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Making the Case for Quality Science Programming for Older Youth in Out-of-School Time

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Abstract. The Youth Astronomy Apprenticeship (YAA) is an initiative to promote science learning among youth age 14–19 from underserved communities. Informed by a social justice approach, strategies implemented in the YAA model are motivated by results from both direct practice and research. A key strategy in this effort is to provide continuity of support and mentoring, and opportunities for deeper learning and increased personal responsibilities.

1. Introduction

In the opening pages of "Science for all Americans" it is stated: "Education has no higher purpose than preparing people to lead personally fulfilling and responsible lives. Science education should help students to develop the understandings and habits of mind they need to become compassionate human beings able to think for themselves and to face life head on. It should equip them also to participate thoughtfully with fellow citizens in building and protecting a society that is open, decent, and vital" (AAAS, 1990).

Notwithstanding the remarkable effort over the past 20 years by the formal and informal science education communities alike to provide tools and resources to move towards the goals cited above, a serious underrepresentation of minorities, persons with disabilities and females in the STEM (science, technology, engineering, mathematics) workforce still affects our society. To specifically address this issue we propose an approach that is based on the understanding (following NSF, 2005) that to address STEM underrepresentation at its roots, we need to focus on this issue as a human capability realization problem, rather than purely as a STEM capacity building problem.

To contribute to the realization of the vision promoted by "Science for All Americans" among those that need it the most, we designed and implemented the Youth Astronomy Apprenticeship (YAA), an out-of-school time (OST) initiative that fosters science learning among older youth (age 14 to 19) from urban underserved communities. The strategies implemented in the YAA model reflect results from both direct practice and research:

1. There is a growing consensus that high-quality OST programming for older youth is an important tool to meet the need for increased engagement and success in high-school, enrollment in college and overall chances to become a productive member of society (Friedman & Bleiberg, 2007).

2. Among populations underrepresented in STEM, older youth are often underserved by OST programs because they require programming conditions, both programs offered and expertise of adult staff involved, different from those that serve younger children. Of more than six million children enrolled every year in afterschool programs in the U.S., only 8% are older youth (Afterschool Alliance, 2004). These programs provide supportive environments for learning academic and social skills, but few offer science programs (Walker, Wahl & Rivas, 2005).

3. In order for young people to be prepared to successfully navigate today's job market, they need higher-end skills, such as the ability to communicate effectively beyond their peer groups, analyze complex information from multiple sources, write or present well-reasoned arguments, and develop solutions to interdisciplinary problems (Partnership for 21st Century Skills, 2004). However, research concerning the preparation of high school graduates (Achieve, Inc., 2005) indicates that as many as 40% of the nation's high school graduates are inadequately prepared to deal with the demands of employment and postsecondary education lacking work habits, ability to read and understand complicated materials, and math, science and writing skills.

4. Teenage youth identify effective programs as those that engage them in challenging but fun activities, and that contribute to their learning and social development. Youth are looking for opportunities for skills and knowledge development that are otherwise unavailable to them, and for positive relationships with adults, including skilled professionals and experts, who provide mentorship and who can serve as role models.

Considering the challenges already faced by the formal education system in helping youth from underrepresented groups to overcome the achievement gap in many STEM fields, the apprenticeship model implemented in YAA is a successful example of a way to introduce science learning to support not just academic enrichment, but also skills building and youth development opportunity.

2. The YAA model

The YAA program was designed and is managed by the MIT Kavli Institute for Astrophysics and Space Research (MKI), with support from the Harvard-Smithsonian Center for Astrophysics (CfA), and the Timothy Smith Network and with funding from NSF. In the YAA model equal effort is put in pursuing science learning for academic enrichment and in stressing the link between employable skills and the skills developed in science and other professional fields—such as the performing arts. This approach allows us to reach out to older youth from underserved groups in a way that both satisfies their interests and meets their needs. By weaving together science learning and the practice of skills needed in a range of different professions, YAA aims to help youth develop a strong sense of ownership of their work and to make them attentive to and responsible for the quality of the science presentations they offer during their outreach events. A key strategy in this effort is to provide continuity of support and mentoring, and opportunities for deeper learning and increased personal responsibilities: YAA youth start as unpaid trainees, transition to paid apprentices, then to teaching assistants, and some of them eventually land intern positions at the MIT Kavli Institute. The YAA program

progressively develops youth's science knowledge and 21st century employable skills through several stages:

Afterschool Program: Youth as Trainees. Youth engage in astronomy investigations, take astronomical images using robotic telescopes they can operate via the Internet, learn to use software tools to process astronomical images, and produce reports and presentations about their investigations. The afterschool sessions take place at local community-based organizations.

Summer Apprenticeship Program: Youth as Apprentices. Youth that complete the afterschool program are eligible for a paid position with the YAA apprenticeship program that takes place at MIT. Because the summer program is an actual apprenticeship, YAA is committed to bringing to the program professionals from a variety of fields to train and work with the YAA apprentices. Youth benefits from the expertise provided by: Scientists and science educators from MKI and CfA, members of a local theater company, staff from a museum exhibition design and planning company, the director of a local marketing and advertising company.

With the support of many local professionals, YAA apprentices: Write, produce and perform science/astronomy plays; Design and facilitate activities to introduce a lay audience to the use of the telescope; Create components for professional museum exhibits; Create and run planetarium shows that they perform at various venues using a portable planetarium; Create a promotional campaign for their community outreach events and to recruit new participants.

Community Outreach Events: Youth as Science Ambassadors. By the end of the summer apprenticeship, YAA youth are ready to present their science/astronomy performances at various venues in their communities across the city for both at local Cambridge Science Festival) and national events (AAAS conference).

Youth Assistant Program: Youth as Agents of Change. At the end of the summer apprenticeship some of the youth are willing to take on a major role in the YAA program itself and join MKI staff to work as youth assistants for the YAA afterschool programs.

With additional training and under the mentorship of YAA staff, youth are gradually empowered to share their learning and passion for science with other youth. As they grow in their roles, youth realize the challenges involved in facilitating somebody else's learning experience. With surprise, they also find themselves being identified as role models: These young ambassadors of science can prove to their peers that—contrary to a widespread teenage urban culture—to engage in science activities in and outside of the classroom is actually "OK," and that it can be a rewarding and exhilarating experience.

YAA Interns: The future generation of YAA educators. Youth that stay in YAA for two to three years and enter college have now the opportunity to become YAA Interns, an MIT paid position. YAA Interns take full part in all activities of the MKI Education and Outreach Group: they become instructors for the adults that will facilitate another of our initiatives, the Kids Capture their Universe program (describe elsewhere in these proceedings), and further develop their teaching skills to become YAA instructors at the same community afterschool sites where they started their YAA career. At the same time they pursue their education at local community colleges and take astronomy

courses at the Harvard Extension School. The YAA interns are becoming the future of the YAA program itself, as stated by one of the interns: "*Thanks to YAA I have an idea now on what it takes to survive out there in the real world which is all about being responsible and about getting done what is asked of you. But the most important thing of all to me is to do something that I enjoy doing (astronomy), something that allows me to grow and be a better person over all.*"

3. Results from Evaluation

Over three years, the YAA program recruited 178 youth (49% boys and 51% girls) with a retention rate of 54% (52% for boys and 54% for girls). In three years 71 YAA apprentices worked at MIT in the summer, and 17 became YAA assistants: 100% of the assistants returned to the YAA summer apprenticeship the following summer. Of the 178 youth that joined the program so far 95% are from populations historically underrepresented in STEM.

Concerning skill development, preliminary results of the evaluation for the first two years of the YAA program indicate that the majority of youth improved their communication skills, both within a working group of peers and larger, public audiences. Concerning impacts of YAA on the participants' academic and career plans, as a whole, the participants in the YAA summer program see themselves as college-bound (74%). Interestingly, 16% of respondents said they would like to be in graduate school. For the youth who wanted to pursue astronomy in college or as a career, YAA may have played an important role in supporting their interest and continued focus on their academic and career goals. Several youth mentioned that they would want to be involved with astronomy or take astronomy classes, even though it was not the focus of their studies. This idea of keeping astronomy in their lives as a long-term pursuit of astronomy as a free-choice learning interest, through an amateur astronomer group, continued reading, or supporting astronomy in the community, although not as a career, may prove to be one of the most long lasting impacts of the YAA program.

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