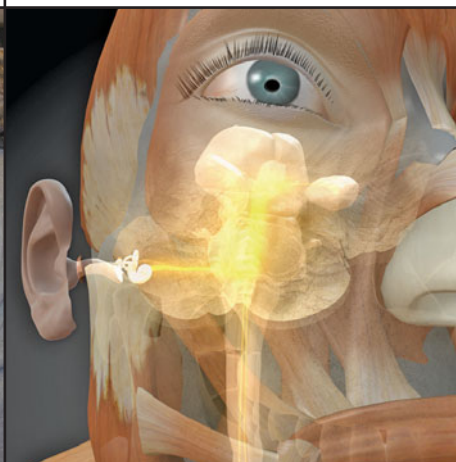


# The Impact of Informal Science Education A Massachusetts Perspective



# The Impact of Informal Science Education

## A Massachusetts Perspective

### A Summary of Impacts and Outcomes

The projects described in this booklet represent the work that has been funded by the Informal Science Education program at the National Science Foundation. The outcomes of these projects have provided a wide range of opportunities for students, teachers, and the general public to become more familiar and interested in learning about science. Just a few of the impacts that have come about as a result of this work are:



- Wired to Win is expected to reach between 8 to 10 million viewers over a 5 year distribution period. In Boston alone, over 68,000 individuals have seen the film.
- Terrascope Youth Radio will have nationwide impact, as teen participants work with members of other youth media organizations to improve their ability to cover science and engineering.
- The Urban Ecology Institute and Boston College's AYS and ITEST projects have improved students scores on standardized assessment measures and enhanced their likelihood of pursuing a STEM career.
- The Youth Astronomy Apprenticeship (YAA) empowers urban teens to develop new science understanding as they develop personal and interpersonal skills needed to fully participate in the life of our society.
- The Terrascope Youth Radio project empowers urban teens to understand and communicate stories about environmental science and engineering to their peers.
- The Youth Astronomy Apprenticeship (YAA) fosters science learning among urban teenage youth and their communities.
- The Urban Ecology Institute and Boston College's AYS and ITEST projects have impacted over 2000 students and 200 teachers in three years. This work has lead to curriculum materials that are in use in schools across the country.

# Urban Ecology as a Framework for Improving Student Learning and Engagement in STEM



## Vision and Goals

Our work is the result of an interdisciplinary collaboration between the Urban Ecology Institute, Boston College's Lynch School of Education, and the Boston Public Schools.

Our work engages students in inquiry-based learning (National Research Council, 1996) through the collection, analysis, and interpretation of data using of appropriate technology to support social environmental action.

We strive to engage students in high-level learning experiences while also conducting rigorous research on the impact of our programs. We have found that our work improves student learning, self-efficacy toward science, and their understanding of how to pursue a STEM related career.

We have found that these results are from our focus on developing and engaging young people in the study of urban ecology through sophisticated and scientifically rigorous exploration of their own urban ecosystem (Barnett, et al, 2008).



## Connecting In-school and Out-of-School Time



We have aligned our work with both the Boston Public School (BPS) out-of-school-time experiences and BPS's in-school curriculum. This has allowed us to develop a suite of activities that complement and build upon one another throughout the entire school day.

Within our model we train high school students to be science mentors, capable of using sophisticated science resources as part of the out of school time activities that they conduct and support at Boston Community Learning

Centers We also engage students to serve as teachers and mentors during our summer programs in which they lead project activities with younger students.

## ITEST: Urban Ecology and IT

Our ITEST project connects out-of-school time activities through the a comprehensive curriculum, teacher professional development, and summer institute for teachers and students. As a central part of our ITEST project we conduct a 4 week summer institute during which students and teachers learn

- the science of urban ecology and the basics of conducting field-based studies.
- how to use information technologies to support students in the study of urban ecology field science.
- how to conduct field-based scientific studies with students
- how best to use and implement the curriculum materials.

### ITEST Curriculum Materials



We have developed two curriculum units that are in widespread use. The first is our bioacoustics curriculum which targets the 8th and 9th grades and includes a field-based and a classroom component (Houle & Barnett, 2008). In this project students use Raven light from the Cornell Lab of Ornithology and analyze birdsong to evaluate whether bird song is impacted by urban noise. The second urban tree inventory has been conducted using Geographic Information System and CITYgreen. Using these software packages

students constructed GIS maps of urban tree cover to understand and evaluate the ecological and economic impact of urban trees either around their school or in their neighborhood.

## Academy of Young Scientists: A Learning Pathway

Through the Urban Ecology Institutes' (UEI's) 6th-8th grade Field Studies Program in Out of School Time, students can access numerous in-school and out-of-school opportunities to study science in a way that reinforces earlier learning and stimulates interest and engagement.

The program's curricular modules are integrated with BPS's YES Program and with the in-school elementary life science curriculum. Students will receive *Greentimes*, the eight-page more senior version of the science newsletter written by high school students.



Eighth graders take part in an "Ecoscenario" based in the Boston ecosystem for the Populations and Ecosystems unit of the nationally-implemented FOSS (Full Option Science Survey) science curriculum.

Students in the 6th-8th grade pathway are supported by LEAH Mentors. Mentors are high school students transitioning from studying science to actually teaching others in the study of science. These mentors are placed in the middle school UEI Boston Community Learning Center sites and provide an important peer-guidance.

## Impact on Learning and Affective Outcomes

Our project has shown several positive outcomes for students and teachers. Below is a small subset of our findings and impacts.

- Over 4000 high school and middle school students impacted
- Over 300 teacher trained on urban ecology in and out-of-school curriculum
- Significantly higher scores on measures of standardized assessment (Houle & Barnett, 2008)
- Significantly improved scores on student self-efficacy, interest in science, and STEM career knowledge (Barnett, Lord, et al., 2006)
- Improved teacher confidence in implementing urban ecology science in out-of-school settings
- Curriculum materials are being used across the nation in several urban school districts

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## Sponsors and Partners



This work is supported in part through a National Science Foundation Academy of Young Scientists Grant #0639466. This work is also supported in part through a National Science Foundation Information Technology Experiences for Students and Teachers (ITEST) program. (Grant # 0525040) and a Hewlett Packard Foundation Teaching with Technology Program (Grant #189660).

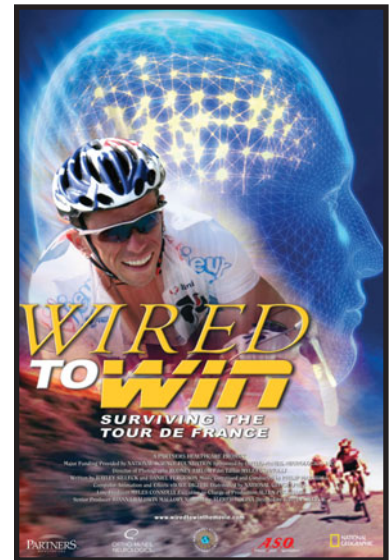
## Wired to Win — A Comprehensive Public Science Education Project

### *Wired to Win: Surviving the Tour de France*

This award-winning multi-component large-format film project, exemplifying best practices in the field of informal science education, is aimed at increasing popular understanding of brain biology and recent advances in neurosciences. From its inception, the project was designed as a completely integrated, wide-ranging educational initiative, with all components — film, print, online, and outreach — working together to explore new discoveries in the neurosciences. *Wired to Win* has received universal recognition and acclaim across all project components — from stellar project rankings by NSF reviewers, to nominations and awards for the film by the large-format industry, to prestigious awards for print and online components by the educational publishing industry.

### *Wired to Win* — The giant screen film reaches national audiences

*Wired to Win* takes advantage of the large-format screen to reveal what we know of the remarkable functioning of a normal human brain, leveraging the sheer expanse of the screen coupled with state-of-the-art computer generated imagery to afford audiences a “first-ever opportunity” to deconstruct various brain processes. Moreover, the narrative of the film — the Tour de France and its extraordinary competitors — is seamlessly integrated with the science story we tell, and animates the film with a poignant human story. *Wired to Win* takes full advantage of the worldwide network of 400 large-format (IMAX) theaters — including virtually every major science center in the U.S. — reaching 8–10 million viewers over the life of the film. With audiences ranging from school groups to adults to families, giant screen films offer a rich informal science educational opportunity outside the classroom.



Theater poster for the *Wired to Win* film

### *Wired to Win* — Educational materials and symposia

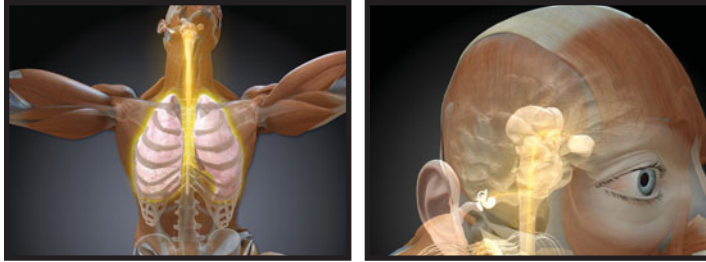
The *Wired to Win* award-winning educational initiative is one of the most ambitious programs ever mounted in the giant-screen film arena, providing an innovative array of print outreach materials which include activity guides, educator training, informational posters for schools and community organizations, a cutting edge website, and a “fun facts” guide for families, all distributed nationally. The *Wired to Win* Neuroscience Education Symposium brought together educators from around the country for an intensive 3-day experience to train educators in inquiry-based teaching methods related to neuroscience to enhance their educational efforts in their own communities.



Neuroscience educator, Carrie MacNabb, counsels a middle school teacher in a symposium workshop focusing on neuroanatomy sheep brain dissections

## Funding

*Wired to Win* was made possible by a \$2.8 million grant from the National Science Foundation, which in turn leveraged \$4 million from Partners HealthCare and \$3 million from Ortho-McNeil Neurologics. As is most often the case, a lead NSF commitment encourages funding from many different sources to bring important educational opportunities to the public.



Computer generated images of the fear response from the *Wired to Win* film

## Science + Society: Closing the Gap

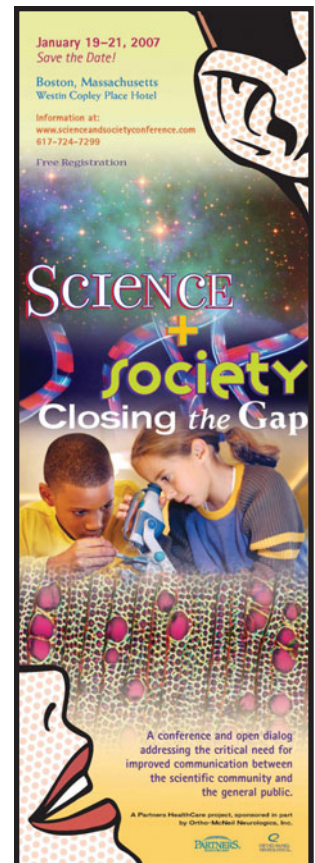
### Science + Society — overview and speakers

On January 19, 2007, Partners New Ventures hosted *Science + Society: Closing the Gap*, ([www.scienceandsocietyconference.com](http://www.scienceandsocietyconference.com)) an ambitious two and a half day international conference engaging speakers and participants in a conversation on the nature of scientific research, how scientists reach and inform the public about scientific advances, and the role of the scientific enterprise in public policy issues. Keynote speakers Al Gore and Dr. Shirley Ann Jackson (president, Rensselaer Polytechnic Institute and past president of the AAAS) set the stage for an assessment of science literacy in the United States and the importance of science education if the nation is to remain a leader in scientific and technological research and innovation in the 21st century.

Fifty-four assembled conference speakers included notable figures representing science, public policy, and communications, including: Rita Colwell, 11th Director of the National Science Foundation; Julie Louise Gerberding, Director of the Centers for Disease Control; and Alan Leshner, Chief Executive Officer of the American Association for the Advancement of Science, among others.

### Sessions

Conference sessions covered a variety of topics and issues, including: an examination of the importance of the public's awareness of science and technology today, and an exploration of practical and effective strategies for improving communication among and between scientists, policy makers, business and industry leaders, educators, and the general public; a focus on leading researchers as they described some of the most exciting research and considered what the future may hold in store; and a consideration of how to make the public a more active partner in the scientific enterprise through better public engagement programs, among other topics and issues.



## National and international reach

*Science + Society* brought new voices into the national and international science dialogue, and the conference organizers reached out to individuals across diverse professions and institutions. With ease of access (no conference fee) and an impressive series of sessions and speakers, *Science + Society* drew over 1,600 registrants from 34 states and over 20 countries, representing scientists and researchers, educators and students, policy makers, librarians and community organization educators, corporate executives, communicators in publishing and broadcast, and attendees from all walks of life.



*Panelists and attendees interact during the Science in the Media conference session*

## In sum

As keynote speaker, Al Gore, pointed out in his opening remarks: “I would like to congratulate [the conference organizers] on bringing together such a great group of people for a national dialogue and making it all so accessible to everyone. I’m honored to take part in it.” With such events, and with the funding an early NSF commitment encourages in the private sector for projects like *Wired to Win*, we can help close the gap between the scientist and the public he or she serves, and encourage a new generation of scientists for the 21st century.



*Al Gore, 45th Vice President of the United States, delivers the conference keynote address*





## Youth Astronomy Apprenticeship (YAA) An Initiative to Promote Science Learning Among Urban Youth and Their Communities

*Principal Investigator: Dr. Irene Porro, MIT Kavli Institute for Astrophysics and Space Research*

The Youth Astronomy Apprenticeship (YAA) is an **out-of-school time initiative** to foster science learning among urban teenage youth and their communities. The **goal** of YAA is to broaden the awareness of science learning as an effective way of promoting overall youth development and of leading to competitive professional opportunities.

### Collaborations

YAA is a program by the **MIT Kavli Institute for Astrophysics and Space Research** in collaboration with the Smithsonian Astrophysical Observatory, the Timothy Smith Network, and the Institute of Learning Innovation. **Community partners** that hosted YAA after-school programs over the last two years: Roxbury Multi-Service Center, Inc., Urban League of Eastern Massachusetts, Dimock Community Health Center, Tobin/Mission Hill Community Center, Upward Bound Program at the Roxbury Community College and Hispanic Office of Planning and Evaluation.

### Rationale and Impact

- For science learning to have a lasting impact on the life of a teen-age youth, it has to be integrated with the youth's personal development process so to be fully owned by the learner.

*The main impact for YAA is to empower teens to develop new science understanding as they develop personal and interpersonal skills needed to fully participate in the life of our society.*

- As we consider populations historically underrepresented in science, we understand that in order to encourage and support youth to pursue STEM learning and eventually STEM career paths, it is important to foster an environment that supports the same goals.

*YAA additional impact is to engage all YAA audiences (families, other teens, members of community-based organizations) in some science learning experiences through the community outreach work presented by the youth apprentices who graduate from YAA.*

- As urban teenagers, YAA participants are able to communicate to their peers - and other members of their communities - a message about the value of science literacy that is much more effective than that the traditional science outreach establishment could provide.

*YAA additional impact is to foster the role of urban youth as science ambassadors and as advocates for increased opportunities for science learning among underrepresented communities.*

### Youth Astronomy Apprenticeship Program

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.

The YAA program progressively develops youth's **science knowledge and 21<sup>st</sup> century employable skills** through several stages:

**After-School Program** - 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 after-school sessions take place at local community-based organizations.

**Summer Apprenticeship Program** - Youth that complete the after-school 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 MIT and Harvard
- Members of the Underground Railway Theater - a local theater company
- Staff from Jeff Kennedy Associates - a museum exhibition design and planning company
- The director of ThinkCollaborative - 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. In 2007-2008 YAA performances reached out to an estimated 750 people, both at local ("*Astronomy in the City*" at Hibernian Hall) 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 after-school 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.

### **An Example of YAA Positive Impact**

Heleno is a rising senior at the Jeremiah E. Burke High School in Dorchester. His mother and 3 brothers moved to Boston from Cape Verde 5 years ago. When Heleno joined YAA in 2007 he had very basic computer skills but a great interest in science. He attended the after-school program, became a YAA apprentice and then a YAA assistant. His communication and critical thinking skills improved greatly as he discovered his passion for astronomy and even joined a local amateur astronomers club. Under the mentorship of the director of YAA, Heleno worked on an astronomy project for the 2007-08 science fair: in May 2008 he won one of the MA State Science Fair first prizes, the Apollo Award awarded by the Massachusetts Space Grant and a \$20,000 scholarship for UMass Amherst. This was indeed a life changing experience for Heleno whose family would not be able to financially support him in college.

### **Demographics**

Over two years, the YAA program recruited 113 youth (49% boys and 51% girls) with a retention rate of 54% (51% for boys and 54% for girls). 43 youth became YAA apprentices, and 8 of them are currently YAA assistants: 100% of the assistants returned to the YAA summer apprenticeship for a second year. Of the 113 youth that joined the program so far 98% are from populations historically underrepresented in STEM. The ethnic groups with the largest number of participants so far are: African-American (40%), Hispanic (25%), and Somali (4%).

For more information on *Youth Astronomy Apprenticeship*, contact Dr. Irene Porro, Director, at [iporro@mit.edu](mailto:iporro@mit.edu) or 617-258-7481

*Program funded through NSF Informal Science Education grant No. 0610350*



In **Terrascope Youth Radio**, urban teens develop, report, write, produce and host radio programming on environmental topics. Their work will be broadcast and distributed nationally through partnerships with National Public Radio's popular **Science Friday** program, the **Pacifica Radio Network** and the **Public Radio Exchange**, along with numerous local stations.

Terrascope Youth Radio leverages the success of the rapidly growing youth radio movement, empowering teen participants while reaching thousands of their peers with relevant, interesting and scientifically accurate information. The project is expected to have major impacts on three primary audiences:

- **Urban Youth**, a notoriously difficult audience for messages having to do with science, technology, engineering and mathematics (STEM). Yet it is members of this generation who be making the environmental decisions of the future and living with the consequences of today's policies. Who better than their peers to understand what will interest, inspire and excite this audience? At Terrascope Youth Radio they will hear stories told in voices like their own, by other young people who understand what they care about and want to hear
- The program's **Teen Participants**, who will emerge with greater interest in STEM subjects, greater communication skills and valuable work experience that empowers them to continue their studies.



- **Other Youth Radio Programs Nationwide**, with whom Terrascope Youth Radio will collaborate, helping their participants to acquire a greater appreciation and understanding of STEM topics and strengthening their ability to present these subjects to their own listeners.

**For more information on Terrascope Youth Radio, contact Dr. Ari W. Epstein, Director, at [awe@mit.edu](mailto:awe@mit.edu) or (617) 253-3666.**

Massachusetts Institute of Technology • 77 Massachusetts Avenue, Room 16-177 • Cambridge, MA 02139  
Phone: 617-253-3666 Fax: 617-252-1390 E-mail: [tyr@mit.edu](mailto:tyr@mit.edu) Web: <http://web.mit.edu/tyr>

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Cambridge Youth Programs

