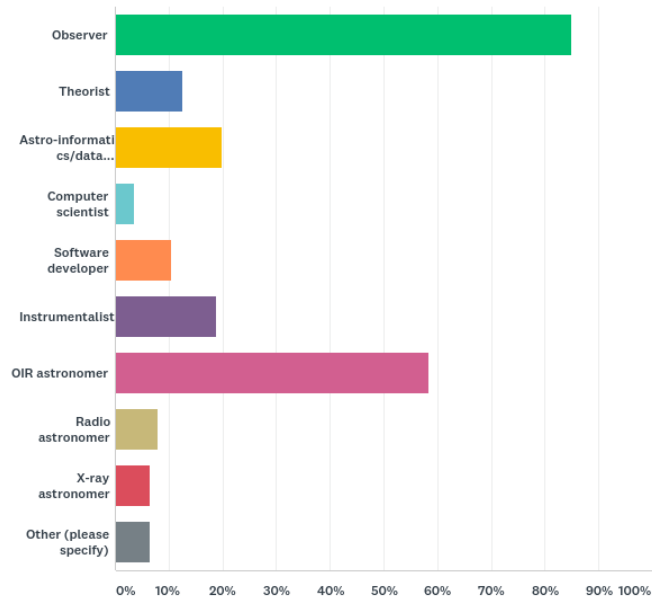


Q3 My home institution is a (select best match)



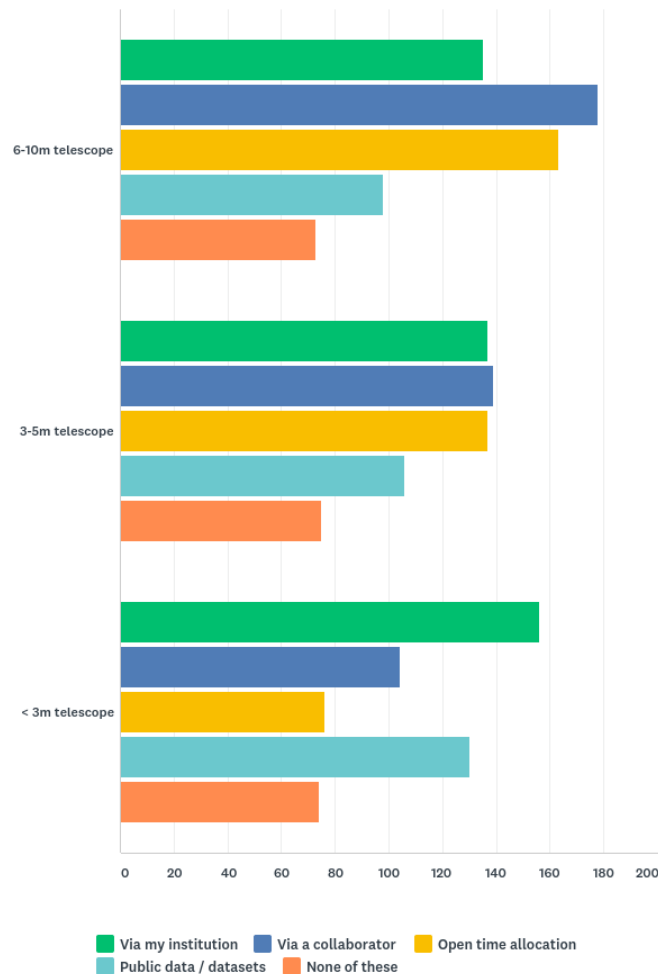
The great majority of the respondents are observers (85%) and OIR astronomers (60%), one-fifth are instrumentalists, and approximately one-third characterizing themselves as data scientists (20%), software developers (10%), or computer scientists (4%). Approximately 13% are theorists (Q4).

Q4 I consider myself a/an (select all that apply)



Our respondents have used both large (6-10m), medium (3-5m), and small (<3m) telescopes in the past 3 years. **Open time allocation plays a significant role in access to resources, although it is not the dominant access pathway** for this group. Access through one's own institution or through a collaborator is equally or more common (Q5).

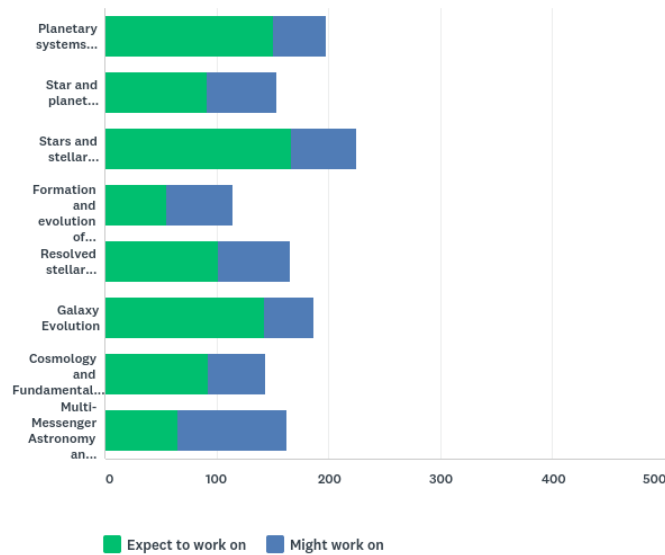
Q5 What kinds of observing resources from the US ground-based OIR system have you used in the past 3 years (e.g., published a paper with data from, proposed for time on, used data from)? and How did you get access to the resource? (Through your institution; via a collaborator with institutional access to the resource; via open time allocation; via publicly available data or data products?) (select all that apply)



3. My Science in the 2020s

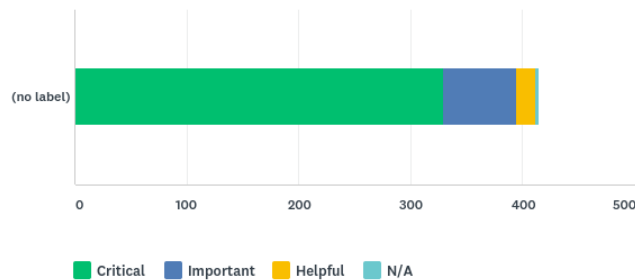
The research plans for our survey respondents cover all of the Astro2020 thematic science areas (Q6). Thus, **ground-based OIR resources will play an important role across a broad range of Astro2020 science areas.**

Q6 Indicate the Astro2020 topics you expect to work on, or might work on, in the coming decade):



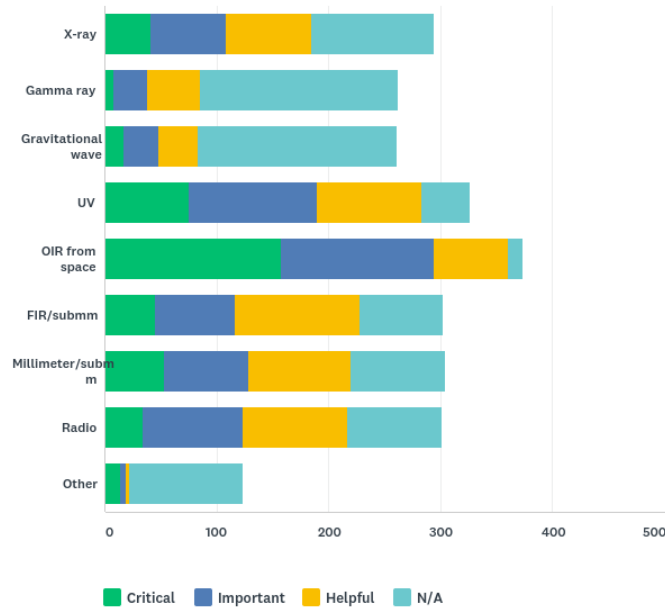
Of the 415 respondents to Q9, **ground-based OIR resources will be critical** (for 329 or 80%) **or important** (for 66 or 16%) in accomplishing their research in the coming decade.

Q9 How important will ground-based OIR resources be to your research in the 2020s?



Many respondents also intend to use space-based resources as a critical or important part of their research program (294 OIR; 108 X-ray; 116 FIR/submm; 129 mm/submm; 123 radio; see Q10). Thus **ground-based OIR will continue to have strong scientific synergy with use of spaced-based and other ground-based resources.**

Q10 If you will use other resources in your research (i.e., non-OIR and/or space-based facilities) in the coming decade, indicate their relative importance in your research program.

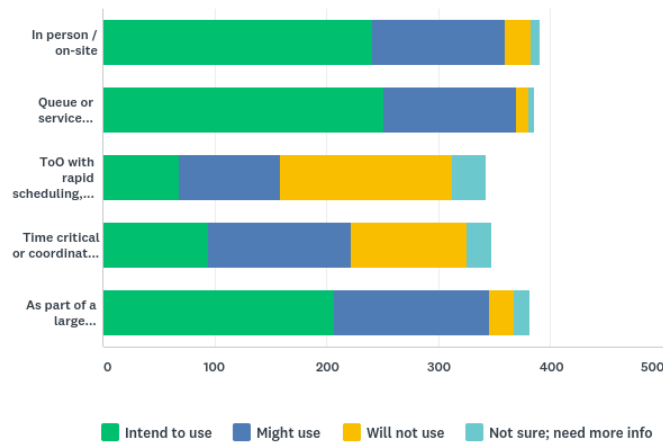


4. How I will obtain data in the 2020s

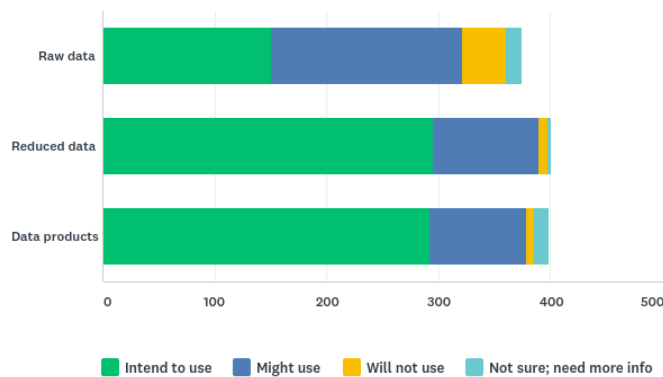
In the coming decade, respondents intend to observe in person/on-site at a telescope, but they also intend to make frequent use of other observing modes. The survey results show that queue or service observing is equally important as on-site observing. People also intend to observe as part of large collaborations, to make time critical coordinated observations that do not require rapid scheduling, as well as those that do and may interrupt other scheduled observations (Q11).

Archival data, **especially reduced data and data products, will also be important for research in the 2020s.** Almost all those who responded to this question (412) intend to or may use data in these latter two categories (Q12).

Q11 Will you take data at a telescope? How?



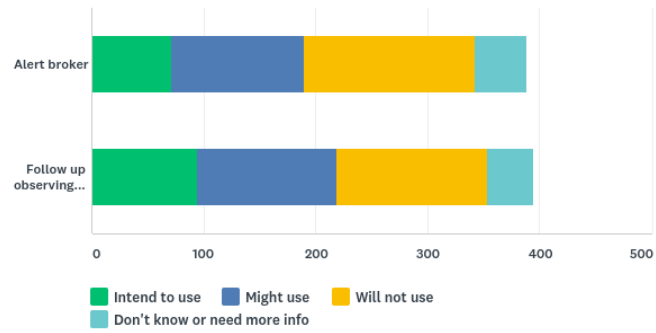
Q12 Will you use archival data and/or data products?



5. Time domain services needed for my research in the 2020s

Of the total number of people who responded to Q13 (400), approximately 20% intend to use alert brokers and follow-up observing systems, approximately 30% might use these resources, and 10% don't know or need more information.

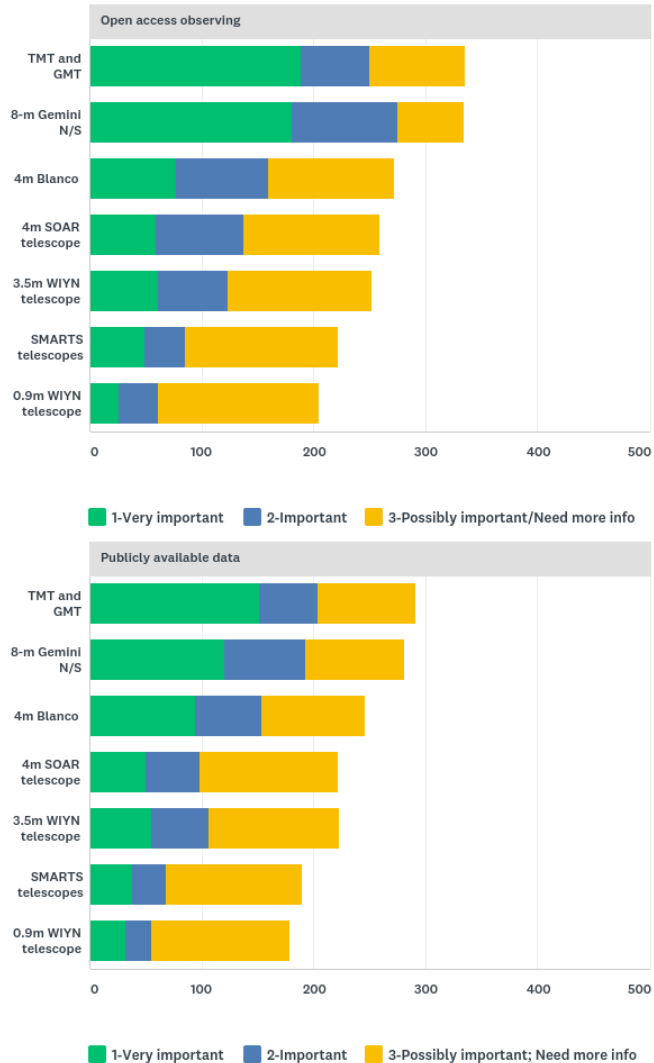
Q13 How likely are you to use these resources in your research?



6. Facilities that are important to my future research

Open Access Facilities. For the 371 respondents who responded to Q14, **open access to facilities of all apertures are very important, important or potentially important for more than half of all respondents**, both in terms of observing time and the publicly available data they produce. Generally, the larger the aperture, the larger the number of respondents indicating the facility as important for their science in the 2020s. However, at the upper range in aperture, the number of people indicating the much larger ELTs as important was only comparable to that of the 8-m Gemini telescopes.

Q14 Open access facilities. NOAO, Gemini, and LSST are a collective gateway to the following resources. Which of these facilities and associated data will be important for your research in the coming decade? Using the dropdown menus below, indicate which open access facilities and/or their publicly available data are 1=Very important, 2=Important, 3=Possibly Important/Need more info. Indicate all that apply.



The need for LSST data was polled in separate question because LSST does not offer open access observing. Of the 351 people who responded to Q15, 275 (or 58% of all 476 respondents) find the publicly available data from LSST very important or important to their 2020s research, comparable to the number of people who responded similarly for Gemini and ELT open access observing.

Q15 Please do the same for LSST, which offers publicly available data but not open access observing.



These results show that **observing facilities with a wide range of apertures (including LSST) will be important in carrying out research in the 2020s.**

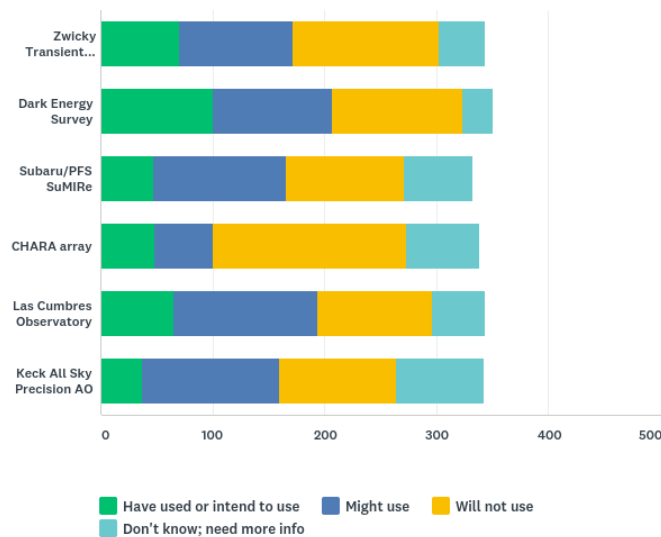
Externally-funded Facilities, Programs, and Projects. These programs are very important, important, or possibly important to 62% of all respondents (297/476). Of these, 156 (or 33% of all respondents) indicated that participating in these programs is very important or important to their research now and/or in the future. A larger fraction of all respondents (189/476 or 40%) indicated that publicly available data from these programs is important to their research. Thus, **users of externally-funded facilities are a significant new part of the NOAO community.**

Q16 Externally-funded facilities, programs, and projects. Over the past decade, some NOAO facilities have transitioned to supporting large surveys or focused research programs that are enabled by external funding. Examples include the Dark Energy Survey (DES) on the 4-m Blanco telescope, the Dark Energy Spectroscopic Instrument (DESI) on the 4-m Mayall telescope, the NASA-NSF Exoplanet Observational Research (NN-EXPLORE) partnership for exoplanet discovery and characterization on the 3.5m WIYN telescope, and Robo-AO on the Kitt Peak 2.1m telescope. Data from or related to these programs are often publicly available (e.g., DES, Legacy Surveys, NN-EXPLORE). How important to your research are these programs or any future programs on these facilities? How likely are you to make use of publicly available data from these programs? Using the dropdown menus below, indicate which are 1=Very important, 2=Important, 3=Possibly important/Need more info). Indicate all that apply.

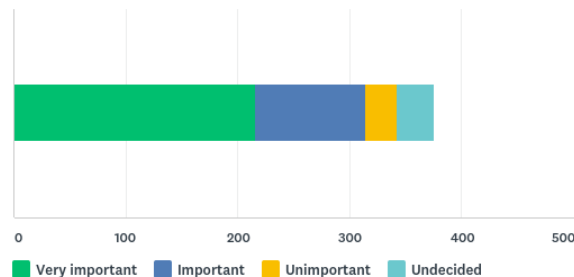


NSF-funded Community Resources. Of the 376 people who responded to Q17, 236 (or 50% of all respondents) indicated that they have used or intend to use one or more of the 6 resources listed below. A greater number (355 or 75% of all respondents) indicated that they have, intend to, or might use one or more of these resources. Future awards that enable open access time or publicly available data are very important or important to 314 (or 66% of all) respondents (Q18). Desired future facilities are diverse and include Magellan, Keck, MMT, VLT, Subaru, and CHARA.

Q17 NSF-funded community resources. In previous years, the NOAO community has had access to non-federal facilities (Keck, MMT, Magellan, LBT, etc.) through NSF's Telescope Systems Instrumentation Program (TSIP). More recently NSF's Mid-Scale Innovations program (MSIP) has made awards in ground-based OIR astronomy, the majority of which offer a benefit to the US community in the form of publicly available data or open access observing time. Zwicky Transient Facility (ZTF): open data from community surveys Dark Energy Survey: images and public data products PFS/Subaru: publicly available SuMIRe survey images and spectra CHARA array: open access through the NOAO TAC (currently available 2010-2023) Las Cumbres Observatory: open access through NOAO TAC (currently available 2017-2020) Keck All Sky Precision AO: all data publicly available Have you used (or how likely are you to use) the benefits from these MSIP awards?



Q18 How important to your research are future NSF awards that enable open access time on or publicly available data from these or other facilities?

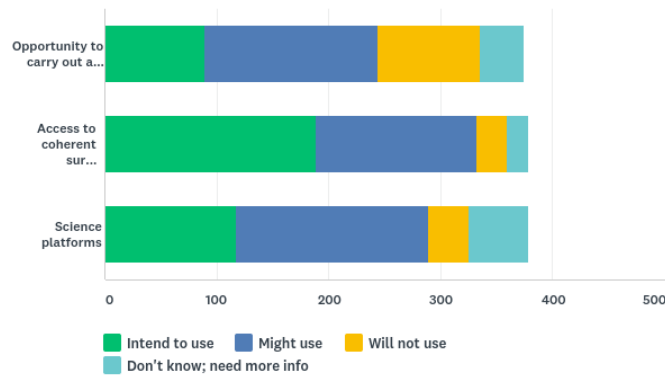


7. Survey and data discovery services

Of the 386 respondents who answered Q21, 89 intend to take advantage of opportunities to carry out a large survey, 189 to take advantage of access to large coherent data sets, and 117 intend to use science platforms. Much larger numbers (250 to 330) will or might take advantage of these resources.

Thus, “Survey science” will continue to be a major pathway for discovery for a large fraction of our community, both by carrying out new surveys and by using coherent data sets created by others. Science platforms are likely to be a widely used tool for discovery.

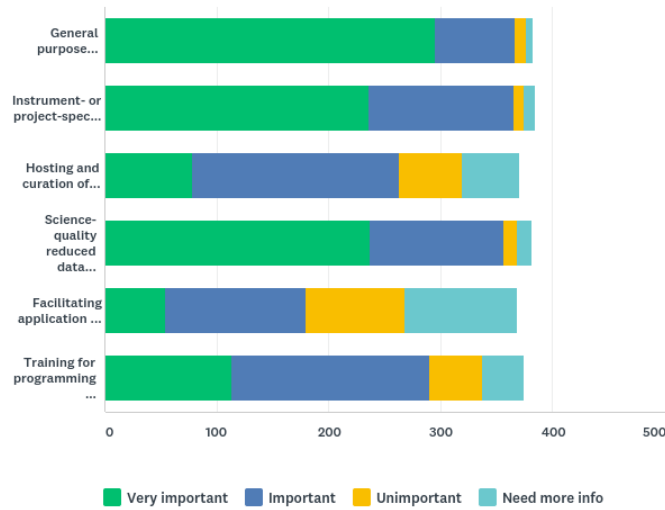
Q21 How likely are you to use the following resources in your future research?



8. Software-related Services

For the 386 people who responded to Q24, the highest priorities for software-related resources were for general-purpose astronomy software (like IRAF, Astropy); instrument- or project-specific pipelines, tools, and cookbooks; and science-quality reduced data products.

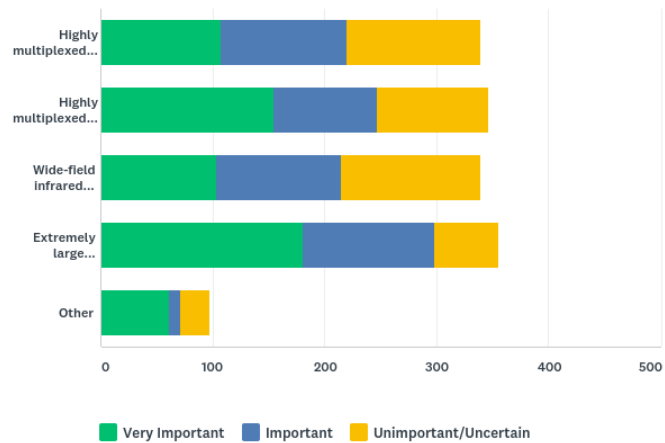
Q24 How important is it for a national center like NOAO to support these software-related resources?



9. New instrumentation or facilities

For the 371 respondents to Q25, the new instruments and telescopes that are “very important”/“important” in the coming decade include highly multiplexed wide-field spectroscopy on 4m telescopes (107/113), highly multiplexed wide-field spectroscopy on 8m telescopes (155/92), wide-field infrared imaging (103/112), and extremely large telescopes (181/117), which have also been called out for development in previous studies.

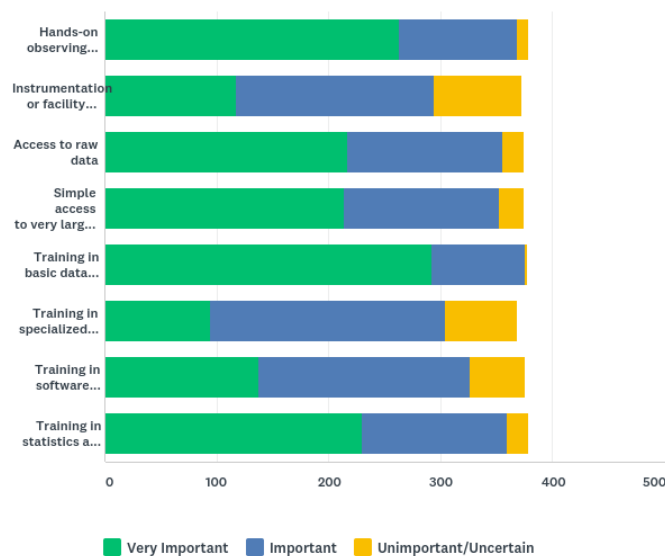
Q25 Previous studies have called for capabilities like those in the list below. If your needed capability is in the list, indicate its importance. If it is not in the list, please describe it in the comment box below.



10. Student and Mentor Training

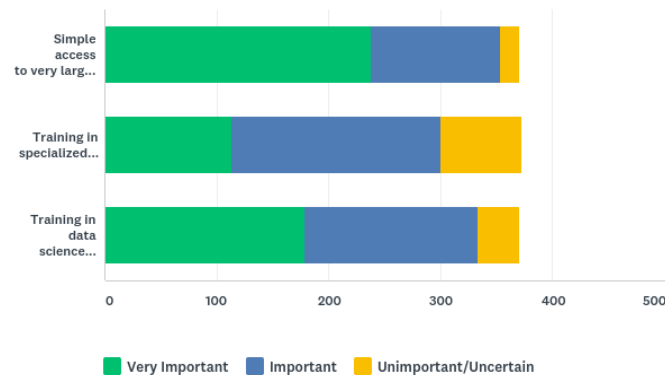
As we enter an era when archival datasets are increasingly used in research and data analysis methods are increasingly sophisticated, student training remains important and needs are diverse. The highest priorities for student training for the 383 respondents to Q26 are training in basic data reduction and analysis techniques (very important for 292) and hands-on observing experience (very important for 263). In addition, training in statistics and data science methods (very important to 230), access to raw data (very important for 217) and simple access to very large, homogeneous data catalogs (very important for 214) are also highly valued.

Q26 How important is it for students to acquire the following types of training or resources?



For the 373 respondents to Q27, mentor training is also highly important. The highest priorities for mentor training were simple access to very large, homogeneous data catalogs (very important for 238) and training in statistics and data science methods (very important to 179).

Q27 How important is it for established researchers and student mentors to receive the following types of training or resources?



11. Overall Priorities for the 2020s

For the 387 respondents to Q28 who considered their overall priorities in a funding-limited environment, their highest priority, by far, was for observing time on telescopes. The next 3 highest priorities were for archival data products (reduced data and catalogs), new instrumentation, and software and data pipelines, followed by student or mentor training, with new telescopes rounding out the top 6.

This ordering makes a lot of sense. The 4 top priorities are important to do science now. The resources below the top 6 (science platforms, follow-up observing systems, alert brokers) are new capabilities that are important for time domain science and large surveys. As new capabilities, they may have yet to attract a large community of users.

New telescopes, which are prioritized equally with training, take longer to come on line and cost a lot more. **Apparently respondents think that new telescopes are important but not the most critical need for the coming decade. Alternatively, if new telescopes are built, their development should not compromise the higher priority needs for scientific success in the 2020s.**

Q28 Now considering your responses to the previous questions in a relative sense, please indicate how important these resources are to you in a funding-limited environment.

