

Yale Peabody Museum of Natural History

EVOLUTIONS AFTER SCHOOL PROGRAM

IMPLEMENTATION TOOLKIT

EVOking Learning & Understanding Through Investigations Of the Natural Sciences

INTRODUCTION

This document details implementation of the EVOLUTIONS After School Program. EVOLUTIONS is a program based at the Peabody Museum of Natural History on the campus of Yale University. EVOLUTIONS was started in the spring of 2005 with 11 teens and has grown to include roughly 100 high school students. The program was specifically designed to address the lack of students – particularly those from historically underrepresented groups – pursuing advanced degrees in STEM disciplines (science, technology, engineering and mathematics): a problem currently plaguing the U.S.. To this end, our primary objectives include: 1) Helping teens see the connection - and steps between - secondary education and careers in order to motivate students and facilitate future planning; 2) Expose students to the breadth of STEM, in order to inspire and engage; 3) Empower students through hands-on science experiences, including internships with university researchers; 4) Reshape student perceptions of what it means to be a scientist and do science toward the facilitation of the consideration of STEM careers.

Funding

Though Yale University and the Peabody Museum of Natural History continue to provide the majority of the financial support for the EVOLUTIONS After School Program, the program's external funding history is as follows:

- 2005/06: Major funding provided by the Environmental Protection Agency Environmental Education Program with additional funding provided by United Illuminating and the Howard Hughes Medical Institute.
- 2006/07: Major funding provided by the National Science Foundation (Communicating Research to Public Audiences program) with additional funding provided by United Illuminating, Peggy Dannaman and The Ardenghi Trust.
- Summer 2007: Internship funding provided by the H.A. Vance Foundation.
- 2007/08: Major funding provided by the National Science Foundation (Enhancing Opportunities for Diversity in the Geosciences program) and the Institute for Museum and Library Services (Museums for America program; year 1 of 2) with additional funding provided by United Illuminating and the New Haven Community Foundation.
- 2008/09: Major funding provided by the Institute for Museum and Library Services (Museums for America program; year 2 of 2) with additional funding provided by United Illuminating and the New Haven Community Foundation.

Program Goals

The EVOLUTIONS mission statement, including program goals and objectives, is attached. The specific curriculum developed and utilized by program staff is intended to supplement formal school-based learning. We are striving to reshape student perceptions as they pertain to the sciences and inspire them to consider careers in science. This is done primarily through a curriculum focused on science career exploration and hands-on, real world exposure to the sciences utilizing the various resources of Yale University and the Peabody Museum of Natural History. In support of this mission, we also work to provide students with the tools and knowledge to successfully navigate pre-college academics and the transition into college.

RECRUITMENT

Ninth through twelfth grade students are recruited from the New Haven Public School System and the West Haven Public School System during the first month of school. In its first year, 7th and 8th grade students were also recruited. However, program staff found this age group to be too young for the various intended messages of the program (specifically, the college and career-related curriculum components) and, over the next two years, recruitment of these age groups was phased out. The 2007/08 school year was the first with only high school students but included students who started their association with EVOLUTIONS as 7th graders in 2005/06. One of the program's long-term goals includes returning to these age groups when staffing and resources allow for the development of an appropriate curriculum.

The week before school starts, emails are sent to the science chairs and/or principals of each high school requesting the opportunity to come to the school to talk to students, *specifically* during large-group presentations (e.g. class orientations, town meetings). We've discovered that this method of recruiting is, by far, the most effective as opposed to no presentations or presentations made to individual science classes. To be clear, there is something about the dynamic of a large group that results in significantly more applications than talking to an equivalent number of students across several science classes. That said, it can be difficult to get on the agenda during these school events, particularly at the larger high schools.

On the day before the first day of school, packets containing the following are hand-delivered to the principals, science teachers, parent/teacher organization representative and other science staff at all targeted high schools:

- A program information fact sheet for teachers (1);
- A color flyer with pull-off tabs for the classroom wall (1);
- A 1/4 page handout for students (1 sheet);
- An application (1).

**All are attached*

Over the first 3-weeks of school, the program coordinator dedicates his calendar to in-school presentations. Presentations are 5-20 minutes in duration depending on the venue and any interested students are given a ¼ sheet of paper with contact information for the

program which includes the website where students can download the necessary application forms or fill out the application online (application and student handout attached). Here, they can also gain access to the program web pages on the Peabody Museum website, which contain information and a recruitment video (Quicktime format; see <http://www.peabody.yale.edu/education/afterschool.html>). Applications used to be handed out to students instead of the ¼ page information sheets during presentations, however, we talk to several thousand students each year and the applications are several pages in length. The ¼ page sheets are more portable, cost-effective and environmentally friendly.

Student program applications are due at the end of the 3rd week of school at which time we hold an event allowing program veterans to help score new applications (new applicant identities are kept confidential). New student applicants are notified as to the status of their application over the 4th week of the program and the program begins in the 5th week.

The program application is several pages long and asks, among other things, for details concerning a student's extracurricular involvement, grades, interest in the program and academic interests in addition to requiring two (2) teacher recommendations. Though the length of the application is an effective deterrent against unmotivated students, there is currently no minimum grade requirement. Student applications are scored primarily based on completeness, the statement of interest and teacher recommendations. In short, the program seeks to recruit students interested in science, serious about school and committed to participating, who are considering college. Maintaining a student constituency representative of the NHPS student population is a program goal though students are not chosen based upon anything but the qualifications listed above. That said, our student population (cumulative) includes 64% young women and 60% students from ethnic groups historically underrepresented in STEM disciplines. The averaged within-year retention rate is 81% and the averaged between-year retention rate is 82%.

Recruitment mechanisms that we have not utilized but plan to explore in the future include:

- Targeting pre-start-of-school parent orientation events;
- Recruitment through parent-teacher organizations;
- End-of-year 8th grader recruitment.

Academic Incentives & Grading

During early program development, the program coordinator worked with district science supervisors and independent study coordinators to get the EVOLUTIONS program approved for independent study credit, which is currently available to all students.

Students earn ¼ credit per 45 hours invested in the program. By academic year's end, most students earn a ½ credit though some students with high involvement have earned as much as one (1) full credit over an academic year. Because students earn credit at their schools, we are required to give grades for work completed, though grades are calculated as follows in an effort to avoid hurting student transcripts (grading rubric attached).

The EVOLUTIONS After School Program
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<u>Percentage Earned</u>	<u>Letter Grade Reported to Schools*</u>
90-100%	A
80-89%	B
70-79%	Pass
<70%	Incomplete

**All "A" & "B" students have the option of receiving a grade of "Pass"*

Historically, students successfully completing a full academic year were provided a narrative evaluation written on Yale letterhead and intended for use in job and/or college applications. Student letters were updated each year for students who stayed with the program over several years. More recently, this has become administratively unfeasible given the number of students in the program and our limited staffing. Currently, all students are encouraged to use program staff as references and for letters of recommendation when applying for jobs, internships and college.

PROGRAM SPECIFICS

Program participants meet one day a week for the duration of the school year. Currently, first year students meet on Tuesdays and Wednesdays, second year students on Thursdays and 3rd+ year veterans on Fridays. Mondays are “free days” and the classroom is open for students wishing to receive homework help from a math tutor (a Yale undergraduate), use our computers for school projects or just hang out!

Formal class meetings are held Tuesday-Friday from 3:30 – 5:30pm though students arrive as early as 2:00pm depending both upon when their school lets out and travel time to the museum. City bus passes are provided free to the program/students by the New Haven Public School System and West Haven High School students are transported to the Museum (note: when the program included 7th and 8th grade students, the New Haven Public School system also transported students from their schools to the Museum).

When students arrive to the classroom, program staff typically have a craft activity or games available for students though students are also allowed to use one of our 12 Macintosh laptop computers for school work or recreation (monitored). Classes start with any housekeeping announcements, science updates (weekly science news articles) and trivia questions in the form of SAT prep questions (source: College Board). The day’s work is conducted between ~3:45pm and 5:00pm. In the interest of fun, and retention ultimately, the last 30 minutes of class (5:00-5:30pm) is reserved for a fun activity in the form of a class game, science demo or other engaging hands-on activity.

Committees

EVOLUTIONS allows students to participate in one or more of three committees run by program staff:

Newsletter committee: Students produce a newsletter once per semester that highlights program activities and student artwork and writing. It is emailed and/or snail-mailed to parents, Museum staff/volunteers and other friends of the program. It is intended, in part, as a marketing tool in addition to providing a mechanism to maintain contact and buy-in from parents.

Fundraising committee: Students raise money primarily by selling concessions at Museum events or from one of two concession carts catering to staff and students. Students typically raise ~\$3,000 in an academic year. This money is intended primarily to fund a fun, end-of-year trip (e.g. bowling/pizza/movie party, local amusement park) though, in the past, students have also donated some of the money to charity.

Community service committee: Helping students to develop a sense of social awareness is an objective of the program and the purpose for this committee. In past years, students have participated in hosting an AIDS-walk, volunteered at an AIDS hospital ward and worked at a local book-bank. Hours spent conducting community service are recorded separately to accommodate those students with a community service graduation requirement.

Staffing

Though the program has always utilized undergraduates as program staff, in the past we have also recruited staff from Public Allies (see www.publicallies.org). The current staffing structure is as follows (job descriptions attached):

2 Teaching Fellows: Yale undergraduates that teach the Tuesday through Thursday classes (1 instructor teaches 2 classes).

2 Museum Fellows: Yale undergraduates who teach the Friday Sci.CORPS class who are also primarily responsible for implementing Sci.CORPS (Sci.CORPS details below).

1 Administrative Assistant: Yale undergraduate who helps with administrative duties ~10 hours/week.

1 High School Math/SAT Tutor: Yale undergraduate available to students on Mondays. This student also manages the classroom on Mondays.

NOTE: Over the 2007/08 academic year the program received NSF OEDG funding (Opportunities for Enhancing Diversity in the Geosciences). During this academic year, we hired a graduate student in Yale's Department of Geology and Geophysics who was tasked with developing and implementing geoscience-focused presentations in addition to liaising with the Yale Department of Geosciences and Geophysics to secure access to resources. Curriculum materials attached.

CURRICULUM / ACADEMICS

There are three broad categories of program activities in which students participate: In-house projects, in-house workshops and field trips. These forms of engagement expose students to a side of science not readily accessible in the formal school environment while simultaneously providing the skills and knowledge to support their success in school and preparation for college. Survey results (below) demonstrate that this approach is effective toward achieving program goals and is valued by students.

In-house Projects

In-house projects are typically completed over the long term (i.e. a semester) and aspects may be assigned as homework with specified deadlines given at the front-end.

Career exploration & panel production: First-year students participate in an individual-based project giving them a formal mechanism to explore science careers of interest. In the program application, students are asked to note their science career interests. Program staff used this as a jumping-off point to develop a list of careers that includes those listed by students but that also includes related careers perhaps unknown to students, in addition to including a host of STEM-related careers not accounted for on student lists. For this project, students are asked to choose two (2) careers and, for each, generate a 2-page fact sheet (project guidelines and career list attached). Among other things, this project requires student interviews of professionals and/or college admission officials in addition to researching those college classes required for a major leading to the careers of interest. The career exploration project takes place during the fall semester. During the 2007/08 academic year, geoscience careers were specifically highlighted and student career explorations included at least one geoscience-related career.

Student exhibit: On alternating years all program participants work in groups to mount a museum exhibition. Exhibit topics are driven by funding though students vote on the specific topics. Over the 2005/06 school year, students produced an ambitious exhibition focused on the environmental effects of the terrorist attacks of 11 September 2001. Our 2006/07 exhibit focused on wood frog ecology and highlighted the work of Yale professor David Skelly. The 2007/08 exhibit highlighted careers in the geosciences (NSF funded). The 2008/09 exhibit focuses on the ocean sciences.

As stated, students are involved in the topic decision process and engaged in all aspects of exhibit research, design, layout, construction and marketing. For the exhibit focused on the environmental effects of 9/11, students worked in groups to research various aspects of related events. They produced panels for the exhibition, which, in some cases, included interviewing first-response organizations and individuals. Students helped to layout the exhibit space, erect temporary walls and paint a New York City skyline, in addition to hanging their framed panels. At the exhibit opening, students hosted their families, Museum

staff and other friends of the program. The exhibit was in the Peabody Museum for several months over the summer and opened again the following September 11th (2006) at a local environmental museum.

In preparation for our exhibit focused on wood frog ecology, students visited the field site of professor David Skelly and worked in groups to conduct lab-based experiments on wood frog tadpoles. Students tested the effects of everything from road salt and fertilizer to temperature and pH on tadpole growth. Student experimental results were presented graphically in PowerPoint slides which were turned into a movie for the exhibit. Students also conducted research related to the focus of their experiments, which provided text for several panels included in the exhibition. Finally, the students' tadpoles were released into a large terrarium where, over several weeks, students and visitors watched them metamorphose into wood frogs.

GEOWhiz, our NSF funded geoscience exhibition, entailed involved turning our exhibit space into a giant cave containing several smaller caves where panels and objects related to various geoscience careers were displayed. Students built our cave walls which were constructed of crumpled chicken wire covered with muslin dipped in a mixture of flexible glue, water, joint compound and sawdust. Individual exhibits within the cave focused on the following geoscience careers: climatology, paleontology, planetary geology, oceanography, geoarchaeology, glaciology and vulcanology.

This year's ocean science exhibition will feature student-produced videos of interviews with Yale marine researchers. The exhibition will also feature text versions of these interviews, an exhibit on biodegradation and biopolymers (produced in collaboration with Dr. Julie Zimmerman's lab) and a station where visitors can build their own ROVs (remotely operated underwater vehicles) out of PVC which they can test-drive in a pool of water utilizing control boxes constructed by students in the program (based on the Monterey Bay Aquarium's ROV-in-a-Bag-Kit).

Our exhibit project is undertaken in the spring though, moving forward, we are considering stretching this project over the entire academic year.

Teaching video: On alternating years students work in groups to produce a DVD-format video focused on an earth science standard taken from the Connecticut Science Framework for elementary and/or middle school students. These videos are marketed to local elementary teachers and made freely available to the general public on the program's website.

In-house Workshops

In-house workshops encompass those activities conducted in the classroom that fall outside the scope of any of the projects detailed above. They are typically focused around skill building though some are more informational (several presentations

attached). These activities are scheduled as they support other assignments or are otherwise scattered throughout the year.

- College workshops: Interactive information session that provides basic information about college and the application process. Also strives to establish a context for high school academics.
- Resume workshops: Students are given the opportunity to produce a resume in the appropriate format for high school students.
- Academic planner and life log workshop: Students work on completing a planner produced by program staff (attached). It provides a place for students to document awards, activities, standardized test information, employment history, and skill accumulation in addition to acting as a high school academic planner. This planner is currently undergoing a major revision and will be greatly expanded. As envisioned, students will get grade-appropriate planning pages to complete each year of the program and these pages will be compiled in student notebooks.
- Transferable skills workshop: An introduction to the concept, value and recognition of transferable skills.
- Citation & plagiarism workshop: Stresses the importance of avoiding plagiarism, presents tools and techniques for citation and provides practice citing texts.
- GPA Game: Activity designed to teach the various aspects of a well-rounded college application.
- Internet research workshop: Tools and techniques for conducting efficient information research on the web.
- Photoshop/PowerPoint Workshop: Teaches the basics of each.
- iMovie 101 Workshop: Teaches basics of iMovie.

Field Trips

“Field trips” loosely include anything that takes us outside of the classroom. These trips are scheduled throughout the year. Specifically, these trips may fall into one of several categories:

Yale University Campus Trips

- Peabody Museum collection tours: The Peabody Museum owns roughly 11 million objects, which reside in 11 different collections with very limited public access. Program participants receive tours conducted by collection managers and curators.
- Yale science lab and facilities tours: Tours of the laboratory facilities of Yale faculty in addition to other science facilities (e.g. observatory, greenhouse, farm).
- Yale admissions tours: Including the general campus tour, science department tour and engineering department tour.
- Yale undergraduate classes: Students sit-in on an undergraduate science class or lab section.

Local Trips, Off-Campus

- Peabody-owned properties: The Peabody field station (Guilford, CT), Peabody Museum Natural Area (Branford, CT), Horse Island (Thimble Islands).
- Yale owned properties: Yale Myers Forest (Union, CT), Yale Outdoor Education Area (East Lyme, CT).
- Trips to local businesses with a STEM focus (e.g. Sikorsky Aircraft).
- Other local outdoor venues that support curriculum.

Regional Trips

- Museums and science centers: To date, we have visited the Boston Museum of Science, American Museum of Natural History (New York), Queen's Zoo (New York) and the New York Hall of Science. Day trips such as these are typically scheduled during weekday holidays (e.g. Veteran's Day, Good Friday), which is convenient for working parents and assures student availability.
- College visitation trips: Each year we take a 2-3 day overnight trip to visit universities in our region. To date we have visited nearly 20 different universities in the greater northeast region. The college trip typically occurs during the students' winter or spring break.

The EVOLUTIONS Podcast

Podcasting is a term coined in 2004 that combines the terms "broadcasting" and "iPod". Though Apple – the makers of the iPod – was not the developer of this technology, they were among the first to develop it in the public realm, hence the name. Podcasts are distinguished from simple downloads or the real-time streaming of files in that the use of a new technology, RSS syndication (really simple syndication), allows anyone on the internet to subscribe to audio or video files. RSS subscriptions are typically free and enable audio or video files to be automatically downloaded onto one's computing device so that the subscriber can access them at their convenience. Our podcast, EVO-Cast, is an MP3 file of recorded student discussions regarding contemporary issues in science and education. You can subscribe to our podcast via iTunes.

Internships / Career Ladder Program

In the summer of 2007, money was given to the EVOLUTIONS After School Program by the H.A. Vance Foundation to support a pilot internship program placing high school students in the labs of Yale science faculty. During the pilot, 10 students were placed with five participating Yale faculty. The internship program was a tremendous success both from faculty and student perspectives (see evaluation results below). Further funding (NSF & IMLS) provided stipends for 20 student internships with Yale researchers over the 2007/08 academic year and another 20 for summer 2008 most of which focused on the geosciences. Internships culminate with a student presentation in front of their internship hosts and parents at a program-sponsored luncheon.

The EVOLUTIONS After School Program was chosen to participate in the New York Hall of Science's 2007-09 Science Career Ladder Dissemination Project providing training and technical assistance in the development of a youth employment program (see

http://www.nyscience.org/fun_learning/SCL). Two Peabody education staff (including the EVOLUTIONS program coordinator) attended a 3-day training/implementation workshop at the Hall during in November 2007. During the summer of 2008 two Yale undergraduates and three EVOLUTIONS high school veterans were hired to work with the EVOLUTIONS program coordinator to develop the structure of our own career ladder program which has since been named Sci.CORPS: the Science Career Orientation & Readiness Program for Students. Sci.CORPS is characterized by three career rungs and is currently being piloted over the 2008/09 academic year. Since implementation, Sci.CORPS has undergone constant revision in response to challenges encountered and student feedback. Current versions of the Sci.CORPS handbook and training guide are attached.

PARTNERING WITH RESEARCHERS & INSTITUTIONS OF HIGHER LEARNING

The integration of scientific research and education is the focus of the National Science Foundation's (NSF) Broader Impact review criterion. Successful projects develop substantive partnerships among researchers, educators and students and are able to demonstrate positive impacts. Though most researchers easily navigate the NSF's Intellectual Merit review criterion, they often struggle with this requirement. The EVOLUTIONS After School Program was specifically designed to render it amenable to partnerships with researchers seeking ways to fulfill the broader impact requirements of NSF and other granting agencies by allowing them to "plug into" program activities. As detailed above, long-term projects and field trips are a standard part of the EVOLUTIONS curriculum. Therefore, student career fact sheets/museum panels, exhibit and video lesson plan projects, lab tours, internships etc... can all provide opportunities for students to learn about current research.

These are some tips for working with faculty, gleaned from our experience working with many different scientists:

- Solicitation of faculty research partners was accomplished through a one-page flyer (attached) that was distributed among Yale science departments. It gives details regarding the EVOLUTIONS program in addition to potential partnership scenarios. We received several inquiries from this solicitation and find that the demand for letters of support for researcher grants continues to increase.
- There is an inherent disconnect between university faculty/researchers and teenagers. Specifically, the vocabulary of even the most conscientious researcher can fly right over the heads of most high schoolers. In return, high school students can often seem aloof and uninterested during presentations and tours. So the question becomes how do we truly form a meaningful connection between the two? We've learned to employ several strategies:
 - When faculty are solicited to give presentations, tours and the like, an effort is made by program staff to establish a realistic expectation. For example, though teens will often seem uninterested and even complain about being asked to take part in some particular activity, invariably those same teens will relive some interesting part of the presentation to program staff or parents. In teen speak, "that wasn't as bad as I thought it was going to be" is near to a rave review!
 - Staff are poised to ask for definitions or clarifications when any presentation reaches a certain level of complexity.
 - Before presentations by researchers and/or faculty, students are reminded to be polite (spelling out the specifics) and encouraged to ask questions.
- "Partner preparation" is more intensive when it comes to internships. Specifically, interns attend a job training conducted by staff where several basic

guidelines related to employment are discussed. For many students, the internship may represent their first real experience working at something that could be construed as a job with all the associated responsibilities. Staff make themselves available to faculty wishing to discuss the types of projects amenable to teen participation and faculty surveys have already become an invaluable resource of relevant information. In addition, before the internship, staff facilitate a meeting between the faculty host, laboratory staff and interns. At this meeting, expectations and sources of trepidations on both sides are discussed. In particular, program staff make certain that all laboratory rules and safety precautions are clear and understood by students. Survey results from students and faculty have revealed that students typically perform above faculty/researcher expectations to the point that roughly $\frac{1}{4}$ of the interns have been picked up by their faculty beyond the initially agreed upon end-date of the internship.

- Involving graduate (and where possible undergraduate) students in the program is extremely beneficial both for the students and faculty.
- Thanking people is extremely important. For short term partnerships, participating faculty/researchers are always thanked and an effort made to share a positive student reaction or anecdote. During longer-term associations such as internships, program staff will continually check-in with students and their hosts, taking pictures for marketing purposes and may offer to generate documentation for use in grant applications.

EVALUATION

Since the program's inception evaluation has been carried out by Judah LeBlang of the Program Research & Evaluation Group (PERG) based at Lesley University. Program evaluation consists of pre- and post-program student surveys, mid- and end-of-year focus groups with students and end-of-year focus groups with parents. Interns and their faculty mentors are also surveyed and interns included in focus groups. The 2008/09 evaluation report is attached.