Outreach, Education, and Training

Working Group 3.2 - Australian Astronomy Decadal Plan

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1. Executive Summary and Recommendations

There is a growing body of anecdotal evidence that from an educational perspective astronomy has the potential to be a gateway to STEM. Therefore, as the astronomy community looks ahead, there is a growing emphasis on setting clear, actionable goals that leverage the gateway aspect of astronomy to support broader national priorities while addressing critical gaps in funding, training, and engagement.

A central theme emerging from both the discussions and survey findings is the importance of adopting **SMART goals—Specific, Measurable, Achievable, Relevant, and Time-Bound.** These well-defined objectives will help ensure that educational and outreach initiatives can secure the institutional support and funding necessary for success.

A recurrent theme revealed significant concerns about the **adequacy of funding** for educational and outreach initiatives. While some institutions reported just enough resources to maintain existing programs, others found the funding landscape inadequate, particularly for long-term or large-scale projects. Internal funding remains limited, which is a significant barrier to the expansion of programs and ARC and other category 1 funding is nearly non-existent.

Despite these financial challenges, **many institutions have successfully implemented a range of astronomy training programs for teachers.** These include hands-on workshops, school visits, and professional development sessions on topics such as astrophotography, telescope use, and Indigenous knowledge integration. However, barriers such as teacher availability, time constraints, and limited institutional support make it difficult to sustain broader engagement, especially when teacher training is left to individual staff members rather than being driven by a concerted institutional effort.

Another significant focus is **workforce development**, particularly in light of major projects like the **Square Kilometre Array Observatory (SKAO) and SKA-Low** and the **European Southern Observatory (ESO)**. These projects have underscored the need for broader training programs, especially in technical and vocational areas that are not traditionally covered by universities. To fill this gap, there is a growing push to expand vocational training and incorporate institutions like **TAFE** (Technical and Further Education) into the educational framework. This would not only strengthen the technical workforce but also prepare future

generations for roles that demand specific, practical skills in astronomy and space science.

States like Victoria are already shifting their focus toward integrating technical skills into high school curricula, a trend that is expected to gain momentum nationwide.

In terms of **collaborations**, the community is keen on building partnerships with external organizations, such as amateur astronomy groups, industry bodies, and educational institutions. This collaborative approach will enable the astronomy community to broaden its reach, share resources, and create opportunities for public engagement.

Curriculum development has also been an area where institutions have made valuable contributions, particularly by incorporating astronomy into national and local education systems. Some institutions have played advisory roles in developing lessons on dark skies, Indigenous knowledge, and other astronomy-related topics. These lessons not only enrich the science curriculum but also foster a deeper appreciation for the cultural and scientific significance of the stars and the sky.

Mentorship programs have been another bright spot, with several institutions successfully guiding students through competitive science fairs, research projects, and even international competitions. While these programs have seen success, they are often constrained by the availability of staff time and institutional resources, limiting their scalability and reach.

Despite the successes, the community faces several persistent barriers, including **limited funding, institutional support, and teacher engagement**. Many institutions struggle to secure the necessary financial and administrative backing for outreach and education programs, and efforts to engage teachers are often hampered by scheduling difficulties and a lack of dedicated workload support.

By setting clear, achievable objectives, building partnerships, and expanding vocational training, the community can address current gaps in education and outreach. **The decadal plan provides an opportunity to refine these goals**, ensuring that they reflect the needs of both the astronomy field and the broader Australian community.

Key Recommendations

1. Prioritisation of outreach and education as a key part of Australian Astronomy

> Outreach and education initiatives often fall into the trap of being viewed as secondary and non-primary to goals of institutions and organisations, which further limits the ability to retain and support those who do it. **An emphasis as one of the key parts of our community** will help to overcome these perceptions.

2. Funding - either through AAL, national bodies, or institution

support for the continuation and growth of initiatives

Across surveys, individuals, institutions, and townhalls - **funding was the common theme.** No regular mechanism exists to provide funding for outreach, education, and training programs - in particular FTE funding. **This means these programs are either done as part of ARC Centres of Excellence, which have limited lifespans, ad-hoc grants, or internal funding at institutions.** Our community has now had a couple of CoEs with ambitious and effective programs, but this is subject to continued CoE funding.

If outreach and education is to grow, and be sustainable, this has to change.

3. Recognition and support of those engaging in outreach, education, and training - through awards, promotion, and time/contract allocation

A large number of our community engages in outreach, education, and training. However, the majority do not receive recognition - formally or informally. The David Allen Prize is given every 3 years, but often is not recognising the people who are not heavily present in the media, but rather the unsung heroes of this field. Activities like the **Australian Science Communicator's Unsung Heroes** is an example of how recognition can be given to those who engage in these efforts but may not be widely seen. Institutions can also recognise the efforts of professional and academic staff in promotions, and that they can be a substantive part of a career, as has been implemented at **CSIRO and ANU**

4. A nationally supported emphasis on goal-oriented programs, such as those working with and supporting under-represented groups

Programs that support under-represented groups - such as women, Aboriginal and Torres Strait Islanders, and those with disabilities such blind and
visually-impaired people, are a key goal for many outreach and education programs. **Support at a national level - either through CoEs, the AAL, or ASA EPOC - can make sure these groups are working together, sharing knowledge and resources, to achieve these goals**

5. Facility and resource access - for teachers and students

A number of programs have been designed, with great success**, such as PULSE@Parkes, ICRAR's Spirit, University of Melbourne's Telescope in Schools, and ANU/ASTRO3D's STARs, and programs on the LCO network** provide free resources - activities, equipment, support, and training for teachers and school students. Increasing these resources - either at a national or institutional level, can and **will drive impact into the education sector for little cost and effort**.

6. Collaborations with the Australian Astronomy Education Research Community.

Measuring the impact of education and outreach programs is key to nurturing the next generation of Australian astronomers using astronomy as a gateway to science. Although ad-hoc has been done for reporting purposes (such as ARC or other funding bodies), this needs to be more formal and consistent Collaborations with groups such as **Deakin University's Science Education Centre** can support this to happen more. Moreover, these evaluations need to be shared across the community - i**nformally and formally, providing useful knowledge**

7. Working with TAFEs and Vocational Institutes to support technical skill shortages

Workforce development, in light of major projects like the **SKAO and ESO is key**. These projects have underscored the need for broader training programs, especially in technical and vocational areas that are not traditionally covered by universities. Working with **TAFEs** and other institutions, often not a part of the astronomy community can help in this workforce shortage

2. Decadal Plan 2016-2025

The previous decadal plan working group focused on three areas - education, careers, and outreach making 29 recommendations.

The education recommendations focused on building stronger connections between the Australian astronomy community and the education sector. The report emphasized that the ASA's Education and Public Outreach Chapter (EPOC) should maintain a list of astronomers and educators to liaise with educational authorities and teacher associations to promote astronomy in school curricula. Astronomers, both professional staff and students, were

encouraged to engage with teachers, and this involvement was to be recognized as a positive contribution by their institutions. **The report also recommended the development of programs for ongoing teacher professional development in astronomy, with a focus on securing substantial funding to support these initiatives**. Another key point was the need to provide easy access to high-quality teaching resources, potentially through an Australian Astronomical Resource Centre or by collaborating with international resources. Collaboration between astronomy research organizations and educational institutions was highlighted as crucial to ensuring effective teaching of astronomy.

Careers addressed the need to improve diversity and career opportunities within astronomy. It called for increasing the number of female students entering PhD programs and for continued support of postgraduate and Early Career Researcher (ECR) workshops to **ensure young researchers received training in key skills. A focus was placed on creating more equitable access to career opportunities, including the promotion of part-time or flexible roles to support individuals taking career breaks, especially for family reasons.** The report also recommended establishing metrics for recognizing outreach work and suggested that outreach efforts be considered in job applications, grant proposals, and time allocation processes. The report recognized that not all PhD students would go on to academic careers, so it encouraged supervisors to discuss alternative career paths with students early on.

Outreach highlighted the importance of fostering stronger links between amateur and professional astronomers. It recommended **reinstating the "seed funding" program to support amateur astronomy engagement, proposing small grants every 1-2 years to build these connections.** Additionally, the report emphasized the need for a long-term social media strategy to maximize outreach efforts and suggested holding social media training sessions in conjunction with ASA meetings. The report recognized that collaboration with amateur astronomers, public observatories, and planetaria could significantly expand the reach of astronomy outreach, but noted that consistent funding and support were necessary to maintain these efforts. Finally, **the importance of recognizing and rewarding outreach efforts was stressed,** as these activities were considered vital for increasing public interest in and support for Australian astronomy.

Despite the recommendations, most of these were not followed through with **only a handful of recommendations (7 - 9** based on how clearly defined they are) were met. Moreover, these mostly were **all in the area of careers** - :“ students receive more training in “transferable skills” and exposure to a variety of job opportunities outside the realm of academic research (C3,4,11,12)”.

Additionally, it is worth noting that **of the 16 previous WG members, 8 have left Australia and/or the field.** Turnover and insecure funding are a clear issue to success and growth in outreach and education.

3. Individual Survey and Input

In the individual survey, **227 respondents reported engaging in outreach or educational activities** below the undergraduate level. These activities can be summarized across 8 - 10 main areas of activities.

- School and public talks. (111 people)
    - School visits, high school talks, public talks, university open days, lectures, science/STEM programs, talks at primary and high schools, public observatory visits, stargazing events, demonstrations
- Media and social media. (48 people)
    - TV interviews, radio appearances, podcasts, writing articles for platforms like *The Conversation*, media releases, documentaries, news segments, social media platforms (Facebook, X/Twitter, Instagram, TikTok)
- Special events and festivals (30 people)
    - Participation in festivals like *Pint of Science*, public engagement events like *Astrofest*, and open days at observatories or science institutions.
- School and teacher programs (25 people)
    - Teacher training programs, STEM Professionals in Schools (CSIRO), developing classroom science curriculum, running workshops, mentoring students for science project.
- Community and amateur astronomy (22 people)
    - Collaborations and events with amateur astronomy clubs such as stargazing nights, and dark sky awareness programs.
- University-led programs focused on high school students (21 people) - University-based programs, facility tours, research internships for students, and programs like *Scientists in Schools*.
- Planetarium activities (17 people)
    - Planetarium shows, observatory tours, star parties, and workshops at facilities like the Parkes Observatory and Macquarie University.
- Science writing (18 people)
    - Writing popular science articles, contributing to astronomy journals, publishing articles in mainstream media, and writing for educational platforms.

- Training programs (15 people)

    - Work experience programs, student engagement, mentoring for underprivileged students, and supervising high school science projects.

When reflecting on the previous decadal plan, emphasized increasing school-level engagement and encouraging astronomers to collaborate with teachers to enhance STEM education.

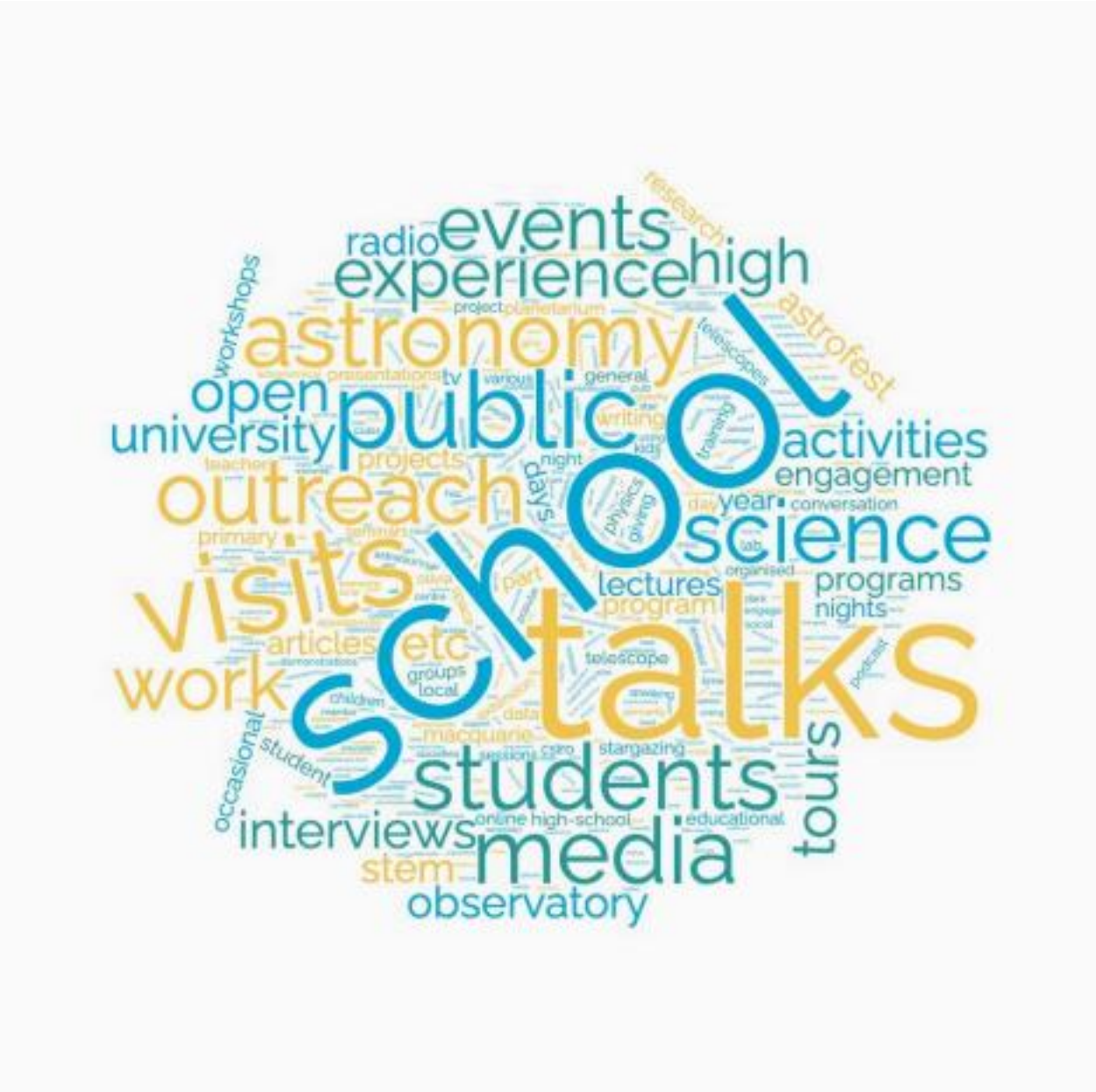
The large number of school visits, public talks, and outreach activities mentioned in the responses directly address this recommendation. The substantial participation in school programs and talks indicates strong progress in communicating astronomy to younger audiences. **However, the plan also stressed the need for formal recognition of this work within professional roles and a more coordinated approach, both of which are missing.**

The previous WG report emphasized the importance of using media to communicate Australian astronomy's successes and to foster a science-literate public. The frequent involvement in TV, radio, podcasts, and science writing activities aligns shows that the increase as suggested happened.

However, the larger national support - from guidelines to training and support has not.

While there has been some efforts toward teacher training programs and engagement with school curricula, the relatively small number suggests that this area still requires more attention and development, **especially in terms of formalized teacher support and access to resources, as recommended in the previous WG recommendations.**

The training and work experience programs reflect efforts to address this recommendation, offering students real-world exposure to astronomy. However, increasing diversity and more structured mentorship programs are areas where continued growth is necessary.



4. Institutional Survey Data and Input

In the institutional survey response, many respondents indicated that their institutions have some form of funding available for education and teaching grants, though the adequacy of this funding varies. Several institutions reported offering teacher workshops and professional development sessions, often hosted at observatories or through partnerships with space education centers. **However, a significant number of respondents noted the absence or insufficiency of funding,** particularly for more ambitious programs such as astronomy field nights or teacher training workshops, which require sustained financial support.

When asked about the overall funding for educational research, responses were mixed. **Many indicated that funding was "just adequate," allowing them to maintain existing programs**

but not expand them significantly. Others labeled the funding as **"inadequate," particularly when it came to expanding teacher engagement or developing astronomy-themed curriculum resources**. The challenges of securing dedicated funding for long-term initiatives were frequently mentioned, with several institutions relying heavily on external sources of funding rather than internal institutional support.

In terms of the number of education-related grants awarded in the last five years, most institutions reported having awarde**d between zero and eight grants, with no institution reporting more than ten.** Many grants were external, with several institutions indicating that 100% of their education-related funding came from external sources, reflecting the difficulty of securing internal grants for these purposes.

Many institutions reported offering astronomy training programs for teachers, ranging from physics and telescope training to workshops on topics such as astrophotography, Indigenous knowledge integration, and dark skies preservation. Examples of these programs include "Mission Gravity," which teaches students about gravity, and outreach talks in schools that introduce teachers and students to key astronomy concepts. However, a notable portion of institutions did not offer specific training programs**, often citing a lack of funding or institutional priorities as the main barriers**.

Teacher participation in these training sessions varied widely, with numbers varying between 60 and 350 teachers attending workshops and conference sessions over five years. These training sessions often included both hands-on experiences and theoretical lessons, helping to equip teachers with the knowledge and tools to introduce astronomy into their classrooms.

In terms of engaging with school teachers, many institutions reported significant involvement through workshops, school visits, and public talks. For example, one institution mentioned providing telescopes and data for extension projects, while another engaged with teachers at national conferences and online workshops. However, **some institutions struggled to engage with teachers due to barriers such as lack of time, funding, or institutional support.**

Several institutions noted that it was difficult to engage with teachers outside of dedicated events due to scheduling challenges and the limited availability of teachers during the school year. In addition, some respondents mentioned that teacher engagement was often left to individual staff members rather than being driven by institutional programs or policies.

Some institutions reported contributing to national or local curricula by incorporating astronomy and Indigenous knowledge into lessons. Others provided expert advice on topics such as dark skies and light pollution. However, **many institutions did not participate in curriculum development due to a lack of resources or connections with educational departments,** highlighting a gap in collaboration between academic institutions and the school system.

Several institutions indicated they had developed astronomy-themed lessons, focusing on topics such as solar observing, the phases of the Moon, and data science. In some cases, these lessons were tied to specific projects or competitions, allowing students to engage with real

astronomical data and apply it to their coursework. **Despite these efforts, many institutions reported that workload constraints and limited funding hindered their ability to further develop and distribute these lessons.**

Mentoring of school-aged students was another area of focus for many institutions. Several respondents shared examples of successful mentorship programs, including partnerships with organizations like the CSIRO STEM Professionals in Schools program and mentoring individual students on research projects. These mentorship programs **often led to notable achievements, such as students winning awards at national science fairs or continuing their astronomy research into higher education**. However, some institutions cited barriers to mentoring, such as **limited time, lack of capacity,** and concerns about working with younger students on campus.

5. Tailored programs, underrepresented groups, and case studies

In recent years, a growing number of STEM outreach programs have prioritized DEI, recognizing the importance of making STEM fields accessible to individuals from diverse backgrounds. Programs such as the International Astronomical Youth Camp (IAYC) and the Gravity Discovery Centre (GDC) integrate DEI into their activities by focusing on gender diversity and Indigenous engagement. ICRAR and OzGrav have initiatives that support women, Indigenous communities, and other underrepresented groups in STEM. These programs provide mentorship, role models, and training to create an inclusive environment where

participants feel valued and supported. By promoting diversity, these programs aim to create a STEM workforce that reflects a wide range of perspectives and experiences.

Research suggests that effective outreach should identify specific underserved audiences and tailor content to their needs, as demonstrated by initiatives like the Girls in Engineering, Mathematics and Science (GEMS**)** program, **which successfully increased girls' interest in STEM by creating a supportive, all-female learning environment.**

Various astronomy programs have embraced this approach. OzGrav focuses on engaging **all-girls and regional schools, with projects like the Quantum Girls Project**, aimed at fostering female participation in quantum physics and computing.

Other notable initiatives include the Einstein-First Project, which demonstrated improvements in girls' attitudes towards science, and ICRAR, which offers programs like the Stargirls STEM camp and the SPIRIT initiative, **providing research-grade telescopes to remote schools. ICRAR also offers internships prioritizing Indigenous students and hosts interactive events such as the Star Dreaming Full Dome Show, exploring Indigenous sky stories.**

ANU and ASTRO3D run the STARS program, bri**nging astronomy to Indigenous schools in rural and remote areas through hands-on learning and telescope training**. Additionally, Macquarie University's National Indigenous Science Education Program (NISEP) promotes **Indigenous student leadership in STEM, incorporating Indigenous knowledge and campus tours based on consultations with Indigenous Elders.**

CSIRO's PULSE@Parkes program now offers online sessions broadening its reach to regional and remote schools across Australia. Working in conjunction with CSIRO's education programs Generation STEM and the Young Indigenous Women's STEM Academy it has targeted regional schools and those in low socioeconomic areas.

The programs mentioned also emphasize the need for long-term engagement, partnerships with local communities, and continuous evaluation. The NISEP example underscores the importance of gathering feedback from students, teachers, and community members to adapt programs and sustain their impact.

Overall, these efforts not only aim to increase diversity in STEM fields but also to address systemic inequities, foster trust within communities, and ensure that these initiatives are sustainable and impactful in the long term.

6. Goal-driven programs

A key objective of outreach programs is to enhance public understanding of science. These initiatives aim to build critical thinking and decision-making skills that people can apply to various aspects of life, such as healthcare, environmental issues, and civic matters. By connecting scientific principles with real-world applications, outreach programs create a more

scientifically literate society. Programs like those led by ICRAR and CSIRO use hands-on experiments and interactive sessions to foster excitement about science, helping to develop a more informed and curious public. Early engagement in science communication is particularly important, as it shapes the next generation of scientists and ensures that future citizens can

make informed decisions based on scientific knowledge.

Another critical goal of education and outreach programs is to provide opportunities for students to engage with STEM and prepare them for careers in STEM fields. Through activities like internships, work experience programs, and STEM competitions, students gain exposure to real-world scientific work and develop skills that are essential for STEM careers. Programs such as ANU/ASTRO-3D's Indigenous work experience and CSIRO's virtual internships provide opportunities for students to engage in hands-on research and collaborate with scientists. These experiences help bridge the gap between education and the workforce, encouraging students to pursue careers in STEM fields. Research shows that students who participate in such programs are more likely to develop and sustain an interest in science, leading to a stronger STEM pipeline.

7. Evaluation and Research

Despite the innovative nature of many outreach programs, their effectiveness in raising awareness and retaining a broader demographic in STEM fields remains largely unmeasured due to limited evaluation data. **A recent study of Australian gender equity initiatives found that only 7 out of 337 programs had publicly available evaluation data, leaving their actual impact unclear.** Without robust evidence, it is difficult to determine whether these programs meet their policy goals or justify continued investment.

As significant resources are dedicated to astronomy education and outreach programs, there is a pressing need to evaluate their impact. **Are these efforts meeting their objectives? Are diversity, equity, and inclusion (DEI) measures being effectively implemented? Evaluation should go beyond cost-effectiveness and include an in-depth review of program design, pedagogy, sustainability, and adaptability. Regular assessment also provides vital feedback to funding bodies, helping ensure the accountability of outreach programs.**

Groups like Deakin University are leading in this, and able to support groups in this endeavour.

Studies suggest that programs must have clear, measurable goals and conduct evaluations throughout their lifespan, rather than waiting until the end. This allows for mid-course corrections. Experts recommend that evaluation be an integral part of program planning from the outset, using both formative and summative evaluations to measure progress.

Key metrics for evaluating outreach effectiveness i**nclude participant engagement, changes in attitude or behavior, knowledge acquisition, and career awareness.** These metrics help program coordinators and science communicators define their objectives more clearly.

Evaluation and research are critical for understanding the true impact of education and outreach programs,ensuring that they continue to meet their goals of promoting STEM education and diversity.