DIVERSITY

A push for inclusive data collection in STEM organizations

Professional societies could better survey, and thus better serve, underrepresented groups

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Professional organizations in science, technology, engineering, and mathematics (STEM) are well-positioned to improve the recruitment and retention (R&R) of underrepresented groups (1, 2) by providing targeted professional development, networking opportunities, and political advocacy (3, 4). Tailoring these initiatives to specific underrepresented groups can enhance their impact (5), but this is predicated on organizations knowing their demographic make-up (6). Here, we report patterns in STEM organizations' collection and usage of demographic data from members and conference attendees, based on information from 73 professional societies representing 712,000 constituents. In light of inconsistencies and limitations that we observed, we suggest survey programs that can serve as models for inclusive survey designs by organizations and, where possible, provide demographic information for benchmarking relative to the general population. With improved surveys, organizations can leverage demographic data to prioritize and evaluate R&R efforts, and share effective strategies for R&R of underrepresented groups across STEM.

Baseline demographic data, when compared to the general population (across STEM or across a country), can help organizations set and prioritize R&R goals and, when monitored over time, help organizations evaluate the effectiveness of R&R efforts. Government agencies often provide the most relevant demographic data for a

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general population in STEM (e.g., the US National Science Foundation) and in a country (e.g., the US Census Bureau) because of their surveys' large sample sizes and broad distributions. As a result, organizations may be compelled to use government surveys as a model for demographic survey design and for benchmarking (i.e., comparing their organization's demographic diversity to the general population). Although these agencies survey many categories of demographic information (e.g., gender identity, family status, citizenship, abilities, race and ethnicity), they do not necessarily collect all the demographic information that is considered meaningful to describe the STEM community—i.e., treating some groups as homogeneous (7) and ignoring other groups completely (8). By contrast, inclusive demographic surveys acknowledge the full diversity of identities that are meaningful among members of the STEM community. Thus, organizations seeking to describe their demographic composition are pressured to choose between following the examples of government agencies versus creating new, inclusive surveys to recognize additional (and evolving) identities within the STEM community.

A SURVEY OF SURVEYS

We surveyed 164 STEM organizations (73 responses, rate = 44.5%) between December 2020 and July 2021 with the goal of understanding what demographic data each organization collects from its constituents (i.e., members and conference attendees) and how the data are used. See supplementary materials (SM) for more details on the questionnaire. Organizations were sourced from a list of professional societies affiliated with the American Association for the Advancement of Science (AAAS, the publisher of *Science*) (n = 156) or from social media (n = 8). The survey was sent to the elected leadership and management firms for each organization, and follow-up reminders were sent after 1 month. Although these organizations can have international memberships of up to 40% (6), we focus our study on the demographic data that

are culturally important in the US, under the assumption that US-affiliated organizations usually hold events in the US and thus the relevant demographic context is US based.

The responding organizations represented a wide range of fields: 31 life science organizations (157,000 constituents), 5 mathematics organizations (93,000 constituents), 16 physical science organizations (207,000 constituents), 7 technology organizations (124,000 constituents), and 14 multidisciplinary organizations spanning multiple branches of STEM (131,000 constituents). A list of the responding organizations is available in the SM.

Our survey may have selected for organizations that are committed to, or are interested in, collecting demographic data. However, based on the AAAS-affiliated recruitment of the organizations and the similar sizes of constituencies across STEM fields, we conclude that the responding organizations are likely a reasonably representative cross-section of the most prominent STEM organizations in the US. Each organization was asked about the demographic information that they collect from their constituents, the response rates to their surveys, and how the data were used. Organizations participated under the condition that no data would be associated with them directly. Hence we report aggregated findings and de-identified organization-level data, and do not report any group- or discipline-specific patterns to minimize potential for identification.

Most STEM organizations (59 out of 73, or 80.8%) collect demographic information from their constituents. Commonly surveyed demographic categories included sexual orientation, disability status, racial and ethnic identity, and gender identity (see the top panel of the figure). The number of options offered for each demographic category varied among organizations, resulting in datasets with different resolution and validity (i.e., how accurately the response options reflect the identities of the respondents). Specific response options for each demographic category are shown (see the box) and provided in the SM.

Of the organizations that provided response rates to their surveys (n = 22), the average response rate was 36.1% (SD = 30.4%), which is close to response rates reported by other organizations (9). When asked the year of their most recent demographic survey, 29 out of 59 organizations (49.2%) indicated either 2020 or 2021, 7 (11.9%) indicated a year from 2012 to 2019, and 15 (25.4%) indicated that they collect demographic information on a rolling basis with member registration.

Of the organizations that collected demographic data and shared details of their data usage (n = 48), 87.5% reported using demo-

graphic data for one or more purposes that fell in the general categories of temporal monitoring, resource planning (e.g., for conferences), publishing reports (e.g., internal or external reports summarizing organizational growth), writing grant proposals, and contributing to third-party research (see the bottom panel of the figure). Some respondents provided specific examples, which included using data to create statistical reports for an organization's board of directors, writing proposals and progress reports to federal funding agencies, and ensuring diverse representation on organizational service committees and speaking panels. Thus, there are disparities between STEM organizations in the underlying design of demographics questions, the administration of surveys, and the usage of the collected data.

Our results indicate that some STEM organizations do not recognize entire groups in STEM, including individuals in sexual minorities (i.e., LGBTQ+ people) or individuals with disabilities (see the top panel of the figure). This observation is surprising given the well-documented discrimination and underrepresentation of these groups in STEM (8, 10). Furthermore, variation in response options on demographic questions—e.g., for racial and ethnic identity and gender identity—signals that only a fraction of organizations aim to give a voice to distinctive identities that are frequently relegated to broader demographic classifications. For instance, numerous Asian American and Pacific Islander (AAPI) ethnic groups are often consolidated into a single "Asian" or "AAPI" grouping (7).

In response to survey designs that ignore or obfuscate demographic identities, individuals from underrepresented groups may elect not to respond to certain questions or elect not to complete the survey, introducing a nonresponse bias into the data. As a result, the collected data do not directly reflect the true demographic composition of the organizations. Nonresponse biases may become even more prominent if surveys lack anonymity—e.g., data collected during member registration are likely linked to a respondent's identity (11, 12). Cumulatively, these findings suggest that the bulk of professional organizations in STEM are not collecting de-

mographic data that are representative of the true diversity within STEM, which misinforms any subsequent use of the data for supporting or guiding organizational operations such as R&R.

GUIDES FOR SURVEY DESIGN

Our data and the recommendations made here are based on a subsample of US-affiliated STEM organizations, and thus they are limited in part by the demographic categories that are prominent and culturally important in the US. Nonetheless, we believe that the principles outlined below are applicable to both US and international organizations. STEM organizations can look to national surveying programs with publicly available data to model demographic survey designs and provide benchmarking of organizational

diversity relative to the general population (13), though these national programs may have flaws. In the US, three such programs are the National Science Foundation's Survey of Earned Doctorates (SED), the US Census Bureau's American Community Survey (ACS), and the Centers for Disease Control and Prevention's National Health Interview Survey (NHIS).

The SED targets individuals receiving research doctorates in the US (~55,000 per

year), whereas the ACS targets the general US population (~3.5 million households per year). Thus, the SED and ACS can provide relevant benchmarking data for demographic surveys of STEM organizations, but the diversity of identities recognized in their survey questions pales in comparison to the questions of the smaller NHIS (~32,000 to 59,000 households per year, 2015 to 2020). For example, in questions on race, the NHIS and ACS each recognize seven distinctive Asian identities, whereas the SED recognizes only a singular Asian group. For ethnicity, the NHIS recognizes seven distinctive Hispanic or Latinx identities, whereas the ACS and SED each recognize only four. Organizations wishing to describe international constituents should avoid describing racial groups as "American" (e.g., "Asia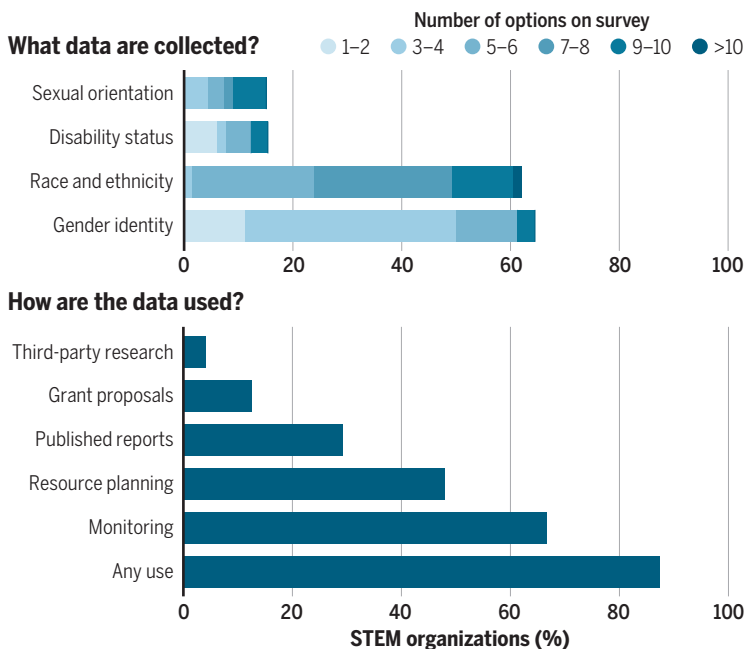n American") and consider asking for country of residence (6). However, "residence" can have several definitions, such as legal versus historical, so surveys should be explicit in their use of this term.

In addition to race and ethnicity, the NHIS asks sexual orientation (SED and ACS do not explicitly do this), and the survey includes a series of questions regarding cognitive, motor, visual, and auditory abilities that are more comprehensive in scope and response options than the abilities-related questions of the SED or ACS. Thus, for racial and ethnic identity, sexual orientation, and disability status, the NHIS is likely the most effective, all-in-one guide for question design and benchmarking by STEM organizations. Unfortunately, the SED, ACS, and NHIS do not ask questions explicitly related to gender or transgender identity. Programs that survey these categories do not, to our knowledge, publicly release data that would be helpful for benchmarking by STEM organizations, but their survey questions can still act as guides. For instance, Indiana University's National Survey of Student Engagement provides a model for gender identity questions (with additional, nonbinary response options), and a survey from the advocacy group, National Center for Transgender Equality, provides a model for transgender identity questions. Outside of the US, orga-

Demographic data collection and usage in STEM

We obtained information about demographic data collection and usage from 73 STEM organizations, representing 712,000 members and conference attendees. Organizations most commonly collected race, ethnicity, and gender identity information but with different resolution and validity (top). Demographic data were commonly used for monitoring and resource planning (bottom). "Any use" refers to one or more of the individually listed uses.

nizations can follow these same guidelines by identifying large-scale, local survey programs that collect and report meaningful data from the general population and modifying the survey as needed to provide inclusive questions and options.

STEM organizations may wish to survey demographic categories beyond those discussed here, which were limited to the four most surveyed categories observed in our dataset (see the top panel of the figure). We encourage organizational leaders to find inclusive guides and benchmarking data for additional categories using reputable sources, such as the national survey programs described above. And just as national surveys evolve over time, organizational leaders should openly include new questions and response options to reflect and recognize levels of diversity that are important to the STEM community.

Adding new, inclusive survey elements does not necessarily compromise long-term studies of organizational diversity (i.e., continuity between surveys). In many cases, the inclusive suggestions described here involve recognizing distinctive identities from within groups historically treated as homogeneous. If needed, data from the updated (inclusive) surveys may be compared to historical values by statistically aggregating these newly recognized groups. In other cases, new identities and dimensions of diversity are recognized. Continuity between surveys is then less important because historical surveys were not collecting information that is now considered correct or meaningful to the community.

Inclusive survey questions and response options alone do not guarantee representative demographic data. Other aspects of surveys can prompt or prevent entire groups from responding, resulting in non-response biases. Response rates in general can be improved—and nonresponse bias reduced—by ensuring anonymity (e.g., delinking surveys from member registration), sending reminders, minimizing survey length, and providing incentives (*11, 14*). Furthermore, for sensitive questions, response rates may also benefit from providing a justification for data collection, such as that the results will influence specific R&R initiatives.

It is our hope that the guides presented here will enable more STEM organizations to quantify demographic diversity among their constituencies and use the data to inform and evaluate R&R efforts. To improve capacity to compare the efficacy of R&R efforts, partnering STEM organizations may wish to develop compatible frameworks for data collection by first identifying a common survey program for survey

Different surveys that ask about disability status offer different response options

Surveyed STEM organizations provided varying sets of options for responding to a question about disability status on demographic surveys. See supplementary materials for response options provided for other questions regarding racial and ethnic identity, gender identity, and sexual orientation.

Survey A (ten options)
Sensory impairment (vision or hearing) • Learning disability (e.g., ADHD, dyslexia) • Autism spectrum disorder • Long-term medical illness (e.g., epilepsy, cystic fibrosis) • Speech or language impairment • Mobility limitation or orthopedic impairment • Mental health disorder (e.g., Major depressive disorder) • Temporary impairment due to illness or injury • Disability or impairment not listed - diagnosed or undiagnosed • I do not identify with a disability or impairment

Survey B (ten options)
Deaf/hard of hearing • Visual impairment • Mobility impairment • Cognitive or learning disability • Mental health diagnosis • Neuroatypical • Autoimmune or pain disorder • Moderate to severe allergies/asthma/environmental sensitivities • Other • None of the above

Survey C (six options)
Difficulty seeing • Hearing • Speaking • Walking • Lifting/carrying • Concentrating/remembering

Survey D (five options)
I have serious difficulty walking or climbing stairs • I am deaf or have serious difficulty hearing • I have been diagnosed by a health professional as having permanent memory loss or learning disability • I am blind or have difficulty seeing even when wearing glasses • None of the above

Survey E (five options)
Hearing impairment • Vision impairment • Learning disability • Mobility/orthopedic impairment • Other

Survey F (three options)
Yes • No • Specify if you wish

Survey G (two options)
Yes • No

design and benchmarking data, and then agreeing on the demographic questions and response options to ask constituents. With this collaborative approach to survey design, organizations can then share successful strategies for the R&R of specific groups, resulting in impactful and widespread support of underrepresented groups across STEM.

Future work in this field should seek to understand how organizational recognition of diverse identities influences the R&R of underrepresented groups, and how this relationship varies across disciplines, organization types, and world regions. For instance, the analysis presented here is an aggregate snapshot of US-affiliated organizations across all areas of STEM. Do some STEM disciplines stand out in their approach to demographic data collection and R&R—e.g., in ways that could be good examples for other disciplines? Do for-profit organizations approach demographic diversity in ways that could inform R&R strategies in other organizations? Detailed assessments in these areas could identify and refine key strategies for demographic data collection and usage, and the use of these surveys for assessing R&R more broadly. Disseminating these findings to all STEM organizations will facilitate society-led support of underrepresented groups on a broad scale.

REFERENCES AND NOTES

1. N. Sellami, B. Toven-Lindsey, M. Levis-Fitzgerald, P. H. Barber, T. Hasson, *CBE Life Sci. Educ.* **20**, ar11 (2021).
2. National Science Board, "Science and engineering indicators: The state of U.S. science and engineering 2020" (NSB-2020-1, National Science Foundation, Alexandria, VA, 2020); https://ncses.nsf.gov/pubs/nsb20201/.
3. J. M. Scott, J. L. Rachlow, R. T. Lackey, *Bioscience* **58**, 865 (2008).
4. N. P. Burnett *et al.*, *Nat. Ecol. Evol.* **4**, 1283 (2020).
5. M. A. Armstrong, J. Jovanovic, *J. Women Minor. Sci. Eng.* **21**, 141 (2015).
6. C. A. Rushworth *et al.*, *Evolution* **75**, 208 (2021).
7. K. H. Nguyen *et al.*, *Bull. Ecol. Soc. Am.* **103**, e01939 (2022).
8. J. B. Freeman, *Science* **374**, 1333 (2021).
9. Y. Baruch, B. C. Holtom, *Hum. Relat.* **61**, 1139 (2008).
10. National Center for Science and Engineering Statistics, "Women, minorities, and persons with disabilities in science and engineering: 2021" (Special Report NSF 21-321, National Science Foundation, Alexandria, VA, 2021); https://ncses.nsf.gov/wmpd.
11. P. Roth, *J. Manage.* **24**, 97 (1998).
12. J. B. Yoder, A. Mattheis, *J. Homosex.* **63**, 1 (2016).
13. C. M. Snipp, *Annu. Rev. Sociol.* **29**, 563 (2003).
14. S. J. Sills, C. Song, *Soc. Sci. Comput. Rev.* **20**, 22 (2002).

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