**Final Report**
**of the**
**AAS 2016 Task Force on Education**

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# 2016 AAS Education Task Force Executive Summary

The AAS Task Force on Education, as charged by President C. Megan Urry, met and worked throughout 2016 to (1) survey the current educational activities of the Society; (2) collect meaningful data about education-related activities and needs from the astronomical community; (3) develop a coordinated education strategy for the Society; and (4) recommend to the AAS Council a prioritized portfolio of education-related activities for the Society to pursue.

In fulfilling its charge, the Task Force undertook extensive data-gathering efforts, including collecting more than 80 white papers from the astronomical community and conducting an anonymous online survey that gathered data from more than 1,800 respondents in one week.

Analysis of these and other data led the Task Force to affirm that many of the current education-related activities of the AAS are of high quality and have an impact on our membership, suggesting they should be continued or expanded as funding allows. The following broad themes unify what the AAS can and should promote for its membership via its education-related activities:

- Engagement with astronomical ideas and data
- Communication and Networking
- Mentoring at all levels
- Diversity, Inclusion, and Equity

The Task Force recommends that the AAS undertake the following activities to implement its education strategy:

(1) an active and vital Internet presence for AAS Education in the form of a curated, moderated blog with both formal and informal components for news and scholarship on educational practices and materials;

(2) a well-funded small grants program, — $1,000-$10,000 per grant, with the total annual funding level to be determined — to provide material support for membership-driven educational activities and initiatives, primarily at Society meetings but perhaps also outside them;

(3) a graduate education Task Force charged to fundamentally reassess graduate education in astronomy, with emphasis on collecting and disseminating the research and best practices in admissions, mentoring, and student retention, particularly with regard to students from under-represented groups.

These activities will ultimately require a sustained level of effort from the AAS Executive Office staff (total commitment to be determined) working with an empowered Astronomy Education Board (AEB) that serves not only in an advisory capacity, but also actively works to develop and implement these and other education-related policies and programs.

The Task Force's list of detailed recommendations by category is summarized below.

**A. Cross-Cutting Recommendations:** The AAS should solidify and strengthen partnerships with related professional societies such as AAPT, NSTA, and APS to deliver maximum value to AAS members in education-related areas. Collaborations within the Society should likewise be strengthened, between the AEB, the Executive Office, AAS Council (particularly the Vice-Presidents), and other AAS committees to maximize educationally relevant outcomes for AAS members. The AAS Vice-Presidents should plan to reserve two plenary sessions at each winter meeting relevant to the Society's broader goals in collaboration with the committees/boards of Education, Employment, and the diversity committees (CSMA, CSWA, SGMA, and WGAD).

**B. Professional Development:** The AAS should undertake professional development activities in the area of education and mentoring, with the goal of enhancing the knowledge, skills and abilities of its members

to educate all the audiences with which they engage. These professional development activities cut across the boundaries between education and mentoring, and include areas of interest to the Employment and diversity committees. The AEB should coordinate with all of these committees. The AAS should support a comprehensive, grant-funded professional development workshop program around education at AAS winter, summer, regional, and/or topical meetings, much like it currently does with respect to other aspects of employment such as mentoring and interviewing. The AEB, with AAS staff support, should create and maintain an astronomy education blog.

**C. Graduate Education:** The AAS should invest in a fundamental assessment of graduate astronomy education in the U.S., including the creation of a focused Graduate Education Task Force, organized by AAS but not limited to its membership. This Task Force will recommend actions to address the long-standing challenges of graduate programs in astronomy – in particular, in matters relating to information for prospective students, admissions criteria, demographic diversity, an inclusive environment, the graduate student experience (e.g., doctoral qualifying exams), Master's Degree and "Bridge" program outcomes, and postgraduate employment.

**D. Undergraduate Majors:** The AAS should support the development of instructional and assessment strategies that are shown through research to improve the quality of education and retention of STEM students taking undergraduate astronomy courses. The AAS should endorse, and be engaged in the dissemination of, these strategies to ensure their adoption and high-fidelity implementation in astronomy courses designed for students planning to pursue a STEM career. The AAS should also endorse and help to disseminate the high-quality programs and resources of parallel organizations – for example, AAPT professional development and the SPS Careers Toolkit. The AAS should provide professional development (see Section B) surrounding authentic and inclusive undergraduate classroom and research experiences.

**E. Undergraduate General Education:** The AAS should support its members in the teaching of college-level general education (so-called "Astro 101") astronomy classes. The AAS should disseminate research-validated best practices for its members who teach these classes in a wide variety of ways, such as through workshops at AAS meetings and elsewhere, plenary sessions on astronomy education research topics at AAS meetings (see Section A), and curating web resources via a AAS education-related blog (see Section B).

**F. K-12 Education:** The AAS and/or its members should work to find ways to increase the options for presenting topical and relevant astronomy content in high school STEM courses such as physics, chemistry, biology, and earth science. A partnership between AAS members and K-12 teachers should be established to design and create authentic astronomy content that addresses K-12 standards such as Common Core and NGSS. This could take the form of a cadre of volunteer AAS education agents/ambassadors to serve as state liaisons and connect the AAS to the K-12 community.

**G. Informal Education:** The AAS should provide its membership with briefs related to the most prominent news stories – about 4 to 6 stories per year – at the time of the press release, and easy access to all press releases via the AAS website. The AAS should also provide space, online or at meetings, where those engaged in education and public outreach can network and collaborate.

## Full Report of the 2016 AAS Education Task Force

### 1. Introduction

In August 2015, the AAS Council and staff worked diligently to map out a strategic plan that will guide and move the Society forward for years to come. Among the many strategic priorities that were identified, one of the most important was education — that is, the "share" part of the mission of the AAS, which is to enhance and share humanity's scientific understanding of the universe.

During that discussion, the Council recognized that education is a broad term that includes among other things formal and informal education, public outreach, education research, and professional development in teaching and learning. Furthermore, the AAS membership is remarkably diverse in the variety and number of education-related activities in which it engages — and also in the opinions held about the role the Society should play and the resources it should commit to those activities. Accordingly, the Council recommended the creation of a Task Force on Education that would provide the AAS with a data-driven, well-considered path for the future of the Society's educational philosophy and activities.

In early 2016, AAS President C. Megan Urry appointed the members of the AAS Task Force on Education and presented them with the following charge:

- Survey, categorize, and assess the past and current education-related activities of the Society, including undergraduate, graduate, and postgraduate education; pre-K, primary, and secondary education; public outreach, social-media activity, and informal education; professional development of Society members; and astronomy education research.
- Collect statistically meaningful data from the Society membership to catalog and assess the amount, breadth, and significance of education-related activity in their astronomy-related and career-related efforts, in all the various categories listed above.
- Develop, guided by those data and assessments, a coordinated education strategy for the Society, with clear goals and metrics for success, aligned with the best interests of the Society's members and the mission and vision of the Society; and, if resources will be required, indicate the level and possible origins of those resources (including the AAS).
- Recommend to the AAS Council a prioritized portfolio of education-related activities for the Society to pursue, in both the short term and long term, which will further the coordinated education strategy and the achievement of its goals.

The members of the Task Force met three times during the year – at O'Hare Airport in Chicago (May), the American Museum of Natural History in New York (June), and AAS Headquarters in Washington (October) – and had numerous conversations by electronic means during 2016.

## 2. Overview of the Data

The following were the major sources of data used by the Task Force in producing this report.

### 2.1. Education Task Force White Papers

In May and June 2016, the AAS membership was invited to submit white papers for consideration by the Task Force on any matter related to the education activities, policies, or programs of the AAS and its members. A total of 81 white papers were submitted; the complete list of these documents and their authors is provided in Appendix I. Any or all of the individual white papers are available to the AAS Council upon request.

The white papers generally fell into at least one of two categories, with many spanning both categories. In the first category, the white papers described specific education-related activities and programs in which AAS members were engaged that went beyond typical classroom teaching duties. These ranged widely, from work with the general public (adults and children) to K-12 students, undergraduates, graduate students, and groups underrepresented in astronomy and science in general. In the second category, both specific and general ideas of how the AAS should (or should not) conduct and support the education-related activities of its members were offered. These ideas also ranged widely; the most common theme that emerged is that the AAS should have a well-defined and stable infrastructure in place to support the educational activities of its members.

### 2.2. Education Task Force Survey

To gather key data on the education-related activities and experiences of the AAS membership that were unavailable by other means, the Task Force conducted a short online survey in October 2016 using SurveyMonkey. The anonymous survey, which was open for one week, was pilot-tested with the AAS Executive Committee, and then was widely advertised online and by word-of-mouth.

The survey received 1,893 responses. Although not every respondent answered every survey question, 80% of the respondents answered the question, “Are you a member of the AAS?” and 82% of those answered “Yes.” This implies that slightly more than 20% of the AAS membership responded to the survey. Comparisons between this survey and the 2013 AIP demographic survey of the AAS membership suggest that our survey respondents represent well the demographics of the AAS membership; for example, 62% ($N$ = 1214) of AAS members in this survey reported their institution to be a 4-year college or university, compared to 58% ($N$ = 508) for the AIP survey. Non-AAS members were invited to take the survey, and respondents were invited to provide comments at many points throughout the survey.

Overall, although time constraints prevented the Task Force from pursuing more extensive survey validation before its distribution, the survey provides a significant amount of quantitative data as well as many hundreds of short-answer responses relating to the AAS and astronomy education. Excerpts of the results of this poll are given in Appendix II. The full survey dataset is available to the AAS Council upon request.

### 2.3. AAS Membership Demographic Information

Demographic information about the AAS membership, including their current employment status, activities, and types of workplaces, were obtained from the 2013 demographics survey conducted by the American Institute of Physics (AIP) (the most recent data available) and AAS membership demographic data as of August 2016. The relevant data from the 2013 survey is presented in Appendix III.

### 2.4. Education Component of the 2017 AAS Annual Report

The 2017 AAS Annual Report lists the activities of the Society. The reports of those activities relevant to education, including readership statistics of the AAS education newsletter *Spark*, are presented in Appendix IV.

### 3. Core Beliefs and Unifying Principles

The synthesis of the data described above provides substantial guidance for establishing the future education-related strategies of the AAS. In particular, the following core principles emerged from that synthesis to shape the recommendations in this report.

**(1) Engagement** of members and non-members with both foundational and new astronomical ideas and data, and in both formal and informal settings, is an overarching mission that the AAS should systematically and vigorously support.

**(2) Communication and networking** via the AAS is needed to connect people with a wide variety of expertise such that they can pursue coordinated efforts in education.

**(3) Mentoring** at all career stages is an essential activity for supporting a diverse, thriving astronomical community, and members should have opportunities both to receive high-quality mentoring and to be trained in how to provide it.

**(4) Equity, inclusion, and diversity** are considerations that should drive all AAS activities related to education, and engaging our membership on these topics directly is itself an educational endeavor that the AAS should pursue.

These core principles have been discussed widely across much of the work of the AAS, and many of the sub-communities within the AAS have addressed them to varying degrees. One example, to which the Task Force referred in shaping this report, is the set of Inclusive Astronomy Recommendations on Teaching and Mentoring, provided in its entirety in Appendix V.

## 4. Recommendations of the Task Force by Category

The Task Force has organized its recommendations in this report by category. The first category cuts across a range of AAS activities including but not limited to education. Following that we address, roughly in their order of significance to the AAS and its membership: education-related professional development, graduate education, undergraduate education (sub-categorized by majors and general education), K-12 education, and informal education. Along with the recommendations, we provide some of the motivations for making them as well as detailed discussion, relevant background information, and references.

Importantly, these recommendations are by no means a laundry list of everything that can and should be done to promote education in astronomy. Rather, the Task Force has (as per its charge) prioritized the activities in each category, based both on what *can* be achieved by the AAS and what most urgently *needs* to be achieved to further the AAS mission and goals as outlined in its strategic plan.

### 4.1. Cross-Cutting Recommendations

The Task Force recommends greater collaboration and partnerships between the AAS Astronomy Education Board (AEB), the AAS equity and inclusion committees (CSWA, CSMA, WGAD, SGMA), other relevant AAS committees (e.g., Employment and Public Policy), the AAS Executive Office staff, and the AAS Vice Presidents.

The Task Force recommends that the AAS create a policy to rebalance plenary talk topics (particularly at the winter meeting) to reflect the broad interests of the AAS membership. In particular, we suggest that two plenary talks at each winter meeting be devoted to non-science talks across multiple topics, including those represented by the committees/boards, e.g., Education, CSMA, CSWA, SGMA, WGAD, and Employment. The committees would recommend speakers to the VPs who would select the speakers on these topics for each meeting. The committees would be encouraged to jointly recommend speakers on cross-cutting topics.

**Motivation:**

Education has consistently been a major priority of the AAS. Substantial effort and resources have been invested by the AAS in education for decades, and the AAS Council has reaffirmed the Society's continued commitment to education through the work of this Task Force and other valuable activities.

An overarching theme that emerged during the work of the Task Force is that an important misconception must be dispelled: education is not merely an ancillary activity of the AAS and its members. **Education is fundamental to the purpose and mission of the AAS** – to enhance and share humanity's scientific understanding of the universe. The data show unequivocally that nearly 100% of AAS members engage in formal or informal education, and that 100% of AAS members have experienced and have been shaped significantly by education. Not surprisingly, every AAS member contributes to, interacts with, and perceives education uniquely; accordingly, the AAS education strategy must be highly flexible yet comprehensive, and fully integrated into the spectrum of AAS activities.

**Discussion:**

One key way to help achieve this integration is to have education be a primary presence at AAS meetings. In large part, education activities occur at the fringes of the AAS meeting schedule – in the days before the opening reception, or at specialized education sessions not centrally accessible to attendees in general. This kind of isolation is not limited, however, to education. At the 2015 and 2016 AAS winter meetings, for example, 31 of the 34 (91%) plenary talks (including prize talks) were on research science topics. Only 3 were on non-research science topics, and all 3 were on public policy. Although public policy is extremely important to the AAS membership, it is the only non-science topic regularly featured in plenary talks, even though the non-research science interests of AAS members are

much broader – as, indeed, the goals of the AAS itself must also be if it is to share humanity's scientific understanding of the universe successfully.

In 2016, events in the astronomical community led to the rapid scheduling of a lunchtime Town Hall on harassment in the astronomical sciences. This was possible only with great and commendable effort by the AAS Vice-Presidents, and in part because a previously scheduled Town Hall convener agreed to move to a less desirable time slot; and even then, another Town Hall was scheduled at the same time, so the meeting on harassment was not truly a plenary session.

The Task Force recognizes that AAS meetings, especially the winter ones, are crowded with plenary sessions, many of which are mandated and unavoidable. The AAS Vice-Presidents labor mightily to create meeting schedules, and need time, support, and cooperation to accommodate any kind of systemic change to the scheduling process. Thus, the Astronomy Education Board (AEB) must feel empowered to work with the Vice-Presidents and the AAS Executive Office staff, over long periods of time, to plan and prepare the effective broadening of the AAS plenary schedule. AEB's coordination must also reach out to the Employment Committee and the diversity committees (WGAD, SGMA, CSWA, and CSMA) who also should be part of the integration process.

Creating a plenary agenda which helps achieve the broader goals of the AAS represents just one step in the overall recognition and integration of education as a key part of the AAS mainstream. The AEB has for many years served almost exclusively as an advisory body; but its charge also includes the authority to "implement education-related AAS activities consistent with the mission, goals, and strategic plan of the Society." This active role of the AEB should be encouraged and fulfilled; and as education touches upon so many other aspects of AAS committee activities such as employment, diversity, and public policy, AEB should be allowed and empowered to coordinate its activities with all the various AAS committees going forward.

### 4.2. Professional Development in Education and Mentoring for the AAS Membership

The Task Force recommends that the AAS create opportunities for professional development activities in the area of education and mentoring, with the goal of enhancing the knowledge, skills and abilities of its members to educate all the audiences with which they engage. These education and mentoring professional development activities cut across the boundaries of the roles within AAS of the AEB, the Employment Committee, and the diversity committees (CSMA, CSWA, SGMA, WGAD), and the AEB should coordinate with all of these committees. Specifically, the AAS should support and fund a comprehensive, grant-based professional development workshop program around education, mentoring, and related activities at AAS winter, summer, regional, and/or topical meetings. AAS staff should facilitate the coordination and implementation of workshops that are recommended by AEB, as it does with other AAS committees.

The Task Force also recommends that the AAS create and maintain an astronomy education blog run by the AEB, similar to those run by AAS committees such as CSWA, CSMA, and WGAD, to complement these in-person professional development opportunities.

**Motivation:**

Almost all AAS members teach (93% according to the AAS Education Task Force Survey) and mentor (89%) astronomy students in a wide variety of contexts ranging from graduate to K-12 education.[1] Yet, frequently, AAS members receive no training in teaching (29%) or mentoring (67%) beyond what they

[1] Of the 1328 AAS member respondents who answered Q1 regarding their current and past teaching, only about 7% reported that they had not, nor were currently, teaching to any groups of learners identified in the survey; of the 1228 AAS member respondents who answered Q3 regarding their current and past advising/mentoring, only about 11% of AAS member respondents who answered Q5 regarding their current and past mentoring reported that they had not, nor were currently, advising/mentoring any groups of learners identified in the survey.

learned from observing their own teachers.[2] What educators learn from this "apprenticeship of observation" (Lortie & Clement, 1975) typically is not satisfactory for supporting a diverse population of students (e.g., Johnson 2007); instead, intentional changes to these inherited educational practices are often needed to better meet these goals. Teaching and mentoring are challenging, complex tasks for any educator to undertake, and professional development around these tasks can help astronomy educators foster more positive experiences for all their students, and particularly for students who are more likely to be disadvantaged by traditional practices. These more equitable and inclusive educational practices are detailed in subsequent sections of this report, including many of the white papers (Appendix I) and the Inclusive Astronomy Recommendations on Teaching and Mentoring (Appendix V).

The AAS is uniquely positioned to facilitate the improvement of astronomy education by providing education and mentoring professional development (EPD) opportunities for its members. While some institutions provide non-discipline-specific EPD opportunities around these issues, the quality and prevalence of these opportunities vary widely across institutions, and local teaching and learning centers are unlikely to provide the discipline-specific recommendations and examples that allow educators to bring what they learn in professional development contexts more easily and directly into their own instructional contexts. Consistent with this reasoning, our survey data seems to demonstrate that AAS members are more likely to participate in EPD opportunities provided by the AAS than in local EPD.[3]

Moreover, by providing a range of learning opportunities related to teaching and mentoring that are shared across many AAS members, the AAS can play an important role in promoting and normalizing continuing, research-informed discussions about teaching and mentoring within the astronomy community. Similarly, there is significant educational expertise embedded within the AAS community — both the wisdom of experienced practitioners and the findings of education researchers — and the AAS should help to share and cultivate that expertise by connecting its members in EPD contexts.

**Discussion:**

As stated above, the Task Force first recommends that the AAS provide sustained support for a series of education and mentoring-focused professional development (EPD) opportunities that bring state of the art practices in education, mentoring, and inclusivity to its membership and enable the formation of networks of AAS members who can pursue educational improvements together. Rather than provide an exhaustive list of potential professional development opportunities that would be appropriate to bring to the AAS membership, we will instead articulate a framework that should be used to inform the creation of a high-impact AAS EPD program. This framework is intended to help guide the Society in deciding what kinds of EPD to offer (topics and formats) and how to facilitate a program that meets the needs of both those who will provide the EPD and those who will participate in it.

To operationalize these ideas, the Task Force recommends that the Astronomy Education Board administer an EPD proposal program. Through this proposal program, the AEB would solicit and evaluate proposals from the AAS membership to lead EPD experiences at winter, summer, regional, and/or topical meetings. In order to be successful, proposals must describe EPD that: (1) is appropriate for the target AAS membership, (2) centers on research-informed and research-validated instructional and mentoring strategies, (3) considers mechanisms by which these strategies could support equitable and inclusive learning environments, (4) is informed by best practices in professional development such as creating opportunities for participants to consider concrete examples of instruction or mentoring, encouraging

[2] 29% of AAS member who responded to Q5 regarding their training related to teaching, n=803, reported they had never received any training related to teaching regarding any of the groups of learners identified in the survey; 67% of AAS member respondents to Q6 regarding advising/mentoring training, n=833, reported they had never received any training related to advising/mentoring regarding any of the groups of learners identified in the survey.

[3] Of the 1210 AAS member respondents who answered Q11, and 1188 who answered Q12, regarding professional development opportunities provided by the AAS during and outside of AAS meetings, respectively, only 2-8% of respondents reported neither wanting to attend PD workshops, nor wanting the AAS to provide PD workshops, during AAS meetings, whether they be on teaching, advising/mentoring, or diversity/equity/inclusion; also, only 10-15% of respondents reported neither wanting to attend PD workshops, nor wanting the AAS to provide PD workshops, outside of AAS meetings.

multiple perspectives to be voiced, debated, and discussed, and infusing discussions with ideas from current research (Olmstead & Turpen 2016; Prather & Brissenden 2009; Ball & Cohen 1999). The AEB would work to ensure that the EPD program reaches the greatest diversity of society membership and features a complementary array of PD experiences, topics, and target audiences.

To help implement the EPD program envisioned above, the Task Force recommends providing travel stipends and meeting rooms for workshops at regional, national and topical AAS meetings. Travel stipends and room support will be allocated by the AEB as part of the EPD proposal review process. EPD events at national AAS meetings should occur over the Saturday and Sunday at the beginning of meetings *as well as* during the Monday-Thursday portion of the meeting. Regional workshops or those held at other AAS-sponsored meetings should be considered on a regular basis by the AEB, and the AEB should work with the Employment Committee and diversity committees as needed. These procedures and forms of support can help to ensure that this EPD program reaches the AAS members it is intended to serve.

The following points about AAS professional development workshops should also be taken into consideration:

- The AAS Vice-Presidents currently review some PD activities at AAS meetings, especially those competing for Special Sessions against the science program. The AEB should work with AAS leadership to ensure that a core EPD program will proceed. It might be useful to prioritize the sessions requested in case there are limits.

- For EPD workshops that are "proven" (popular, well-attended, and get good reviews), the AAS staff might take over the majority of the work (payment negotiations for consultants, charges for attendees and appropriate waivers of charges, etc.), with AEB continuing to monitor for quality.

- While Society meetings are an ideal venue for EPD activities, it may be appropriate in some cases to move successful EPD programs outward to other institutions such as colleges and universities (see "Additional Discussion" below).

The Task Force also recommends that the AAS create and maintain an astronomy education blog and a related newsletter/digest. This blog would provide regular, continuing opportunities for instructors to learn about teaching and mentoring while at their home institutions, and has the potential to foster a stronger sense of active, shared commitment to education among the AAS community. Online resources in general can provide instructors with access to valuable materials and ideas, and can easily reach instructors who are more isolated and/or are struggling to find high-quality teaching materials to build from. Research on EPD has also consistently demonstrated that: (1) instructors frequently adapt and reinvent existing instructional innovations to match their preferences and the demands of their local environments (Turpen et al. 2016, Dancy et al. 2016, Henderson & Dancy 2008), (2) instructors need to think critically about and discuss new instructional strategies in the long-term in order to sustain their use of these strategies (Henderson et al. 2012), and (3) instructors are more likely to take up new instructional strategies when they are introduced to them by colleagues they know and feel they can trust (Dancy et al. 2010, 2016). Thus, an astronomy education blog that spans a wide range of topics and includes contributions from people with a variety of relevant expertise is an ideal complement to the EPD program described above.

This blog could be modeled after the CSWA's Women in Astronomy blog, as well as the blogs from the CSMA and WGAD. As with these other AAS-related blogs, while the education blog would be curated by AEB members, they would do this on a volunteer basis, and their primary role would be to solicit guest posts from knowledgeable astronomy educators and/or education researchers. This would give AAS members opportunities to learn about astronomy education from many perspectives and get to "know" many instructors within the astronomy education community whose instructional materials and additional expertise they could then seek out. While the AEB would flexibly respond to what it learns about the interests of AAS members over time, likely topics would include: (a) profiles of astronomy educators; (b) short articles that describe educational innovations including research-based instructional materials and point readers to external resources; (c) summaries of recent astronomy and physics education research findings; (d) advice to new instructors or mentors and other opinion pieces; and (e) practitioners'

descriptions of how they have integrated prior education research findings into their work and what they discovered in the process. These topics would inform the teaching and mentoring practices of AAS members individually, and could spark valuable conversations around these topics within and across astronomy and physics departments. There would be frequent opportunities for cross-posts with the blogs of the CSWA, CSMA, and WGAD surrounding issues of equity and inclusion, which would help to increase readership and showcase the strong connections between promoting equity and improving instruction. Moreover, by elevating the voices of knowledgeable members of our community, the AAS would cultivate new leaders and networks surrounding shared educational pursuits, which would in turn bolster the larger educational mission of the AAS in the long term.

**Additional Discussion: Professional Development for Earlier-Career AAS Members**

The proposed professional development program in education described above offers a concrete opportunity for members at all levels of seniority. Some PD issues are specifically of interest for reaching earlier-career members of the AAS – graduate students and postdocs – namely, those more closely related to obtaining and retaining employment. For graduate students, many universities already provide PD in teaching; however, it is not clear if university EPD programs are effective, even though many schools and departments may push back against the intimation that they are not. EPD needs can be even more acute for postdoctoral fellows, who are not necessarily at universities and do not necessarily have access to these services even if they are. In developing its EPD program, the AEB should consider the following points.

- The AAS currently provides a broad range of PD activities at its winter meetings, some of which specifically address education goals, while others focus on software development, presentation skills, and employment seeking (see Appendix VI for the list of activities at the Winter 2016 AAS meeting). These activities are widely sought by junior scientists, including graduate students and postdoctoral fellows. Because the winter meetings are becoming saturated with PD activities, the recent Task Force Report on Meetings suggested piloting some PD activities at the summer meetings, where a smaller number of activities are offered. However, the (less-well-attended) summer meetings have a significantly lower proportion of junior attendees than the winter meetings. The potential relevance of summer EPD workshops to junior attendees should therefore be taken into consideration when making these scheduling decisions.

- The AAS Employment Committee focuses most of its activities on junior scientists. In developing the Education PD program, the Astronomy Education Board should consult with the Employment Committee to determine responsibility for activities that might overlap and review lessons learned.

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### 4.3. Graduate Education

The Task Force recommends that the AAS invest in a fundamental assessment of graduate astronomy education in the U.S. This investment would include the creation of a focused Graduate Education Task Force, organized by AAS but not limited to its membership, that will recommend actions to address the long-standing challenges of graduate programs in astronomy – in particular, in matters relating to information for prospective students, admissions criteria, demographic diversity and an inclusive environment, the graduate student experience (including doctoral qualifying exams), Master's Degree and "Bridge" program outcomes, and postgraduate employment.

The Graduate Education Task Force membership should include a broad range of stakeholders, including leading astronomy PhD-producing programs, minority-serving and Hispanic-serving institutions (MSIs/HSIs), leaders of successful Bridge and other diversity/inclusion programs, graduate students, post-graduate employers, funding agencies such as NSF or NASA, related professional societies such as the American Physical Society, and education and social science researchers who have studied the problems that need to be addressed.

While the Graduate Education Task Force should explore the totality of graduate education, we recommend that they focus on these four broad issues: (1) graduate recruitment and admissions, with a particular focus on practices that promote diversity and inclusion, (2) the impact of department culture on graduate students, and what practices promote an inclusive learning environment that leads to greater retention, especially for students from traditionally underrepresented groups, (3) the mentoring that graduate students receive, including ways to increase the number of mentors that each student has and improve the quality of this mentoring through mentor training, and (4) the information and training graduate students receive to help them pursue multiple career paths in their post-graduate employment.

**Motivation:**

Graduate education programs in astronomy should strive to create a welcoming and inclusive environment for people of all genders, ethnicities, ability status, socioeconomic status, etc. and intersections thereof. All graduate students should be well-trained, mentored, and supported in pursuing a variety of career paths that become accessible to them as a result of participating in graduate programs. The growing recognition of our society is that these ideals are not being met, particularly in the area of equity and inclusion.

A number of recent developments have taken place in the astronomy community surrounding these issues including: the creation of multiple Bridge and other inclusion programs, primarily at MSIs/HSIs; the Inclusive Astronomy meeting in 2015; the statement on the GRE by the AAS Council; and the recent decision to reexamine admissions and recruitment practices at a number of major astronomy PhD programs. These developments provide an impetus to pursue a coordinated, community-wide effort to improve graduate education.

**Discussion:**

Twenty years ago, in 1996, a report on graduate education, entitled *"The American Astronomical Society's Examination of Graduate Education in Astronomy"* was jointly created by the then AAS Education Policy Board and the Graduate Advisory Board.

The primary goal of that report was to address the perceived overproduction of PhDs at a time of great funding uncertainty. Its three key recommendations were:

- Define and support experiments to enrich graduate education
- Re-examine the Master's degree in astronomy
- Provide students with the information and experience necessary to make informed career decisions

A great deal of effort went into producing that report, and much of what it found and recommended is still relevant today. As such, any effort to assess graduate education today should begin with a careful reading and consideration of the findings of that report.

Beyond the contents of that report, perhaps the most significant issue in graduate astronomy education that the AAS must address is the ongoing lack of racial and economic diversity in the field. According to the latest statistics from the NSF (2015), underrepresented minority (URM) students made up only 3% of PhDs in Astronomy between 2002-2012, yet they comprise 30% of the general population. There were a total of 4 ?2 URM PhDs per year in astronomy during that period *nationally* – a percentage and a number that, if astronomy is to succeed as a largely publicly funded and publicly supported endeavor in America, is ultimately both unacceptable and unsustainable. The 2010 Decadal Survey of Astronomy highlighted this problem, noting that "Little progress has been made in increasing the number of minorities in Astronomy," and recommending "Partnerships of community colleges and minority-serving institutions [MSIs] with research universities and with national centers and laboratories" to overcome this underrepresentation.

The one explicit mention of diversity in the 1996 report occurred in section 4.1.3 entitled, *Deliberate reduction of the population of graduate students or of graduate departments is not wise*:

"…it was agreed that the admissions process is imperfect; identifying college seniors with the combination of intelligence and temperament matched to a research career is, with few exceptions, extremely difficult. Practicing "birth control" at this stage would result in premature evaluations based more on "objective" criteria than on assessment of a student's performance in a graduate research department. Moreover, "birth control" at this early stage would almost certainly compromise the ability of graduate departments to meet their stated goal of enhancing diversity in the physical sciences."

This statement highlights a key point: graduate admissions criteria are one of the steepest barriers to increasing diversity in astronomy. Education and other social science research has shown (Steele & Aronson 1995; Glanz 1996; Sternberg & Williams 1997; Dweck 1999; Sedlacek 2005; Duckworth et al. 2007; Helms 2009; Miller & Stassun 2014) that traditional measures of ability used in graduate admissions, particularly the general GRE and physics subject GRE (PGRE), strongly suppress diversity in the applicant pool, yet are poor predictors of degree completion and long-term success in research, the two main goals of most PhD programs. The AAS Council recently acknowledged this research in a statement suggesting that Astronomy PhD programs eliminate or make optional the GRE exam in graduate admissions (aas.org/governance/council-resolutions#GRE), and a number of major astronomy departments have recently voted to eliminate or make optional the physics GRE in their graduate admissions requirements (astrobites.org/2016/09/09/the-impact-of-the-physics-gre-in-astronomy-graduate-admissions/). Eliminating the GRE alone, however, will not solve our equity and inclusion problem. Graduate faculties need to examine their entire programs to consider how, through admissions and financial aid decisions, qualifying processes, and overall mentoring and support structures (or lack thereof) for graduate students, they enhance or suppress equity and inclusion in their programs and ultimately in the field overall.

Although resistance to change remains significant – how many senior AAS members think, "The system must be perfect because it produced me?" – many in the astronomical community recognize the need to improve graduate education in this crucial respect. Many of the top-tier astronomy PhD-producing institutions – almost none of which are MSIs – have begun sincere and genuine efforts to improve access to their graduate programs for URMs, women, and other underrepresented groups (such as LGBTQIA* and the differently abled). Other notable efforts have included the creation of "bridge programs" and novel summer research programs designed to reach large numbers of URM students who do not traditionally participate in REU programs. These include the Fisk-Vanderbilt Master's-to-PhD program (fisk-vanderbilt-bridge.org), Columbia Bridge-to-the-PhD program (facultydiversity.columbia.edu/bridge-phd-program-natural-sciences), Cal-Bridge (www.cpp.edu/calbridge), CAMPARE (www.cpp.edu/campare), the National Astronomy Consortium (science.nrao.edu/opportunities/student-programs/nac), Princeton Bridge, and AstroCom NYC. Furthermore, professional societies aligned with AAS have also moved to address the issue of diversity and inclusion in graduate education: notably, the American Physical Society has

convened national meetings on graduate physics education and bridge programs (www.apsbridgeprogram.org/conferences/2017/) and have piloted a network for access and inclusion in graduate education through an NSF INCLUDES award. It is time that our Society formally engages with these efforts.

Meanwhile, the three principal recommendations of the 1996 report remain relevant. The connections between our discipline and the wider economy have multiplied in the past twenty years: from robotics to statistical inference, and from design to big data, the prospects for an astronomy PhD student outside the traditional academic track have brightened. Both our curricula and our cultural attitudes need adjustments to reflect this new reality. Furthermore, many potential future members of the astronomical community – perhaps especially URM students, who disproportionately face difficult economic circumstances – need viable options for employment and professional development other than a traditional doctorate leading to an academic position, as well as viable career "off-ramps" if they do not complete the PhD for whatever reason.

While an appropriately configured Master's degree will, and should, remain a stepping stone to the PhD for many students (especially for those who find astronomy late in their undergraduate careers and/or come from institutions lacking the resources to provide competitive graduates for PhD programs), this degree can also provide access to multiple careers such as those noted above as well as in education, science communication, and public policy. Creative approaches that link astronomy programs with other institutional resources could satisfy this broader agenda.

Finally, prospective students should be provided with complete and accurate information about graduate program opportunities and outcomes. The 1996 report contained explicit recommendations for offering such information to prospective students; however, these recommendations have not been bolstered by the AAS. The AAS has taken a leadership role in rationalizing the postdoc market by imposing uniform decision deadlines and creating (and evolving) a universally used job register. Our expectation is that an appropriately constituted AAS body could likewise develop a practical set of community standards for the provision of information to prospective graduate students.

After the AAS Graduate Education Task Force completes its work, the AAS should act upon its recommendations, incorporating them into metrics as part of the Society's strategic plan, and sustaining a continual process of reassessment and improvement – it must not be another twenty-plus years before the next such review.

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### 4.4. Undergraduate Majors

The Task Force recommends that the AAS support the development of instructional and assessment strategies that are shown through research to improve the quality of education and retention of students taking these courses. The AAS should endorse and be engaged in the dissemination of these strategies to promote their high-quality implementation in astronomy courses that are part of astronomy majors programs.

The Task Force recommends that the AAS engage in professional development for its members in how to provide and support authentic and inclusive undergraduate research experiences. Additional professional development is needed to better train our members in inclusive and equitable mentoring of majors. The AAS should endorse and disseminate high-quality resources and programs from parallel organizations, e.g., professional development from the AAPT and the SPS Careers Toolkit.

**Motivation:**

Many AAS members understand the value of using well-researched, evidence-based practices in educational activities. Currently, however, research and curriculum efforts that inform how we can best teach and assess the teaching of our undergraduate majors courses are sorely lacking in the astronomy education research (AER) community. There is a clear need for increased efforts to understand the struggles learners experience with the topics taught most commonly at the undergraduate level. Additionally, there is a need for research on the development of validated instructional techniques proven to help students develop more robust discipline-specific knowledge and abilities.

The majority of undergraduate physics and astronomy majors will not become professional astronomers, *but the majority of future professional astronomers will come from these populations*. Likewise, many recipients of undergraduate astronomy degrees do not intend to pursue careers in astronomy. The quality of classroom instruction and mentoring for both categories of students is central to the mission of the AAS, and the data show that efforts by the AAS to support and disseminate effective pedagogy in this area would directly support the activities of a large fraction of Society members.[4]

**Discussion:**

Perhaps surprisingly, there is still a need for a valid study of what is generally taught – or should be taught – in an undergraduate astronomy program; without one, it is not yet possible to know what it really means to get a Bachelor's degree in astronomy in the modern era. There is also little research on what kinds of mentoring of majors are most effective, on the assessment of what astronomy undergraduates are learning, and on whether astronomy educators are achieving what astronomers think is important for successfully teaching undergraduate majors. In other words, there is almost nothing to disseminate to members yet about undergraduate astronomy majors that is evidence-based, let alone research-validated.

Thus, prior to the development and endorsement of these instructional and assessment strategies, the AAS should engage its membership in a consensus-building discussion of expected goals and experiences for students in the undergraduate majors. This could be modeled, after the AAS Department Chairs Meetings several years ago that led to the goals statement for Astro 101 (Partridge & Greenstein 2003).

Ironically but fortunately for the AAS, undergraduate degrees in astronomy continue to be popular, despite the lack of uniformity or understanding of what an "astronomy major" is. A 2014 survey by Nicholson and Mulvey (2015) of all degree-granting astronomy departments in the United States shows that undergraduate astronomy enrollments in the US continue to rise with junior- and senior-level enrollments exceeding the previous year's all-time high. Increasing undergraduate enrollments produced 428 bachelors in the 2013-

[4] 58% of AAS members who responded to the 2016 education survey teach or have taught undergraduate STEM majors - see Appendix II.

14 academic year, also an all-time high. Undergraduate astronomy degree production will likely continue to rise given the increases seen in undergraduate enrollments.

Although the percentage of undergraduate astronomy students who engaged in undergraduate research that go on to graduate school in astronomy is unknown, essentially 100% of all astronomy graduate students engaged in research as undergraduates. This underscores the importance of such experiences. The AAS should continue to support the growing population of undergraduate students and their research, with programs like the undergraduate reception at AAS meetings, and allowing undergraduates wide access to publish AAS abstracts and present at AAS meetings.

**Reference:**

Partridge, B. & Greenstein, G. “Goals for ‘Astro 101’: Report on Workshops for Department Leaders, *Astronomy Education Review, 2*(1).

### 4.5. Undergraduate General Education

The Task Force recommends that the AAS strongly support its members in the teaching of general education astronomy college classes, often referred to as "Astro 101." The AAS should disseminate research-validated best practices for its members who teach these classes in a wide variety of ways, such as workshops at AAS meetings and elsewhere, plenary sessions on astronomy education research topics at AAS meetings, and (through substantial and careful effort) curating educational and curricular resources on the Internet via an education-related AAS blog.

The Task Force recommends that the AAS increase its support of astronomy education research (AER), especially AER that leads to more effective teaching of undergraduate astronomy, and that the AAS disseminate the results of that research in the variety of ways described above.

**Motivation:**

Undergraduate general education is one of the highest priorities for the AAS because it provides the most opportunity for impact; i.e., undergraduate general education is the cross section between what the AAS is well-positioned to do and where it can have the greatest impact. Between one-half and two-thirds of active AAS members are at degree-granting institutions (see Appendices II and III). Fraknoi (2001) estimates that in the year 2000 approximately a quarter of a million students enrolled in an introductory astronomy ("Astro 101") course. According to the National Center for Education Statistics, the total undergraduate enrollment in degree-granting postsecondary institutions increased 31 percent from 13.2 million in 2000 to 17.3 million in 2014; if Astro 101 courses have grown at a commensurate rate, then annual enrollment easily exceeds 300,000 students. This group represents by far the largest demographic reached by undergraduate formal education and should be a priority for the AAS. It is also worth noting that a significant fraction of AAS members have taken a general education astronomy course (see Appendix II).

An impressive 73% of AAS members who responded to the education survey teach or have taught Astro 101 courses (see Appendix II). Clearly, efforts by the AAS to support and disseminate effective Astro 101 pedagogy would directly support the educational professional development and activities of the Society's members. Although a significant and growing number of AAS members are aware of some relevant results in astronomy and physics education research, far fewer have received significant training in effective teaching pedagogy (see Appendix II) in methods such as "Think-Pair-Share," Lecture-Tutorials, and course-based undergraduate research experiences (CUREs).

The impacts of AAS efforts in this area would be even broader than that, however. A survey of non-research institution instructors by Fraknoi (2001) also showed that only 38% have a PhD. Of these, only 20% have their highest degree in astronomy (with 40% in physics) and most teach other science courses besides astronomy. The AAS needs to be mindful of the fact that most Astro 101 instructors are not research scientists in astronomy and may lack the ability to teach–or at least be uncomfortable with teaching–some Astro 101 topics. Effective and widespread dissemination of astronomy education research (AER) results, high-quality teaching materials, and educational best practices could thus substantially increase the effectiveness of science instruction for a large number of undergraduates – many of whom (albeit a small fraction of Astro 101 students overall) may be future AAS members; according to the AAS education survey respondents, about as many members have taken an Astro 101 course as have not (see Appendix II).

**Discussion:**

In disseminating the results of AER, the AAS has traditionally used workshops as its primary vehicle. Workshops can be a highly effective training strategy because they allow instructors to interact directly with experienced educators and try out high quality teaching methods for themselves. A drawback of workshops, though, is that they are relatively expensive compared to most other dissemination strategies. AAS meetings are (and have been) a natural setting for workshops; if they are held during the "prime time" of an AAS meeting (usually Monday-Wednesday) it may help in increasing member participation.

In some white papers (see Appendix I) and numerous informal conversations, AAS members have expressed to Task Force members that online distribution of curated instructional materials – especially for Astro 101 – is a service that many members would find useful. Members who, for example, might be novice Astro 101 instructors, or might wish to infuse their current instruction with the latest methods and materials, could seek out such resources through the AAS education blog.

The Task Force examined the feasibility of this approach, and concluded that it is possible to create and maintain an online collection of educational resources for AAS members – but only in a systematic, carefully crafted and controlled way, with non-trivial levels of support from AAS staff. Previous efforts of this kind by other organizations – a notable example is the comPADRE AstronomyCenter, created by the American Association of Physics Teachers – have not been particularly successful or useful to the AAS community. Some of the pitfalls to consider as the AAS creates and maintains such a web resource include the following.

(1) Too much material will make the website unusable. Online "voting," of the kind popular in hotel or restaurant rating sites, has never worked well for online educational materials. If numerous resources on similar teaching topics are proposed for inclusion, how will the choice of what to include be made? How will the AAS then deal with complaints of exclusion, or of bias against individuals or organizations with rival pedagogical philosophies or styles?

(2) Posting educational material or links to such material on the AAS website, including on an "official" associated blog, implies a level of approval or even endorsement by the AAS. Does this effect lead to legal or ethical complications if, for example, financial undercurrents are at work? Should the AAS allow commercial products to be featured? What kinds of copyright issues will occur – even accidentally, if for example a contributor accidentally uses copyrighted material? How about if an educator's chances of workplace advancement or promotion are affected?

(3) Making educational resources available online provides no assurance that those resources will be properly used. It is indisputable that the same materials used by different instructors can lead to widely different learning outcomes. Will the AAS also provide adequate training to users of the curated material? Would that purpose be served just by having more workshops?

The Task Force concluded that simply posting resources and links to the AAS education blog without substantial ancillary effort would not serve the AAS membership well. On the other hand, with the proper attention to detail and a continual level of effort from AAS Executive Office staff working with the AEB or a subgroup within AEB, a curated online educational resource maintained as part of the AAS education blog would be useful and valuable to AAS members. Such an effort, if sustained, could ultimately provide a significant impact in the largest single educational activity – again, 73% of AAS member respondents to the education survey have participated in teaching Astro 101 – of the Society.

### 4.6. K-12 Education

The task force recommends that the AAS support its members in finding ways to increase the options for presenting topical and relevant astronomy content for easy inclusion in the K-12 classroom. The material should reflect the core ideas, practices, and cross-disciplinary ideas presented in the current national science education standards (e.g., the Next Generation Science Standards, the Common Core Standards for Mathematics, and Common Core Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects).

**Motivation:**

An important goal of the AAS should be for its members to be effective disseminators of astronomy to future astronomers and to future science advocates, regardless of their current knowledge level. K-8 exposure to astronomy content is common. Some school districts do offer astronomy as a high school (grades 9-12) elective, but this is not widely available. Fortunately for the AAS, astronomy is often viewed as a gateway science, and thus has a welcomed place in K-12 education even though it is not always taught at all levels.

Importantly, the AAS must not succumb to the misconception that it has no leadership role to play in K-12 education. Historically, other organizations such as the Astronomical Society of the Pacific have had higher profiles in K-12 astronomy education and public outreach; and most of the AAS membership does not engage in formal K-12 education. That said: the role of the AAS in the K-12 environment is not so much to teach K-12 or implement our content, but to create contacts so that members can reach out or be reached. In this way, good astronomical content can be brought into K-12, even if K-12 educators are restricted in what they can do in their classrooms, and AAS members can learn and adopt best teaching practices.

A K-12 effort directly addresses the following parts of the AAS mission and vision statement: "*The Society assists its members to develop their skills in the fields of education and public outreach at all levels to promote a broad interest in astronomy, which enhances science literacy and leads many to careers in science and engineering… The Society also works with other scientific and educational societies to promote the advancement of science."*

**Discussion:**

Partnerships between AAS members and K-12 teachers to design and create authentic topical material (currently, for example, on the detection of gravity waves) offer great benefits to all involved. Only 10% of AAS Education Survey respondents who are AAS members reported having received past training related to teaching K-12 students and/or K-12 teachers, while nearly one-third of these respondents reported having received no training whatsoever related to teaching (see Appendix II). Partnerships with K-12 experts in the field will expose our members to educational best practices and give them the opportunity to adopt these practices in their own classrooms. In return, the K-12 experts will receive valuable content knowledge that can be passed on to their students. Engaging students in authentic content is one key to keeping them motivated in STEM fields.

A partnership between AAS members and K-12 teachers would leverage both parties' expertise (content and best practice, respectively) and provide an ideal platform for society members to learn about cutting edge best practices in education that are transferable from the grades 9-12 classroom to the university classroom. Teachers of students of all ages, for example, struggle with keeping their students engaged. Having our members cognizant of currently viewed best practices will assist them in developing their own educational skill set.

A cadre of volunteer AAS education agents/ambassadors could serve as state liaisons and bridge AAS membership and the K-12 community. This builds on current valued projects, such as the K-12 Educators Reception, as well as additional activities (workshops, oral/poster sessions, etc.) for non-K-12 educators, at AAS meetings. The AAS should also link to existing excellence in K-12 education; e.g., AIP Toolbox and NASA Wavelength.

Extending these ideas further, the AAS should also supports its members who work to find ways to increase astronomy in other sciences that are a focus in K-12; e.g., astrobiology and using astronomy examples in physics. The effectiveness of adding *ad hoc* material pertaining to exciting new results can be limited due to available class time. At best, this material is usually relegated to the end of the school year. Astronomy content specifically designed to address science/literacy and math standards in subjects commonly offered in grades 9-12 is thus needed in order to leverage the exposure to astronomy at lower grade levels.

### 4.7. Informal Education

The Task Force recommends that the AAS provide, at the discretion of the AAS Press Officer or AAS Communications Director, short briefs related to the most prominent astronomy-related news stories (4 - 6 per year) at the time of their release to the press, and to have access to all press releases via the AAS website, to those AAS members who request them.

The Task Force recommends that the AAS provide spaces – online and at meetings – where AAS members and others engaged in public outreach and informal education can network together and collaborate.

**Motivation:**

The AAS currently conducts a substantial amount of education-related activity beyond education sessions and workshops at AAS meetings (see Appendix IV). Many of these programs, including the Shapley Lectureships, the Astronomy Ambassadors program, the AAS student education outreach program, Doxsey Awards, and Chambliss Prizes, fall partially or completely within the realms of informal education and professional development. The Task Force observed that all these programs have been successful, with positive outcomes for AAS members, and should be continued as the AAS staff (especially the Education and Outreach Coordinator) sees fit, and as long as funding for the programs remains available.

In assessing what gaps in AAS informal education activity exist, and how to address them, the Task Force recognized that AAS members are frequently asked to respond to both media inquiries and public questions related to breaking news about astronomical discoveries – and, as accessible "gateway science" experts, news about technology and the physical sciences in general. A typical AAS member, however, may not be fully prepared to address results from disparate fields without doing time-consuming preparation for a media interview. Information about such discoveries may appear in the popular press, for example, but without reading the relevant peer-reviewed publications or other related information, the AAS member risks being ill-informed about what the discovery really is or what it means to the field or the public.

The Task Force also observed that AAS members conduct a substantial amount of informal education and public outreach, often with large and measurable impacts in their communities and on social media. In conducting most of these activities, however, AAS members are isolated, or otherwise going about their work independently without much support or coordination from the astronomical community. The AAS is in a position to provide, at relatively low cost but possibly to great effect, that kind of community support and networking, simply by creating spaces for such interactions to occur. Such spaces could be physical, for example at AAS meetings, and virtual, for example as part of the AAS education blog.

**Discussion:**

The AAS Press Officer, in collaboration with AASNova, Astrobites, and other Society communications services, do an excellent job overall of disseminating astronomical news to the press and the general public. At the discretion of the Press Officer or a director of communications, news items likely to spark substantial media interest should be given further attention, and described in such a way – perhaps during the embargoed period, in preparation for the moment of the press release – that Society members who are asked to interact with the media can rapidly and accurately respond with scientific authority and confidence, thanks to the AAS. This "deeper press briefing" resource would only need to be produced a few times per year, and would likely broaden the impact of AAS at the informal, public communications level. Furthermore, in our increasingly media-dominated world, increasing the media savvy and mass-communications skills of AAS members represents a valuable kind of professional development.

Support of informal education by the AAS presents an important choice for the Society. A large number of white papers received by the Task Force, as well as numerous comments from the AAS education survey, called for the financial support of informal education by AAS members via a grants program,

funded and administered by the AAS. These AAS members emphasized a great need for such support, which is hard to find or nonexistent through typical astronomy or education funding channels, especially for smaller, highly innovative activities. The Task Force recognized the need for such funding; and in examining the historical and current activities of the AAS, and in consultation with other scientific societies such as the American Physical Society, the Task Force saw that the practice of scientific societies supporting its members' informal educational activities through small grants is a long-standing practice, and can provide a tremendously valuable and impactful service to their members.

The Task Force also recognized that a sustainable, sensible, and highly effective system to administer and distribute such funding would be needed. Rather than fulfilling "wish lists" of projects to be funded, criteria for AAS support must be established, consistent with the mission and goals of the Society. A comprehensive system like this is beyond the scope of what the Task Force recommends. However, the education professional development (EPD) small grants program described above (Sec. 4.2) could encompass some informal education grants which have EPD for Society members as a central, driving outcome. Funding at this level would be consistent with the amount of funding provided for similar activities by other scientific societies like the American Physical Society (typically $10,000 or less).

The Task Force recognized that other, even lower-cost services that support the informal education of AAS members could be provided by the AAS through its education blog. One service could be to aggregate funding sources for informal education on behalf of AAS members. Communication and networking, always a key in successful education activities, could work through the blog, as well as dissemination of impactful or innovative informal education and public outreach activities conducted by AAS members. With the total solar eclipse of August 2017 approaching, the systematic AAS support of informal education in these ways would be timely and potentially extremely effective in promoting the AAS and its mission to enhance and share humanity's scientific understanding of the universe.

## Appendices

I. White Papers Submitted to the AAS Task Force on Education in 2016

II. Relevant Data from the AAS Education Task Force Survey

III. Relevant Data from the AIP Demographics Survey of 2013 US AAS Members

IV. Education Component of the 2017 AAS Annual Report

V. Inclusive Astronomy Recommendations on Teaching and Mentoring

VI. Employment Committee and Education Sessions at AAS227

## Appendix I. White Papers Submitted to the AAS Task Force on Education in 2016

| Author Last Names | Title*<br>(*Note: When authors did not provide a title, one was created on their behalf.) |
|---|---|
| Arcand | White Paper on the Power of Images in Astronomy Communications & Education |
| Berriman | White Paper: Application of Professional Data Processing Tools in E/PO Work |
| Biermann | Astronomy's Role in International Relations |
| Bridgman | An Important Component for Addressing Pseudo-Scientific Claims in Astronomy and other Physical Sciences |
| Brinkworth, Byrd Skaer, Prescod- Weinstein, Teske, & | Building an Inclusive AAS - The Critical Role of Diversity and Inclusion Training for AAS Council and Astronomy Leadership |
| Brissenden | Diversity and Education: They Are Linked! |
| Bruning | Assessment of Educational Impact |
| Burchheim | AAS should embrace the Small-Telescope, Non-Traditional Research Community |
| Clarkson, Bord, Swift, Rasmussen, Matzke, Murrell, LoPresto, Campbell, Clubb, & Salliotte | Sustaining Educational and Public Outreach Programs in Astronomy |
| Coble, Bellovary, Brinkworth, Burgasser, Holley-Bockelmann, Faherty, Isler, Mink, Moreno, Murphy, Norman, Rigby, Rudolph, & Stassun | The AAS Astronomy Education Board's Role in Implementing Inclusive Astronomy Recommendations |
| Coble, Arvidsson, Grin, Grube, & Trouille | AAS-Sponsored Astronomy Education Partnerships with MSIs |
| Connelly, Kastner, Kartaltepe, Richmond, Robinson, Vazquez, Almeda, & Punzi | Education and Public Outreach Activities Hosted and Supported by the Laboratory for Multiwavelength Astrophysics at the Rochester Institute of Technology |
| Cruz | Briefing Memos |
| Dcruz | Professional Development, Education Research, and Meeting Costs |
| DeVore | Why foster and support education and outreach aimed at the public? |
| Dixon | How to Be a Better Professor to Your LGBT+ Students |
| Feldmeier | The AAS and United States Planetariums: More Communication, More Cooperation, and Future Opportunities |
| Fienberg 1 | Professional-development workshops on teaching and learning |
| Fienberg 2 | "Those who cannot remember the past are condemned to repeat it." |
| Forman | Working to Establish a Resource Archive for Use in Developing Astronomy Courses |
| Foukal | Science in Our Time |
| Fraknoi, Morrison, & Wolff | A Free High-Quality Open-Source Textbook in Astronomy |
| Fraknoi & Wentzel | Astronomy Education and the American Astronomical Society |
| Fraknoi 1 | A Role that Fits the AAS like a Glove: Training Early Career Astronomers for Both Teaching and Outreach |
| Fraknoi 2 | What Education and Outreach Work Should the AAS Be Engaged in? |
| Fraknoi 3 | Publishing Papers on Astronomy Education Research and Practice: An Ongoing Dilemma |
| Garmany | AAS Education Task Force White Paper about Education Outreach to the Native American Community |
| Geller | The State of Education and Public Outreach in Astronomy and Today's State of Affairs Compared to that of a Half Century Ago |

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|---|---|
| Genet & Trimble | Small Telescope Research Communities of Practice |
| Gorkavyi | The Popularization of Astronomy through Books and Movies |
| Gugliucci, Crowl, Tan, Ribaudo, Bochanski, Hamilton, & Clarkson | Astronomy Education at Small Institutions |
| Helfand | Graduate and Undergraduate Education and EPO |
| Hintz | *White Paper for the Implementation of Educations Endeavors for the American Astronomical Society* |
| Holbrook & Traweek | White Paper on African American Astronomy Graduate Students |
| Hooper | White Paper on Improving Mentored Experiences in Research in Astronomy and Physics |
| Howard | White Paper for Education/Professional Development |
| Hunter | Increasing Diversity in Astronomy and Physics |
| Jenks | Making the AAS More Relevant, and Known of, to Younger Astronomers |
| Kamenetzky & Crossfield | How Smooth is the Transition from Academia to Industry? |
| Kamenetzky | Availability of AAS Job Register Statistics |
| Keeton & Ballentine | Lessons from a Structured Program for Undergraduate Research |
| Keohane | Platform to Share Our Ideas and Classroom Materials |
| Kuchner | Marketing for Scientists |
| Lesyna | White Paper about SETI Courses for Students |
| Liss, Sokal, Beaton, Johnson, & the DSBK Team | Dark Skies, Bright Kids! and the Value of Repeated Interactions with Elementary School Students |
| Lloyd-Ronning & Fryer | Achieving More Inclusive Science Education |
| Lutz | Astronomer Involvement in Their Local Community of Astronomy Educators and with National Organizations |
| Masters | On the Use of Real Data |
| Mathews, Kadooka, Armstrong, Nassir, Meech, Gal | Hawaii Student / Teacher Astronomy Research |
| McDaid | The Right Balance |
| McIntosh 1 | Freshman University Pre-STEM Program |
| McIntosh 2 | A Bridge to the Stars: High School-to-College Pipeline to Increase STEM Diversity |
| Michaud | Gemini Observatory's "Practical" Vision for Local Outreach |
| Muna | Astroinformatics and Astronomy of Tap |
| O'Connell | Professional Development, EPO, and Education Reform |
| Olmsted & Chambers | Enabling Instructors as Partners an Undergraduate Instructional Change |
| Olmsted & Prather | The Need to Understand Success in Preparing the Next Generation of Astronomers |
| Pasacoff | Preparing Students for the 2017 Total Solar Eclipse Across America |
| Pearson | An Online Video Series for Young Children Suitable to Formal and Informal Learning Environments |
| Perera & Buxner | Establishing a Presence on YouTube for Formal and Informal Astronomy Education |
| Prather | Framework to Guide the AAS Education Task Force's Decision-Making Regarding Educational Programs for the AAS |
| Rebull | Getting Educators Involved in Authentic Astronomy Research |
| Rector | The Need to Develop Evidence-Based Teaching Practices in AAS Members |
| Rehnberg & Nevin | Going Above & Beyond: A Cross-Disciplinary Planetarium Program |
| Rudolph | (Lack of) Diversity in Graduate Education in Astronomy |
| Sanders, Kohler, Villar, Faesi, & the Astrobites Collaboration | Transitioning Undergraduates to Research Careers: Introducing the Astrophysical Literature in Bites |

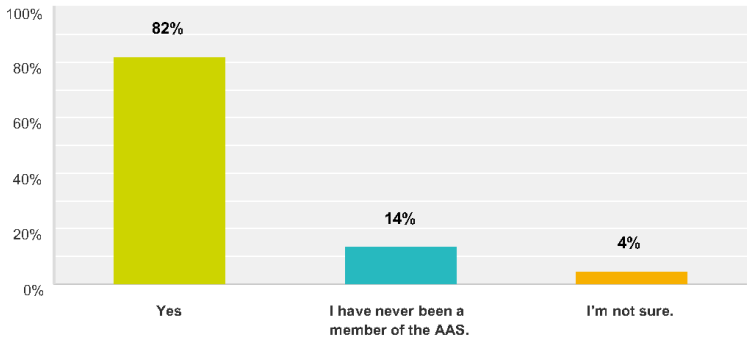
| | |
|---|---|
| Scott & Schaefer | Public Outreach and Educator Professional Development at Towson University: Baltimore Project ASTRO" |
| Short | OpenStars: Web-based Pedagogical Computational Modeling for Astronomy Education and Public Outreach |
| Shupla | Educator Professional Development in Astronomy |
| Siemiginowska | Relevance of Astrostatistics and Astroinformatics to Education |
| Smith | Ways Scientists Can Meaningfully Participate in Education and Outreach |
| Storrs | Teaching with a Planetarium |
| Summers & Eisenhamer | The Scientist-Educator Partnership |
| Swift | Thacher Observatory |
| Towner 1 | AAS Members' Engagement with the Public and Public Policy |
| Towner 2 | Undergraduate Recruitment and Retention |
| Ubach | Public Outreach |
| Wilds | Concern about the Quality of Results of Education in Astronomy and the Effectiveness of Astronomical Educational Outreach |
| Wolf-Chase | Outreach to the "Science Apprehensive Public" |
| York & Masters | A Comment on Outreach for STEM Oriented Students |
| Zingale, Timmes, Fisher, & O'Shea | The Importance of Computation in Astronomy Education |

## Appendix II. Relevant Data from the AAS Education Task Force Survey

In total, there were 1893 individual respondents to the survey of the AAS Education Task Force, though not all respondents answered all questions in the survey. Data was collected over an approximate 1-week period in October 2016. Following are figures and data tables of relevance to this report from the survey. Below each figure and table is a brief discussion of the data.

### Q23 Are you a member of the AAS?

Answered: 1,517 Skipped: 376

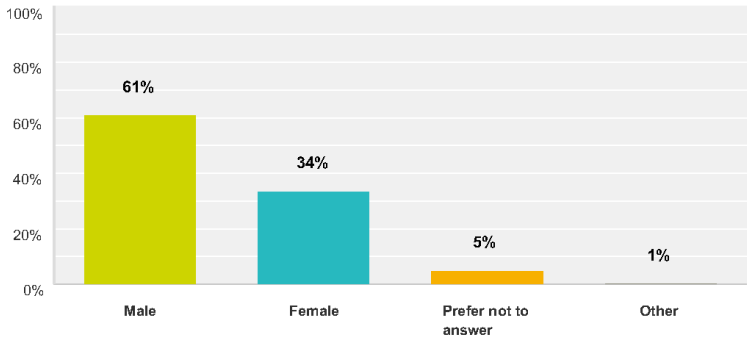



| Answer Choices | Responses | |
|---|---|---|
| Yes | 82% | 1,243 |
| I have never been a member of the AAS. | 14% | 206 |
| I'm not sure. | 4% | 68 |
| Total | | 1,517 |

**AAS Representation in the Survey (Q23):** Of respondents who answered this question (n=1517), 82% reported being current members of the AAS. According to the AAS Website, there are approximately 7000 individual members. This means (within the accuracy of the self-reporting) approximately 22% of the AAS membership is represented by the AAS Education Task Force survey data.

## Q22 In our question about gender, we offer alternatives because we recognize that some people prefer not to be categorized this way. Are you:

Answered: 1,228 Skipped: 15

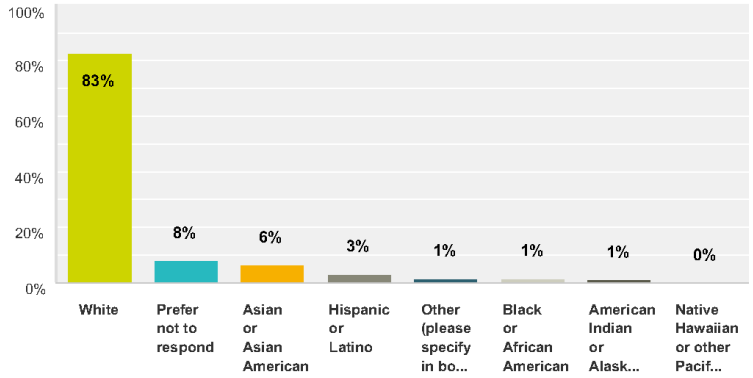



| Answer Choices | Responses | |
|---|---|---|
| Male | 61% | 748 |
| Female | 34% | 414 |
| Prefer not to answer | 5% | 59 |
| Other | 1% | 7 |
| Total | | 1,228 |

**AAS Gender Representation (Q22):** Of those respondents who reported they were current members of the AAS, and who answered this question (n=1228), 61% reported they were male, 34% female, 5% chose not to respond, and 1% responded other.

## Q21 What is your race or ethnicity? (Please check all that apply.)

Answered: 1,219 Skipped: 24

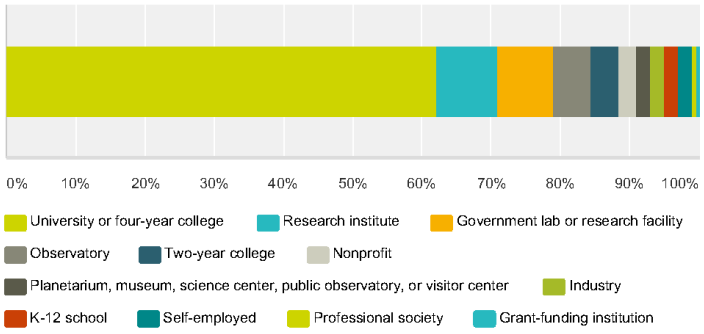



| Answer Choices | Responses | |
|---|---|---|
| White | 83% | 1,006 |
| Prefer not to respond | 8% | 98 |
| Asian or Asian American | 6% | 78 |
| Hispanic or Latino | 3% | 38 |
| Other (please specify in box below): | 1% | 17 |
| Black or African American | 1% | 16 |
| American Indian or Alaska Native | 1% | 13 |
| Native Hawaiian or other Pacific Islander | 0% | 3 |
| **Total Respondents: 1,219** | | |

**AAS Ethnicity Representation (Q21):** Of those respondents who reported they were current members of the AAS, and who answered this question (n=1219), 83% reported they were white; 11% reported they were Asian/Asian American, Hispanic/Latin, Black/African American, or Native American/Pacific Islander; 8% chose not to respond, and 1% responded other.

## Q13 Which best describes your current institution?

Answered: 1,197 Skipped: 46

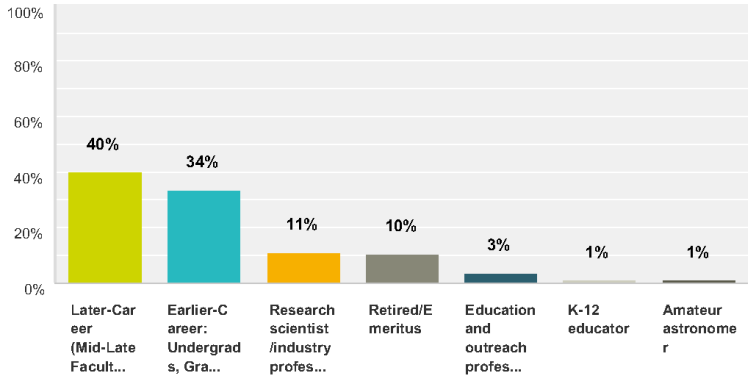



| Answer Choices | Responses | |
|---|---|---|
| University or four-year college | 62% | 744 |
| Research institute | 9% | 106 |
| Government lab or research facility | 8% | 94 |
| Observatory | 5% | 65 |
| Two-year college | 4% | 49 |
| Nonprofit | 3% | 30 |
| Planetarium, museum, science center, public observatory, or visitor center | 2% | 25 |
| Industry | 2% | 25 |
| K-12 school | 2% | 23 |
| Self-employed | 2% | 23 |
| Professional society | 1% | 8 |
| Grant-funding institution | 0% | 5 |
| **Total** | | **1,197** |

**AAS Institution-Type Representation (Q13):** Of those respondents who reported they were current members of the AAS, and who answered this question (n=1197), 62% reported they were currently at a university or 4-year college. No other type of institution (e.g research institute, government lab) was represented by more than 9% of respondents, while the majority of the remaining institution types (2-year colleges, K-12 schools, nonprofits, etc.) were each represented by 5% or less of the membership.

## Q14 Which best describes your current position?

Answered: 1,214 Skipped: 29

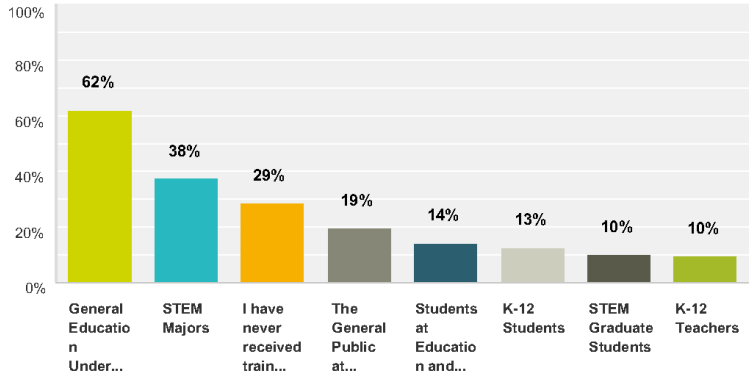



| Answer Choices | Responses | |
|---|---|---|
| Later-Career (Mid-Late Faculty/Staff) | 40% | 484 |
| Earlier-Career: Undergrads, Grads, Postdocs, Early-Career Faculty/Staff) | 34% | 409 |
| Research scientist/industry professional | 11% | 132 |
| Retired/Emeritus | 10% | 125 |
| Education and outreach professional | 3% | 40 |
| K-12 educator | 1% | 14 |
| Amateur astronomer | 1% | 10 |
| Total | | 1,214 |

**AAS Career-Level Representation (Q14):** Of those respondents who reported they were current members of the AAS, and who answered this question (n=1214), 40% reported they were mid-late faculty/staff, while 34% reported they were earlier in their careers (i.e undergraduate and graduate students, postdocs, and early-career faculty/staff.

## Q5 For which groups of people have you received training related to teaching? (Choose all that apply.)

Answered: 803 Skipped: 10

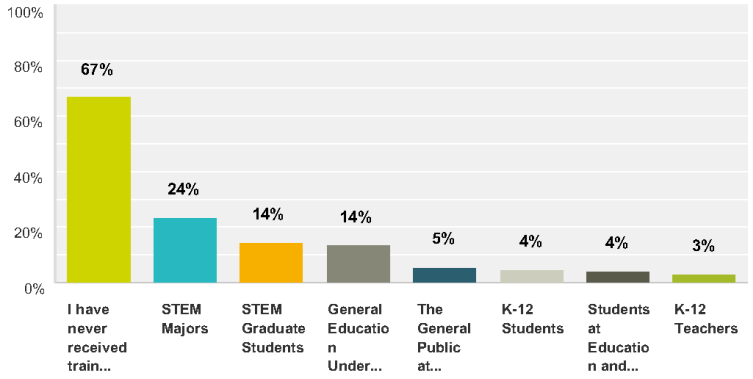



| Answer Choices | Responses | |
|---|---|---|
| General Education Undergraduates (for example, Astro 101 students) | 62% | 497 |
| STEM Majors | 38% | 302 |
| I have never received training related to teaching. | 29% | 230 |
| The General Public at Education and Public Outreach Events | 19% | 156 |
| Students at Education and Public Outreach Events | 14% | 114 |
| K-12 Students | 13% | 101 |
| STEM Graduate Students | 10% | 81 |
| K-12 Teachers | 10% | 78 |
| Total Respondents: 803 | | |

**Who Is/Will Be Teaching College-Level STEM Courses vs Training Received to Teach These Students (Q5):** Respondents were all AAS members who reported they were/would be teaching college-level astronomy courses (gen. ed. students, STEM majors, and STEM graduate students). Of these respondents, 29% reported they had never received any training related to teaching regarding any of the groups of learners identified in the survey. While 62% reported having received training related to teaching gen. ed. students, 38% reported receiving training related to teaching STEM Majors, and only 10% of respondents reported having received training related to teaching STEM graduate students.

## Q6 For which groups of people have you received training related to advising/mentoring – with respect to e.g. research, courses, careers, etc.? (Choose all that apply.)

Answered: 883 Skipped: 41

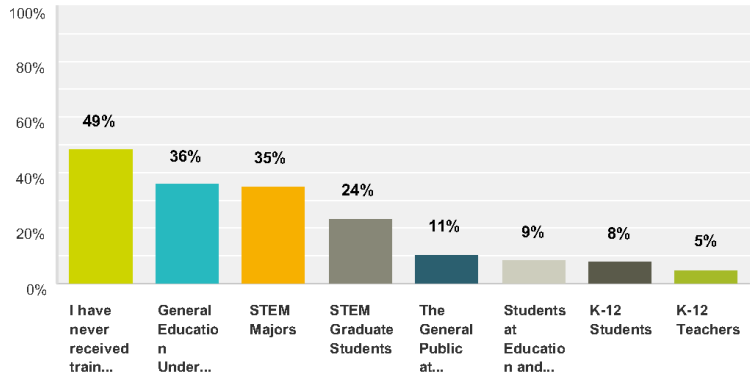



| Answer Choices | Responses | |
|---|---|---|
| I have never received training related to advising/mentoring. | 67% | 590 |
| STEM Majors | 24% | 209 |
| STEM Graduate Students | 14% | 128 |
| General Education Undergraduates (for example, Astro 101 students) | 14% | 121 |
| The General Public at Education and Public Outreach Events | 5% | 48 |
| K-12 Students | 4% | 39 |
| Students at Education and Public Outreach Events | 4% | 37 |
| K-12 Teachers | 3% | 28 |
| **Total Respondents: 883** | | |

**Who Is/Will Be Advising/Mentoring College-Level STEM Students vs Training Received to Advise/Mentor These Students (Q6):** Respondents were all AAS members who reported they were/would be advising/mentoring college-level STEM students (gen. ed. students, STEM majors, and STEM graduate students). Of these respondents, 67% reported they had never received any training related to advising/mentoring regarding any of the groups of learners identified in the survey. While 14% reported having received training related to advising/mentoring gen. ed. students, 24% reported receiving training related to advising/mentoring STEM Majors, and only 14% of respondents reported having received training related to advising/mentoring STEM graduate students.

## Q7 For which groups of people have you received training related to diversity/equity/inclusion – with respect to e.g. research, courses, careers, etc.? (Choose all that apply.)

Answered: 869 Skipped: 55

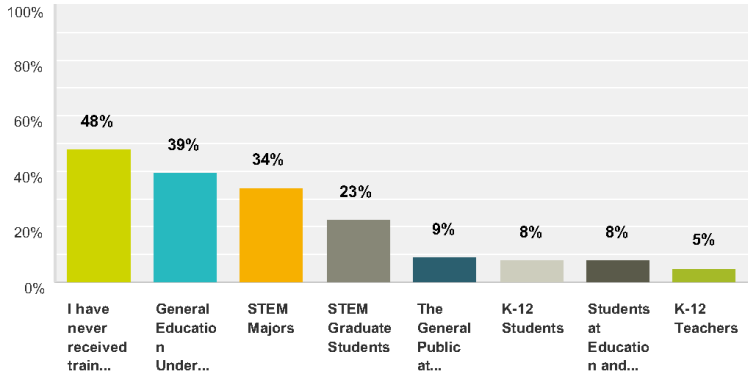



| Answer Choices | Responses | |
|---|---|---|
| I have never received training related to diversity/equity/inclusion. | 49% | 422 |
| General Education Undergraduates (for example, Astro 101 students) | 36% | 315 |
| STEM Majors | 35% | 303 |
| STEM Graduate Students | 24% | 206 |
| The General Public at Education and Public Outreach Events | 11% | 93 |
| Students at Education and Public Outreach Events | 9% | 76 |
| K-12 Students | 8% | 71 |
| K-12 Teachers | 5% | 44 |
| **Total Respondents: 869** | | |

**Who Is/Will Be Advising/Mentoring College-Level STEM Students vs Training Received Related to Diversity/Equity/Inclusion (Q7):** Respondents were all AAS members who reported they were/would be advising/mentoring college-level STEM students (gen. ed. students, STEM majors, and STEM graduate students). Of these respondents, 49% reported they had never received any training related to diversity/equity/inclusion regarding any groups of learners identified in the survey, 36% reported having received training related to diversity/equity/inclusion regarding gen. ed. students, 35% reported receiving training related to diversity/equity/inclusion regarding STEM Majors, and 24% of respondents reported having received training related to diversity/equity/inclusion regarding STEM graduate students.

## Q7 For which groups of people have you received training related to diversity/equity/inclusion – with respect to e.g. research, courses, careers, etc.? (Choose all that apply.)

Answered: 777 Skipped: 36

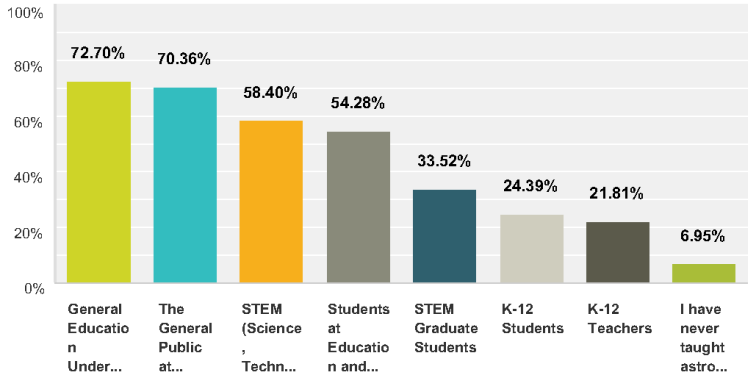



| Answer Choices | Responses | |
|---|---|---|
| I have never received training related to diversity/equity/inclusion. | 48% | 373 |
| General Education Undergraduates (for example, Astro 101 students) | 39% | 305 |
| STEM Majors | 34% | 265 |
| STEM Graduate Students | 23% | 175 |
| The General Public at Education and Public Outreach Events | 9% | 70 |
| K-12 Students | 8% | 64 |
| Students at Education and Public Outreach Events | 8% | 64 |
| K-12 Teachers | 5% | 38 |
| Total Respondents: 777 | | |

**Who Is/Will Be Teaching College-Level STEM Students vs Training Received Related to Diversity/Equity/Inclusion (Q7):** Respondents were all AAS members who reported they were/would be teaching college-level STEM students (gen. ed. students, STEM majors, and STEM graduate students). Of these respondents, 48% reported they had never received any training related to diversity/equity/inclusion regarding any groups of learners identified in the survey. While 39% reported having received training related to diversity/equity/inclusion regarding gen. ed. students, 34% reported receiving training related to diversity/equity/inclusion regarding STEM Majors, and 23% of respondents reported having received training related to diversity/equity/inclusion regarding STEM graduate students.

## Q1 Which groups of people are you currently teaching, or have you previously taught, astronomy? (Choose all that apply.)

Answered: 1,238 Skipped: 5

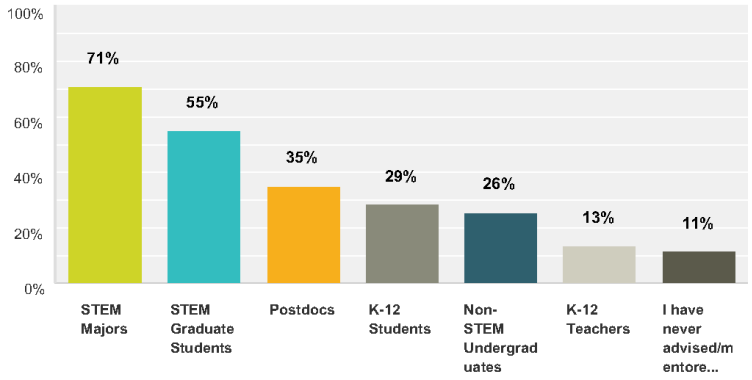



| Answer Choices | Responses | |
|---|---|---|
| General Education Undergraduates (for example, Astro 101 students) | 72.70% | 900 |
| The General Public at Education and Public Outreach Events | 70.36% | 871 |
| STEM (Science, Technology, Engineering, and Math) Majors | 58.40% | 723 |
| Students at Education and Public Outreach Events | 54.28% | 672 |
| STEM Graduate Students | 33.52% | 415 |
| K-12 Students | 24.39% | 302 |
| K-12 Teachers | 21.81% | 270 |
| I have never taught astronomy. | 6.95% | 86 |
| Total Respondents: 1,238 | | |

**Who Is Teaching/Taught in the Past (Q1)**: Of the 1238 AAS member respondents who answered Q1 regarding their current and past teaching, only about 7% reported that they had not taught, nor were teaching, anyone from any groups of learners identified in the survey.

## Q3 Which groups of people do you currently advise/mentor, or have you previously advised/mentored, in something related to astronomy – with respect to e.g. research, courses, careers, etc. – either as a formal part of your current position(s) or not? (Choose all that apply.)

Answered: 1,228 Skipped: 15

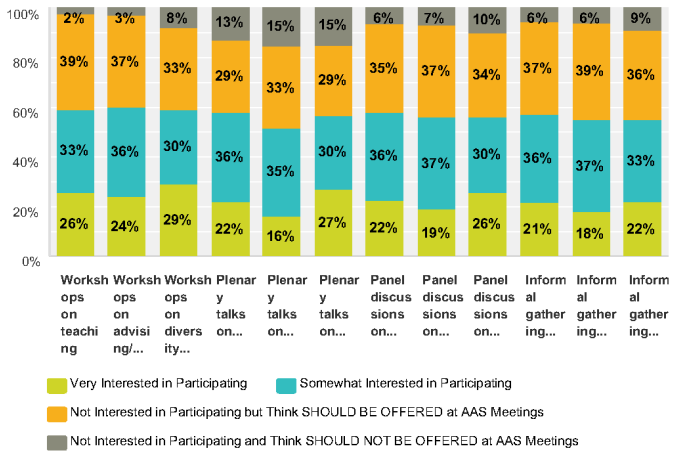



| Answer Choices | Responses | |
|---|---|---|
| STEM Majors | 71% | 874 |
| STEM Graduate Students | 55% | 678 |
| Postdocs | 35% | 427 |
| K-12 Students | 29% | 351 |
| Non-STEM Undergraduates | 26% | 316 |
| K-12 Teachers | 13% | 163 |
| I have never advised/mentored in something related to astronomy. | 11% | 141 |
| Total Respondents: 1,228 | | |

**Who is Mentoring/Mentored in the Past (Q3):** Of the 1228 AAS member respondents who answered Q1 regarding their current and past advising/mentoring, only about 11% reported that they had not advised/mentored, nor were advising/mentoring, anyone from any groups of learners identified in the survey.

## Q11 To what extent are you interested in participating in the following types of activities at AAS meetings?

Answered: 1,210 Skipped: 33

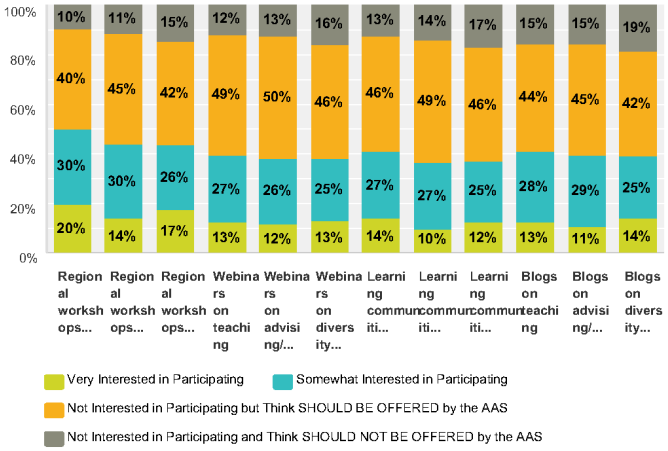



| | Very Interested in Participating | Somewhat Interested in Participating | Not Interested in Participating but Think SHOULD BE OFFERED at AAS Meetings | Not Interested in Participating and Think SHOULD NOT BE OFFERED at AAS Meetings | Total | Weighted Average |
|---|---|---|---|---|---|---|
| Workshops on teaching | **26%** 307 | **33%** 394 | **39%** 463 | **2%** 29 | 1,193 | 2.18 |
| Workshops on advising/mentoring | **24%** 283 | **36%** 433 | **37%** 437 | **3%** 37 | 1,190 | 2.19 |
| Workshops on diversity/equity/inclusion | **29%** 342 | **30%** 361 | **33%** 390 | **8%** 94 | 1,187 | 2.20 |
| Plenary talks on teaching | **22%** 259 | **36%** 420 | **29%** 337 | **13%** 151 | 1,167 | 2.33 |
| Plenary talks on advising/mentoring | **16%** 188 | **35%** 412 | **33%** 385 | **15%** 179 | 1,164 | 2.48 |
| Plenary talks on diversity/equity/inclusion | **27%** 315 | **30%** 346 | **29%** 334 | **15%** 175 | 1,170 | 2.32 |
| Panel discussions on teaching | **22%** 263 | **36%** 420 | **35%** 415 | **6%** 76 | 1,174 | 2.26 |
| Panel discussions on advising/mentoring | **19%** 222 | **37%** 437 | **37%** 437 | **7%** 81 | 1,177 | 2.32 |
| Panel discussions on diversity/equity/inclusion | **26%** 299 | **30%** 356 | **34%** 401 | **10%** 115 | 1,171 | 2.28 |
| Informal gatherings on teaching | **21%** 249 | **36%** 417 | **37%** 434 | **6%** 67 | 1,167 | 2.27 |
| Informal gatherings on advising/mentoring | **18%** 210 | **37%** 433 | **39%** 456 | **6%** 72 | 1,171 | 2.33 |
| Informal gatherings on diversity/equity/inclusion | **22%** 258 | **33%** 382 | **36%** 417 | **9%** 106 | 1,163 | 2.32 |

**Do AAS Members Want AAS to Provide PD Workshops at Meeting and to Participate in Them (Q11):** Of the 1211 AAS member respondents who answered Q11 regarding professional development opportunities at AAS meetings, only 2-8% of respondents reported neither wanting to attend PD workshops, nor wanting the AAS to provide PD workshops, at meetings, whether they be on teaching, advising/mentoring, or diversity/equity/inclusion. That is, the vast majority of respondents said that they were either very or somewhat interested in attending EPD/mentoring/advising PD at AAS meetings (or at the very least interested in the AAS providing them, even if not personally interested in attending).

## Q12 To what extent are you interested in participating in the following types of activities throughout the year (outside of AAS meetings)?

Answered: 1,188 Skipped: 55




| | Very Interested in Participating | Somewhat Interested in Participating | Not Interested in Participating but Think SHOULD BE OFFERED by the AAS | Not Interested in Participating and Think SHOULD NOT BE OFFERED by the AAS | Total | Weighted Average |
|---|---|---|---|---|---|---|
| Regional workshops on teaching | **20%** 228 | **30%** 354 | **40%** 471 | **10%** 112 | 1,165 | 2.40 |
| Regional workshops on advising/mentoring | **14%** 161 | **30%** 352 | **45%** 519 | **11%** 131 | 1,163 | 2.53 |
| Regional workshops on diversity/equity/inclusion | **17%** 201 | **26%** 302 | **42%** 488 | **15%** 171 | 1,162 | 2.54 |
| Webinars on teaching | **13%** 144 | **27%** 308 | **49%** 559 | **12%** 139 | 1,150 | 2.60 |
| Webinars on advising/mentoring | **12%** 134 | **26%** 303 | **50%** 570 | **13%** 144 | 1,151 | 2.63 |
| Webinars on diversity/equity/inclusion | **13%** 151 | **25%** 286 | **46%** 530 | **16%** 183 | 1,150 | 2.65 |
| Learning communities on teaching | **14%** 155 | **27%** 305 | **46%** 514 | **13%** 142 | 1,116 | 2.58 |
| Learning communities on advising/mentoring | **10%** 108 | **27%** 297 | **49%** 549 | **14%** 158 | 1,112 | 2.68 |
| Learning communities on diversity/equity/inclusion | **12%** 137 | **25%** 275 | **46%** 509 | **17%** 191 | 1,112 | 2.68 |
| Blogs on teaching | **13%** 142 | **28%** 323 | **44%** 495 | **15%** 176 | 1,136 | 2.62 |
| Blogs on advising/mentoring | **11%** 120 | **29%** 329 | **45%** 510 | **15%** 175 | 1,134 | 2.65 |
| Blogs on diversity/equity/inclusion | **14%** 158 | **25%** 283 | **42%** 477 | **19%** 210 | 1,128 | 2.66 |

**Do AAS Members Want AAS to Provide PD Workshops outside of AAS Meetings and to Participate in Them (Q12):** Of the 1188 AAS member respondents who answered Q12 regarding professional development opportunities provided by the AAS outside of AAS meetings, only 10-15% of respondents reported neither wanting to attend PD workshops, nor wanting the AAS to provide PD workshops, outside of AAS meetings, whether they be on teaching, advising/mentoring, or diversity/equity/inclusion. That is, the vast majority of respondents said that they were either very or somewhat interested in attending EPD/mentoring/advising PD provided by the AAS but outside of regular AAS meetings (or at the very least interested in the AAS providing them, even if not personally interested in attending).

## Appendix III. Relevant Data from the AIP Demographics Survey of 2013 US AAS Members

The following statements reflect relevant findings based on data presented in the AAS membership workforce survey conducted on our behalf by the AIP (https://aas.org/posts/news/2014/01/2013-aas-biennial-demographics-survey-released). The relevant information for each table in the report is highlighted:

### Table 7: Current Employment

**Table 7 - Current Employer**

| Current Employer of US AAS Members with PhDs, 2013 | | |
|---|---|---|
| **Employer or Sector** | **%** | **N** |
| University or 4-year college | 58 | 508 |
| Govt. lab or research facility | 14 | 124 |
| Observatory | 9 | 77 |
| Research Institute | 8 | 74 |
| Industry | 4 | 32 |
| Other govt. | 2 | 18 |
| Self-employed | 1 | 9 |
| 2-year college | 1 | 10 |
| Planetarium or museum | 1 | 6 |
| Secondary school | - | 2 |
| Other | 2 | 13 |
| ***Total*** | | *873* |

Includes full-time employed respondents with PhDs excluding current postdocs.

About 60% of survey respondents who are full-time employees, who also have PhDs but are not postdocs, are at a university or 4-year college (58%), 2-year college (1%), planetarium or science museum (1%), or secondary school (< 1%).

### Table 10: Desired Employment of Postdocs

**Table 10 – Desired Employer of Postdocs**

| Desired Employer of US AAS Member Postdocs, 2013 | | |
|---|---|---|
| **Desired Employer or Sector** | **%** | **N** |
| University or 4-year college | 63 | 98 |
| Research Institute | 22 | 34 |
| Govt. Lab or research facility | 5 | 7 |
| Observatory | 3 | 5 |
| Planetarium or museum | 3 | 4 |
| Industry | 1 | 2 |
| Self-employed | 1 | 1 |
| Other | 2 | 4 |
| ***Total*** | | *155* |

About 66% of postdocs want to end up at a university or 4-year college (63%) or planetarium or museum (3%).

### Table 11: Current Employer of Former Postdocs

**Table 11 – Current Employer of Former Postdocs**

| Current Employer of US AAS Members who took Postdocs, 2013 | | |
|---|---|---|
| **Employer or Sector** | **%** | **N** |
| University or 4-year college | 59 | 443 |
| Govt. Lab or research facility | 12 | 93 |
| Research institute | 9 | 69 |
| Observatory | 9 | 67 |
| Industry | 3 | 20 |
| Other govt. | 2 | 14 |
| Self-employed | 2 | 14 |
| Planetarium or museum | - | 3 |
| Other | 3 | 24 |
| ***Total*** | | *747* |

Excludes current postdocs.

About 59% of former postdocs are currently at a university or 4-year college (59%) or planetarium or museum (< 1%).

### Table 13: Main Activity in Current Job

**Table 13 - Main Activity in Current Job**

| Main Activity in Current Job Of US AAS Members, 2013 | | | | |
|---|---|---|---|---|
| | **University, 4-year college** | | **All other sectors** | |
| **Activity** | **%** | **N** | **%** | **N** |
| Teaching | 31 | 208 | 5 | 26 |
| Devising, conducting observations | 25 | 165 | 23 | 124 |
| Theory, N-body simulations | 13 | 90 | 7 | 36 |
| Instrumentation, telescope design | 6 | 42 | 12 | 65 |
| Data visualization, mining | 6 | 41 | 9 | 46 |
| Education or public outreach | 4 | 24 | 5 | 29 |
| Management, administration | 3 | 21 | 11 | 57 |
| Multiple activities | 3 | 23 | 1 | 7 |
| Data analysis | 2 | 12 | 3 | 16 |
| Laboratory astrophysics | 1 | 6 | 2 | 10 |
| Other research | 1 | 7 | 1 | 7 |
| Software, IT | - | 3 | 6 | 31 |
| Other | 4 | 26 | 16 | 86 |
| ***Total*** | | *668* | | *540* |

Includes current postdocs.

Of survey respondents at a university or 4-year college, 31% state teaching is their primary activity and 4% state education and public outreach is their primary activity. Those in other sectors report 5% and 5% respectively. Of note in the report:

- "Of those who wrote in multiple activities as their main activity, many specified 'research and teaching'"; and
- "As expected, those who reported teaching as their main activity were concentrated in universities and 4-year colleges."

## Table 14: Time Allocation in Current Job

**Table 14 - Time Allocation in Current Job**

Time Allocation in Current Job of US AAS Members, 2013

| Activity | Average Pct. of Time Spent on Activity | Respondents Doing this Activity % |
|---|---|---|
| | University,4-yr college (All other sectors) | |
| Research (includes writing proposals, articles and books, and attending colloquia) | 44 (43) | 95 (83) |
| Teaching (class, lab time, and prep, office hours, other student contact related to teach or advising) | 40 (29) | 75 (21) |
| Service activities (TAC, proposal reviews, advisor committees) | 11 (10) | 73 (55) |
| Education & public outreach | 9 (16) | 51 (38) |
| Management | 18 (33) | 43 (47) |
| Observatory/mission support/instrument commission | 26 (46) | 24 (49) |
| Other | 35 (57) | 5 (14) |
| ***Total*** | | *661 (536)* |

Includes current postdocs.

Respondents at a university or 4-year college stated they spent about 40% of their time engaged in teaching-related activities (with 75% of respondents from this sector saying they engage in this activity; this includes postdocs, who weren't included in Table 7), and in the other employment sectors respondents still reported they spent about 29% of their time engaged in teaching-related activities (with 21% of respondents from this sector saying they engage in this activity).

For these same respondent groups (university and 4-year versus other), university respondents spent 9% of their time engaged in education and outreach activities (51% of respondents in this sector engaged in education and outreach-related activities), while those employed in other sectors said they spent 16% of their time engaged in education and public outreach activities (38% of respondents in this sector engaged in education and outreach activities).

The report also states: "A greater proportion of AAS members employed by universities or 4-year colleges reported spending time on teaching, service activities, and education and public outreach than those employed in other sectors of the economy."

## Table 15: Primary Area of Interest

**Table 15 – Primary Areas of Interest**

| Primary Areas of Interest of US AAS Members, 2013 | | |
|---|---|---|
| | % | N |
| Star formation & evolution | 30 | 378 |
| Galaxy formation & evolution | 24 | 294 |
| Cosmology | 20 | 252 |
| Solar systems, planetary science | 19 | 240 |
| Interstellar medium | 19 | 238 |
| Astronomy education | 18 | 229 |
| Exoplanets | 18 | 223 |
| Galactic structure and stellar pop. | 17 | 209 |
| Supernovae, GRBs, high-energy phenomena | 16 | 195 |
| Active galactic nuclei | 15 | 191 |
| Clusters of galaxies, large-scale structure | 13 | 156 |
| Heliophysics | 8 | 104 |
| Astrobiology | 8 | 95 |
| Other | 20 | 246 |
| ***Total*** | | *1247* |

The sum of percentages exceeds 100 because respondents were asked to check all that apply.

18% of respondents stated astronomy education was their primary area of interest. The report states that, on average, respondents selected 2.5 primary areas of interest.

## Table 15b: Primary Area of Interest by Sex

**Table 15b – Primary Areas of Interest by Sex**

| Primary Areas of Interest of US AAS Members with PhDs by Sex, 2013 | Male | | Female | |
|---|---|---|---|---|
| | % | N | % | N |
| Star formation & evolution | 30 | 281 | 31 | 88 |
| Galaxy formation & evolution | 23 | 216 | 26 | 73 |
| Cosmology ** | 22 | 209 | 14 | 39 |
| Solar systems, planetary science | 19 | 178 | 20 | 57 |
| Interstellar medium * | 20 | 188 | 15 | 42 |
| Astronomy education | 18 | 167 | 21 | 58 |
| Exoplanets | 18 | 166 | 20 | 56 |
| Galactic structure and stellar pop. | 18 | 166 | 14 | 40 |
| Supernovae, GRBs, high-energy phenomena ** | 17 | 156 | 11 | 32 |
| Active galactic nuclei | 15 | 143 | 16 | 46 |
| Clusters of galaxies, large-scale structure | 13 | 123 | 11 | 32 |
| Heliophysics | 9 | 82 | 7 | 19 |
| Astrobiology | 8 | 72 | 7 | 20 |
| Other | 21 | 195 | 16 | 46 |
| ***Total*** | | *944* | | *280* |

** Indicates a male-female difference with statistical significance at $\alpha < .05$

* Indicates a male-female difference with statistical significance at $\alpha < .1$

The sum of percentages exceeds 100 because respondents were asked to check all that apply.

The reports states that there is NOT a statistically significant difference between males (18%) and females (21%) who report astronomy education as their primary area of interest. The report also states that men and women were equally likely to express interest in most areas.

**Appendix IV. Education Component of the 2017 AAS Annual Report**

Through its education and outreach programs, the AAS nourishes a scientific outlook in society to help increase public support for scientific research, improve science education at all levels, attract young people to careers in science and technology, and make evident the connections between science, technology, and prosperity. The highest priorities of the AAS in these areas are to promote and support training the next generation of astronomers to become successful scientific researchers and educators, and to encourage and support high-quality research on the teaching and learning of astronomy.

Except as noted below, AAS education programs are administered by the AAS Executive Office, primarily by Gina Brissenden, AAS Education & Outreach Coordinator (+1 202-328-2010 x122, gina.brissenden@aas.org). General questions should be addressed to education@aas.org. See aas.org/education for more information about the items listed below as well as other AAS education programs.

Astronomy Education Board: charged with oversight of the education activities of the AAS by providing advice to the Council, the Executive Officer, the Education Officer, and the Education & Outreach Coordinator. The AEB examines the full range of education activities in which the society and its members are involved, reviews the context in which investments in science education are being made by federal and state agencies, recommends optimal mechanisms for developing an effective education strategy for the astronomical community, and recommends appropriate roles for the AAS in exercising leadership in education, and suggests and implements education-related AAS activities consistent with the mission, goals, and strategic plan of the Society. The current AEB Chair is Charles Liu, the AAS Education Officer (2015-2018), educationofficer@aas.org.

**Education Sessions at AAS Meetings:** Oral and poster sessions on various aspects of astronomy education are regular features of AAS meetings. Special sessions and workshops are often organized by AAS members involved in astronomy-related education research, curriculum development, outreach, and other astronomy education-related topics. Additionally, there are often pre- and within-meeting family and middle/high school student astronomy events planned both by members of the AAS and AAS staff. There are also a variety of education-related workshops offered my AAS members and the AAS. The majority of workshops occur on the weekends before regular AAS meetings, but some do occur within the meeting itself, as well as at some AAS Divisions meetings.

**The AAS Harlow Shapley Visiting Lectureship Series:** The AAS coordinates a program of two-day visits to colleges and universities by professional astronomers who wish to share the excitement of modern astrophysics with students, faculty, and the public. Participation is open to two-year colleges and four-year undergraduate institutions throughout the United States, Canada, and Mexico, especially ones without their own astronomy programs. Shapley Lecturers contribute to the host institution's academic program and intellectual environment in many ways. They give at least one presentation that is free and open to the public: The Harlow Shapley Lecture. They may also guest-teach a class in physics or astronomy; give a research colloquium or seminar presentation; interact with students informally about graduate school and careers; discuss teaching and curriculum with faculty, deans, and administrators; and visit local primary and secondary schools.

The goal of the Harlow Shapley Visiting Lectureship is to support not only the part of the AAS mission statement that commits the Society to training, mentoring, and supporting the next generation of astronomers, but also the part that commits the AAS to promoting increased participation of historically underrepresented groups in astronomy.

Toward this end, the AAS waives the institutional stipend paid to the AAS in support of the Shapley program for community colleges and Minority Serving Institutions (MSIs), such as Historically Black Colleges or Universities, Hispanic Serving Institution, Tribal Colleges and Universities, etc. Additionally, the AAS arranges a special Shapley Visiting Lectureship at an MSI that is located geographically near an upcoming AAS meeting or AAS Division meeting, which results in one faculty member from that institution, and five of their students, receiving free one-day registration to attend that nearby AAS/AAS

Division meeting. Additionally, we recently recruited new Shapley Lecturers who are particularly interested in partnering with community colleges and MSIs for their Shapley Visiting Lectureships and who are willing to do some of the reaching out to these community colleges and MSIs to broker the relationship. Since these efforts have been put into place, there has been an increase in the fraction of Shapley Visiting Lectureships that are hosted by community colleges and MSIs. There are approximately one dozen AAS Shapley Visiting Lectureships per year.

**The AAS Astronomy Ambassadors Program:** The AAS Astronomy Ambassadors program comprises a professional development workshop and a community of practice designed to help improve early-career astronomers' ability to communicate effectively with students and the public. It provides mentoring and training experiences for astronomers, from advanced undergraduates to beginning faculty, and provides access to resources and a network of contacts within the greater astronomy EPO community.

By learning how to implement effective education and outreach strategies, AAS Astronomy Ambassadors become better teachers, better presenters at meetings, and better representatives of our science to the public and to the government. And because early-career astronomers are a more diverse group than those who currently do the majority of outreach, they help the astronomical community present a more multicultural and gender-balanced face to the public, enabling members of underserved groups to see themselves as scientists. Ambassadors are provided with a large, growing library of outreach activities and materials that are suitable for a range of venues and audiences. Many of the resources in this library were developed by organizations such as the Astronomical Society of the Pacific, the Pacific Science Center, and the Center for Astronomy Education for other education and outreach programs, though some resources have been created specifically for this program.

The first AAS Astronomy Ambassadors workshop was held at the 221st meeting of the AAS in Long Beach, CA, in January 2013 and served 30 young astronomers chosen from more than 75 applicants. Incorporating feedback from workshop participants and lessons learned from the reports they've submitted after conducting their own outreach events, a second annual workshop for a new cohort of 30 Ambassadors was successfully held in January 2014 at the 223rd AAS meeting in Washington, DC. In October 2014, the AAS co-sponsored the third Ambassadors workshop with the AAS Division for Planetary Sciences (DPS), which was held in conjunction with 46th DPS meeting in Tucson, AZ, for a cohort of 28. The fourth annual workshop was held in January 2015 at the 225th AAS meeting in Seattle, WA, for a cohort of 28 Ambassadors. The AAS Council approved continuing this program in 2016 and 2017, with a workshop being held at the 227th AAS meeting in Kissimmee, FL, for a cohort of 28, and an upcoming workshop to be held at the 229th meeting in Grapevine, TX for a cohort of approximately 30 participants.

**The AAS Student Education Outreach Program:** In June 2012 at the 220th meeting of the AAS in Anchorage, AK, the AAS launched the AAS Student Education Outreach Program. Students and their chaperones (teachers and/or parents) are invited to drop in at AAS meetings on a pre-arranged morning to hear a special presentation from an astronomer and then to tour the Exhibit Hall, where numerous exhibitors conduct age-appropriate interactive demonstrations and other educational activities. This program has proven to be very popular, typically including 150-250 local middle-school through community college students from underserved and underrepresented populations, STEM programs, and home school groups. Through a generous contribution from long-standing sponsor Associated Universities, Inc., the AAS is able to supply transportation to this program free of charge, as well as provide additional free resources.

At the 221st AAS meeting in Long Beach, CA, in January 2013, approximately 300 students from six schools and various homeschool programs heard a talk by Bobak "Mohawk Guy" Ferdowsi and engaged in hands-on science activities led by 23 exhibitors and volunteer outreach groups. At the 222nd AAS meeting in Indianapolis, IN, in June 2013, approximately 200 students from two schools and various homeschool programs heard from Gail Zasowski and participated in hands-on activities led by 14 exhibitors and volunteer outreach groups. More recently in January 2015, 130 students at the 225th AAS meeting in Seattle, WA, heard from astrobiologist Aomawa Shields, who was also a 2015 AAS Doxsey Prize Winner, then participated in hands-on activities with 19 exhibitors. In January 2016, 325 students at

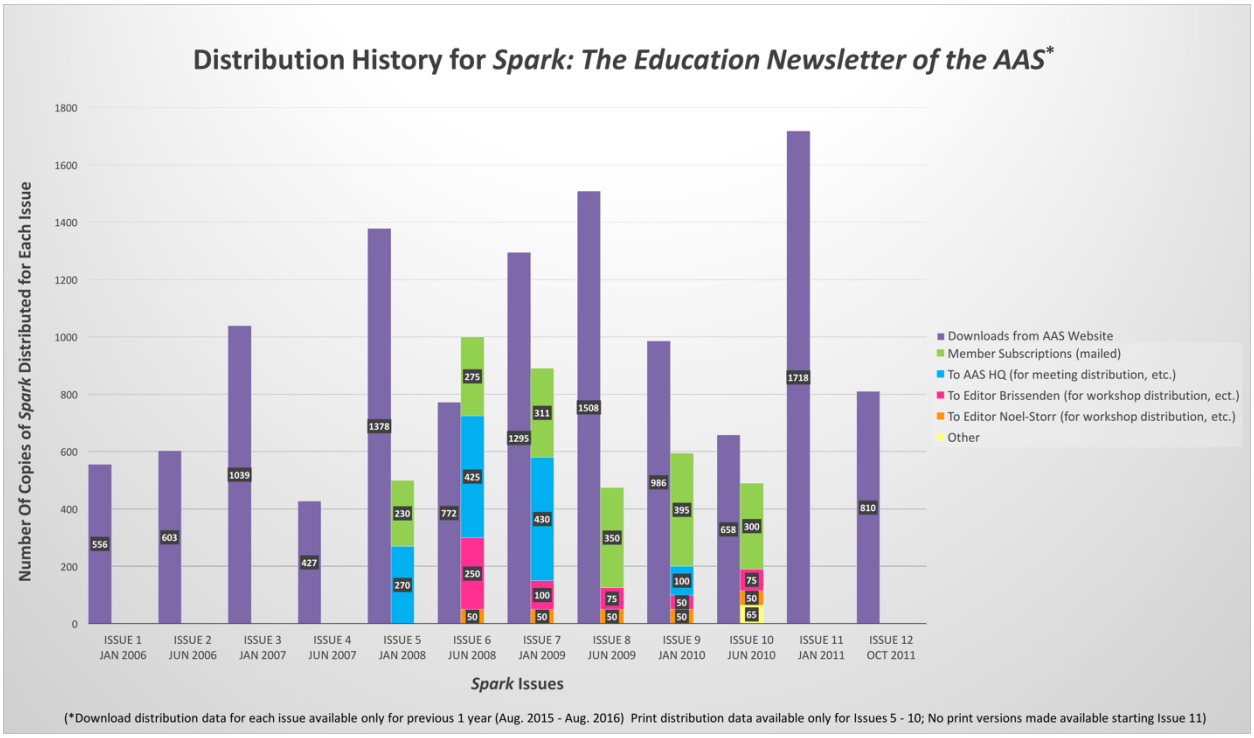
the 226th AAS meeting in Kissimmee, FL, heard from Univ. of Arizona undergraduate Allison McGraw, then participated in hands-on activities with 22 exhibitors.

**The Rodger Doxsey Travel Prize:** The Rodger Doxsey Travel prize provides graduate students or postdocs within one year of receiving or receipt of their PhD with a monetary prize to enable the oral presentation of their dissertation research at a winter AAS meeting. Prizes are awarded to approximately 10% of the dissertation talk presenters at each winter meeting. Recipients receive a cash prize, as well as free registration. In addition, some runner up prizes are usually awarded, which provides free registration to the recipients.

**The Chambliss Student Astronomy Achievement Awards:** The Chambliss Student Astronomy Achievement Awards recognize exemplary research by undergraduate and graduate students who present posters at AAS meetings. Hundreds of students enter the Chambliss competition at winter meetings, with a smaller number entering during the summer meetings. The AAS relies heavily on volunteer members to judge the competition, which often requires hundreds of volunteers.

**The Education and Outreach Coordinator:** The Education and Outreach Coordinator serves as the AAS liaison to other scientific societies' education programs. As a result of such collaboration with the American Institute of Physics (AIP), participation by the Society of Physics Students (SPS) is now a regular feature of winter AAS meetings; SPS exhibits at the undergraduate reception and holds a special evening poster session at which a well-known astronomer gives a career-oriented "pep talk" to the attending students. The Education and Outreach Coordinator is also responsible for answer education-related questions from the membership, at large, as well as from members of the general public.

**Readership of Spark: The Education Newsletter of the AAS:**



**Appendix V. Inclusive Astronomy Recommendations on Teaching and Mentoring**

In June 2015, 160 astronomers, sociologists, policy makers and community leaders convened the first *Inclusive Astronomy* meeting at Vanderbilt University, in Nashville, TN.[5] The goal of this meeting was to discuss the issues affecting people of color, LGBTIQA* people, people with disabilities, women, people disenfranchised by their socio-economic status, and everyone who holds more than one of these underrepresented identities in the astronomical community. A set of recommendations[6] was produced covering four broad areas: removing barriers to access; creating inclusive environments; improving access to power, policy, and leadership; and establishing a community of inclusive practice.

Education can be a powerful vehicle for facilitating the growth of individuals and organizations in the areas of equity and inclusion. Furthermore, effective teaching and mentoring are a crucial part of creating inclusive climates in our institutions and in our classrooms. We propose the following types of partnerships and joint activities between the AEB and the "diversity" committees (CSMA, CSWA, SGMA, WGAD) of AAS. These activities will enable various stakeholders in the AAS membership to design and implement plans based on the IA recommendations at their institutions and in their classrooms:

- Hosting AAS workshops, forums, and other activities on issues related to equity, such as Title IX, Racism 101, allyship, etc.
- Hosting AAS workshops, forums, and other activities on implementing the IA recommendations for teaching and mentoring.
- Plenary talks at AAS meetings that address issues of equity, inclusion, and effective teaching and mentoring.
- Including the AEB in conversations on equity and inclusion, for example by having AEB liason(s) within the "diversity" committees, and through participation in AAS diversity summits.

*Recommendations for Adopting Active and Inclusive Learning Practices*

The foundation of a successful career in Astronomy is educational opportunity. Students from minority/marginalized groups often experience classroom environments and dynamics differently than people from majority groups, and in ways that may reduce the effectiveness of teaching. Adopting research-validated practices and principles of inclusive design can eliminate barriers to learning and biases in assessment, making educational opportunity available to all.

1. Meet and exceed ADA requirements for accommodations in the classroom:
    a. Include explicit wording in syllabi outlining your commitment to extend reasonable accommodations to all students with disabilities, whether visible or invisible.
    b. Know what accommodations are permitted by your campus' Disabilities Office, and assure that students are receiving these accommodations in the classroom.
    c. Work with students who are in the process of obtaining accommodations to complete paperwork, and work with your campus's Disabilities Office to recognize and reduce barriers for students seeking accommodations.
    d. Make available testing environments free from distraction, and provide extra time (without judgment) for those who need it.
    e. Provide resources to faculty so that class notes and other teaching materials can be made available in multiple formats (audio, visual, captioned video, etc.).
    f. Provide students with spaces to move as needed; allow students free access to come in and out of class.
    g. If attendance is required, allow students a well-defined leeway in arrival/departure times, particularly for those with disabilities and when teaching on large campuses.

[5] vu.edu/ia2015

[6] bit.ly/1JXIOzZ

h. Make sure class activities are fully accessible; if they are site-specific (e.g., observatory, planetarium), assure full access to disabled students; if they are at night, assure there are escorts available or on call.

2. Classroom participation and dynamics:
    a. Highlight the scientific contributions of a variety of astronomers, not just those who are white, male, able-bodied and heteronormative.
    b. Be aware of who you are calling on for questions and answers; avoid choosing one demographic group over another (e.g., only the men) or focusing on one section of the room (e.g., only the front). One way to achieve this is to wait until at least three students have raised their hands.
    c. Be aware of and refrain from using racist, sexist, ableist, gender-discriminatory or homophobic language in the classroom; if such language is part of the instructional material (which should be rare in an Astronomy course), give students trigger warnings.
    d. Pay attention to the classroom climate, and address discriminatory behavior promptly and respectfully; it is often helpful to have student representatives available for reporting.
    e. Recognize that a “no-device” policy may inhibit the learning of some students; consider best practices such as separate seating areas in class for students who require devices versus students who find devices distracting.
    f. Make clear policies on accommodation for students who have conflicts due to religious practice, medical treatment, family and/or personal emergencies.
    g. Beware of organizing off-schedule activities that might exclude some students. For example, review sessions at unscheduled times might be difficult for students who have to work and/or commute via public transportation. (Commuting at odd times is particularly challenging for undocumented students, for whom obtaining a driver's license is extremely difficult in some states.)

3. Know what strengths, weaknesses, needs, and resources your students bring to the classroom, and adopt appropriate teaching and assessment strategies:
    a. Consider including diagnostic tests at the beginning of the course to identify what students’ skills are coming into the course; design your teaching based on what the students know, not what you assume they should know.
    b. Diversifying your instruction techniques and resources can significantly improve inclusion; get to know your students and what works best for them.
    c. When implementing interactive teaching methods, make sure that students who do not want to participate (e.g., introverts, those with social phobias) are not forced to do so.
    d. Recognize that not all students have access to technology (e.g., their own laptops, calculators, clickers) and strive to eliminate technology barriers.
    e. Foster a growth mindset in your students.

4. Work to create a thriving, inclusive teaching environment by continually maintaining and improving your undergraduate program, which is necessary but not sufficient for attracting and retaining marginalized students:
    a. Provide opportunities (i.e. workshops, mentoring for teaching) and incentives (e.g. grants, recognition, etc.) for instructors, potential instructors, and teaching assistants to learn new pedagogical techniques and to adopt and develop research-based inclusive learning practices.
    b. Work with professional education researchers (e.g. university’s center for learning, hiring astronomy education researchers) to evaluate and improve instruction in your department.
    c. Develop and support astronomy education research groups who investigate teaching and learning in astronomy through the lens of inclusivity and intersectionality.

*Recommendations for providing effective mentoring and networking opportunities.*

Inclusive support of all astronomers requires robust networks of peers, mentors and advocates. Student-advisor, mentee-mentor and employee-employer relationships are among of the most important in a young scientist's career. However, these relationships can fail for a variety of reasons. Clear, non-stigmatized pathways for changing groups/advisors, having independent and senior advocates of students and postdocs, and developing community-based mentor networks are ways to prevent scientists from being derailed in their career progression. Additionally, realize that astronomers from small institutions or non-academic organizations may not have access to the same support network, and additional effort should be made to support them.

1. Establish a matrix of support for individual students and postdocs that does not rely solely on the advisor. This may be a formal network established by the department or institution, or an informal network endorsed by organizational leaders. Make sure there is both time and funding available for mentoring activities.

2. Follow the leads of HBCUs/MSIs/Community Colleges in establishing student-centered mentoring practices:
    a. Faculty and department leaders should consult with admissions and freshman advisors to identify and start advising potential astronomy/physics majors early on, especially underrepresented students.
    b. Provide support, mentorship, and research opportunities.
    c. Require faculty training on best practices in advising students and postdocs, including issues particular to underrepresented/LGBTIQA*/disabled students.
    d. Proactively engage and mentor transfer students, many of whom come from minority-serving institutions.

3. Establish a mentoring ladder to spans multiple career stages; e.g., graduate mentors of undergraduates, postdoc mentors of graduate students, junior faculty mentors of postdocs, senior faculty mentors of junior faculty, etc.
4. Establish identity support networks within and across STEM departments; and establish, support and make people aware of university-level resource centers for marginalized communities (e.g., Black Resource Center, Queer Resource Center, DREAMer Alliance etc.).

5. Increase networking opportunities for minorities and other disadvantaged students, and early career professionals within departments, at conferences, exchange programs, etc. Examples include the CSMA "Meet and Greet" reception at AAS meeting, travelling speaking grants (e.g., the NSBP/AAS Beth Brown Prize and the AAS FAMOUS travel grants).

6. Provide junior faculty with senior faculty mentors in the department who can guide them through the culture, responsibilities and expectations within the department (funding, tenure, students, navigating administration, etc.), and who can act as an advocate.

7. Support mid-career faculty/scientist mentoring and career coaching through national programs (e.g., Project Kaleidoscope, National Center for Faculty Development and Diversity).

8. Support astronomers from small institutions or non-academic organizations who may not have access to the same support network as those at larger institutions.

**Appendix VI. Employment Committee and Education Sessions at AAS227**

The following is a collection of the Employment Committee and Education sessions from the AAS 2016 winter meeting in Kissimmee, FL. For the Employment Committee sessions, some were free of charge while others $35 to $100 (paid to AAS; waivers were possible). Some were led by volunteers, with travel expenses paid, and a few are led by paid consultants.

*Education Sessions (not counting posters)*

Teaching Introductory Astronomy Using Quantitative Reasoning Activities and Research Projects (1 day)

The CAE's Tier I Teaching Excellence Workshop (2 days)

Renumerating the Astronomy Classroom (2 hrs)

K12 EPO (1.5 hrs)

Astronomy Education Research (1.5 hrs)

*Employment Committee Sessions*

Career Networking and Job Fair

Software carpentry 2-day bootcamp

Hack Day

1-day workshops:
Science Communication Workshop
Leadership and team building
Using Python for Astronomical Data Analysis
Collaborating Online with GitHub and other Tools  Astrostatistics
Bayesian Methods in Astronomy

Shorter sessions:
Career Planning Workshop and Panel
Tools and Tips for Better Software
The Performing Art of Science Presentation
Graduate School and Postdocs as a Means to a Job

Career Hours:
Leveraging Social Media for Networking and Career Advancement
Developing your 30-second value statement (aka elevator speech)
Interviewing: what you need to do before, during and after to get the job

Beyond the Academy:
Showcasing Astronomy Alumni in Non-Academic Careers
Panel Discussion on Securing a Non-Academic Career

The AAS also offered one-on-one career consultations with Alaina Levin of Quantum Success Solutions.