

# Project WISE: Building STEM-Focused Youth-Programs that Serve the Community

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## Introduction

What influences an individual to choose a STEM-based career? In other words, what are the early-life experiences that encourage individuals to choose STEM-based careers? Once we better identify the determinants in choosing STEM-based professions, we will not only improve the STEM-literacy of our students, but better recruit and retain these students along STEM-oriented career paths.

Current research supports the notion that the strongest influences in an individual's decision to enter STEM-based professions occur well before a person enters college. Therefore, we designed a program to recruit future STEM-professionals from an often untapped source – high school-aged women. The current high school curriculum focuses primarily on STEM-content, yet the best way to learn this content, and to be inspired by it, is arguably by teaching it. Unfortunately, high school students have limited peer-teaching opportunities and are rarely exposed to pedagogical issues. The premise of our project is to immerse participants in cohorts that focus on both content knowledge and pedagogical best practices to determine whether our “grow-your-own” pipeline inspires young women to enter STEM-based professions.

## Background

Many researchers have focused on the factors that influence a person's decision to choose a particular career [7], [9], [10], [11]. High on the list of factors is the notion of “self-efficacy.” Self-efficacy is defined as “an individual's confidence in their ability to successfully complete a task” and is acquired from four informational sources: performance accomplishments, vicarious learning, social persuasion, and emotional arousal [1], [2]. Research in educational and occupational self-efficacy shows that the stronger the efficacy beliefs, the more interest students express in a given occupational area. In fact, when comparing STEM-focused to non-STEM-focused careers, occupational self-efficacy

was more predictive than personal interest [8]. Other findings reveal that although college has a significant, unique influence on an individual's career choice, the influence is small in comparison to pre-college variables and that a college's selectivity and highly competitive intellectual environment actually have negative effects on students' decisions to pursue certain career choices [3], [12]!

On the other hand, pre-college factors such as the perceived intrinsic value of a profession, identifying a job that is enjoyable, and choosing a job that gives an individual responsibility and an opportunity to contribute to society, outweigh the impact of a strong college program [6], [7]. The most striking results come from a study that examined graduate-level science students who were successfully recruited into the STEM-teaching profession. This study examined why such students were attracted to the profession and found they were motivated by an early exposure to science in informal settings with favorable working conditions and positive experiences [13]. Other studies also show that people who had exposure to a certain profession were likely to stay in that profession if experiences were early and rewarding [10], [11].

One way to help teens develop a sense of self-efficacy and provide them with this early exposure to STEM-based careers is through informal programs that train them to become teachers and exhibition-developers. For instance, the Association of Science and Technology Center's “Today's Youth Tomorrow's Teachers” program, the Sci-Tech Hands-On Museum program in Illinois, the St. Louis Science Center's “YES” team, and the Museum of Science and Industry's teen programs are a few of the many informal STEM-centers that have successful programs where student-participants develop and implement educational materials. A particularly encouraging program has been the Chicago Historical Society's “Teen Chicago,” in which participants were not only able to conduct detailed research on Chicago history, but formed close relationships with other team members while dispelling negative perceptions of how teens handle themselves in museum settings [5].

## Abstract

We describe the design and implementation of Project WISE, a multi-institutional partnership that assembles interdisciplinary teams of undergraduate and high school females and charges them with developing STEM-based community youth-programs that focus on women's contributions to aviation and space flight. The project's goals are: (i.) to promote young women's interest in STEM-oriented careers through an early, positive exposure to informal science education, and (ii.) to trial-test a model of how high schools, universities, and informal learning centers can collaborate to build strong, successful youth-program partnerships that serve the local community. The project is innovative in its youth-development strategies, its targeting plan for diverse audiences, and its focus on women in aviation and space flight. The project also gives student-participants rare but powerful opportunities to contribute directly to the quality of life in their community and to work in multi-disciplinary, multi-generational teams.

## Project WISE – Design and Implementation

Capitalizing on this past research and our own prior investigations, we structured our after-school program to focus on providing student-volunteers with an early, rewarding exposure to informal science education [4]. We titled our program, “*Project WISE: Working in Informal Science Education*” (Project WISE) and forged a partnership of three neighboring institutions, each providing essential participants and resources to the program: a liberal arts college (~3,500 undergraduates), a nearby high school (~450 students), and a small, urban, privately-funded women’s air and space museum (~7,500 visitors per year). Our model is audience-focused and targets the following two populations that bridge the informal and formal education communities:

**1. Undergraduate and High School Students:** The primary target audience of our program consisted of 35 female high school junior/senior volunteers who enrolled in a twelve-Saturday program that encouraged them to pursue STEM-based careers. These students were chosen simply for their interest in STEM-careers and were not necessarily high academic achievers. Our primary target audience also consisted of 17 undergraduate volunteers (both male and female), majoring in the sciences or education, who would serve as mentors to our high school participants. We paired each undergraduate with two high school students to form a “near-peer/mentor-apprentice relationship” and gave each team a choice of developing one of three types of original, open-ended, standards-based, museum deliverables: (i.) permanent interactive exhibits, (ii.) digital-media of student-performances in flight-related vignettes or in character portrayals of famous female aviators (we labeled these deliverables as “digital-media performances”), or (iii.) activity-stations for young (K-5) museum learners and their families. Teams had complete autonomy over their projects and were responsible for almost all decision-making. These student-teams then collaborated with various STEM-professionals for two semesters, typically meeting 1-2 times per month, to create their chosen projects. At each meeting, the STEM-professionals were available for students to tap for advice and expertise. For example, we arranged for students to meet with a professor of finance to discuss budgeting strategies; an actress from the local historical society to experience a “behind the scenes look” at character portrayals; various

engineers to investigate the physics of flight and aircraft-design; and the director of the local science center to address exhibition-development. Over the two semesters, some of the deliverables developed by the students include: a two-module space station, a “touch-wall” of aviation-related hardware, an aircraft simulator, a 1903 Wright Glider simulator, a portable planetarium show, and several digital-media performances of famous female aviators like Amelia Earhart, Bessie Coleman, and Judith Resnick. Additional samples of the student-produced deliverables are available at our website, [www.wiseproject.info](http://www.wiseproject.info).

**2. K-5 Youths:** At the end of the two semesters, ~350 children (grades K-5) from a major urban school district took part in a culminating, day-long educational program at the museum. At this event, the undergraduates and high school students unveiled the products that they had designed. Thus, a second target audience of our program is informal learners, specifically children in grades K-5 (and their families), recruited from a major urban school district. Of the ~67,000 pre-K-12 students in this school district, 100% are classified as economically disadvantaged, 70% are African-American, and 10% are Hispanic. Our project’s multiple target audiences perhaps represent its strongest feature. As noted by one of our external evaluators: “I can’t think of another program that teams professionals, undergraduates, high school students, and K-5 youths on a common project.”

## Evaluation Protocol

To ensure the objectivity of the evaluation process, we utilized both internal and external evaluation strategies. The internal evaluation included an advisory panel of STEM-professionals who regularly reviewed the project’s implementation progress and impact on students. They conducted on-site surveys, video interviews with participants, and collected written student-narratives after each meeting. The external evaluation consisted of two consultants who provided feedback based on participant pre/post self-reporting surveys. The initial survey was designed to capture the demographics of the participating students at the time of their entrance into the project and the year-end survey asked all participants about the extent to which their participation in Project WISE had impacted them, their ability to work in groups, and their decision-making processes. These surveys included both numeric

and open-ended questions that were especially informative regarding participants' experiences. Finally, the external evaluation also included 20 museum personnel, from outside institutions, who attended a two-day summit (including our culminating event) where they were briefed on the dynamics of our program and provided independent feedback through a series of observation forms.

## Strengths

Our evaluation identified the following five areas as the primary strengths of our program: (1.) impact on career and appreciation of STEM, (2.) team structure and autonomy, (3.) focus on community/family, (4.) recruiting tactics/incentives, and (5.) the accomplishment of event day. Student comments and statistical data are included below to illustrate these strengths.

**1. Impact on Career and STEM-Appreciation:** For students already interested in STEM, Project WISE reinforced their choice of possible careers:

*I always intended to pursue a career in science or engineering, and my dedication to this dream has been happily reinforced by my involvement in Project WISE.*

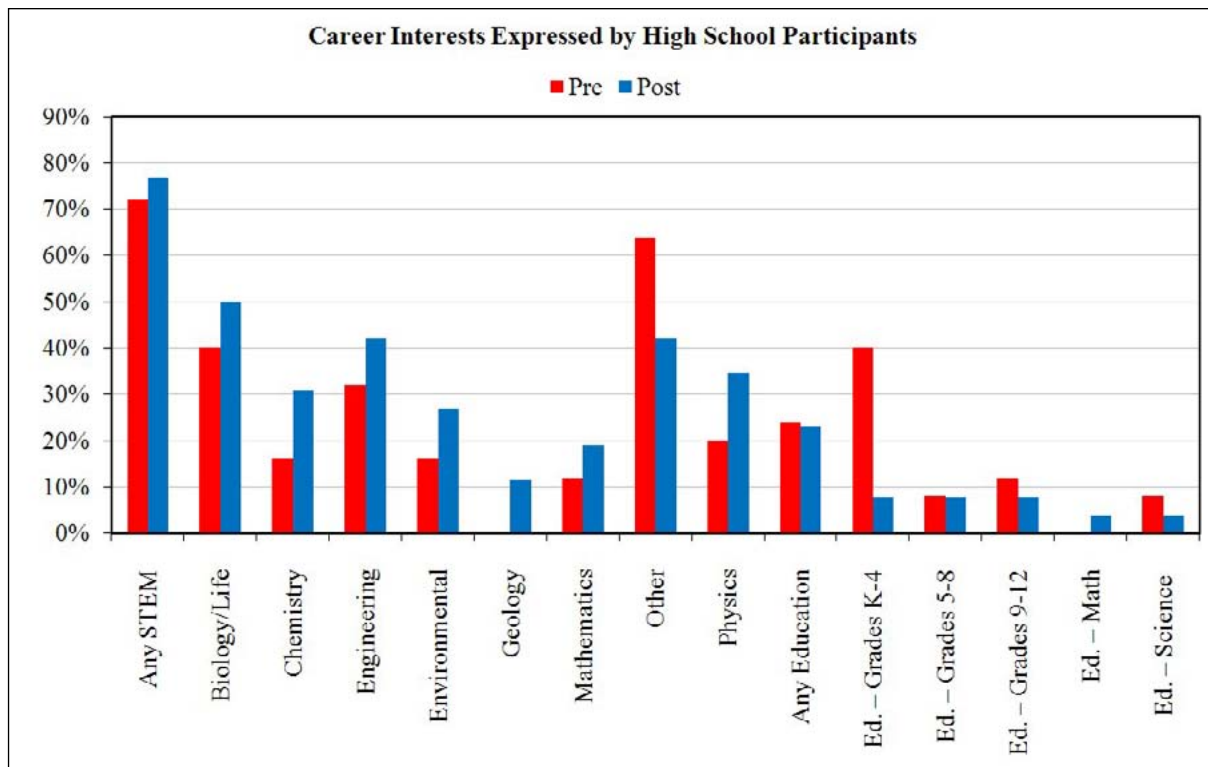
However, significant pre/post differences occurred for high school students who were

initially undecided about the careers they might pursue. By year-end, these students had a significantly greater interest with respect to several STEM-fields: Biology (50% versus 40%), Chemistry (31% versus 16%), Engineering (42% versus 32%), Geology (12% versus 0%), and Physics (35% versus 20%). Interestingly, those students who initially expressed greater interest in certain "other" careers (e.g., business, law, etc.) showed a decreased interest in STEM-careers as a result of their involvement in Project WISE. Evidence also indicates that the students had begun to give more value to teaching as an important skill, but their attraction to education careers remained minimal. Finally, a significant gain was observed in participants' attraction to applied research positions.

Students' essays further highlighted how the experience made all participants more aware of the importance of STEM and increased their respect and appreciation of STEM-professionals. Some students even found themselves promoting STEM-related topics, careers, and personnel:

*After this experience, I now have a better understanding of how smart and gifted scientists really are and how lucky I was to be exposed to so many talented professionals.*

**2. Team Structure and Autonomy:** High school students responded very favorably to their partnering with undergraduates in forming





Teams of undergraduate and high school volunteers worked over two semesters to design and develop project deliverables that would be immediately infused into a youth-program at an informal science learning center.

“near-peer/mentor-apprentice relationships.” Though students viewed Project WISE to be an once-in-a-lifetime opportunity to work with adult STEM-professionals (teachers, museum staff, professors, etc.), they relished the opportunity to make real-life, autonomous decisions without the interference of adults, but with the guidance of near-peers. Ultimately, the undergraduates took on the roles of “middle-level managers,” acting as liaisons between “entry-level personnel” (i.e., the high school students) and “upper-level management” (i.e., the Principal Investigator and STEM-professionals).

**3. Focus on Community/Family:** Students agreed that making lasting contributions to a museum and producing deliverables that were available to the community were perhaps the most exciting aspects of our program:

*Before I joined Project WISE, I didn't really see how STEM affects me or my community.*

*Today, I truly care about how science affects my home and community and am proud that my project will be seen by hundreds of kids that visit the museum.*

At the beginning and conclusion of the program, a reception was held for the participants' families. Families were also encouraged to visit our dissemination website to monitor student-progress and pose questions to the Principal Investigator. Students felt a sense of pride in showcasing their deliverables to their families, while family members were appreciative of being “kept in the loop.”

**4. Recruiting Tactics/Incentives:** Our incentives were extremely powerful in recruiting the undergraduate and high school volunteers. Incentives included: small monetary stipends, free lunches/transportation, credits toward service requirements, opportunities to attend con-



As one of our recruiting tactics for undergraduates, volunteers could attend a national conference and present results of our project.

ferences (all undergraduates were required to present results at either a local or national conference), recommendation letters for resumes/college applications, opportunities to improve public speaking and team-management skills, and an opportunity to work at an informal science center.

**5. The Accomplishment of Event Day:**

Event day was highly successful and had the desired impacts on the volunteers and K-5 youths. All participants enjoyed the sense of accomplishment in seeing young children trial-testing the deliverables. High school volunteers were especially appreciative of dialoguing with the K-5 youths on event day since this reinforced the notion that the children were genuinely engaged in project deliverables:

*I feel that the children really enjoyed what they saw and learned something as well. Seeing the 'light bulb go off' in the heads of the children made this experience all worthwhile.*

**Areas of Improvement**

Likewise, evaluation results indicated that some areas of our project could use improvement, including: (1.) infusion and assessment of STEM, (2.) relationship building, and (3.) training of undergraduates.

**1. Infusion and Assessment of STEM:**

An especially encouraging outcome was the students' desire for further infusion of scientific facts and experimentation into all deliverables:

*In the future, I hope that we could have new activities that are not just fun and interac-*

*tive, but relate more to STEM and challenge the kids to think more about STEM.*

The high school students recommended several specific ways that each deliverable could be enhanced by increasing STEM-content as well as various learning outcomes which would better assess the K-5 youths' experiences at event day.

**2. Relationship Building:** We found a surprisingly high percentage of high school students who concluded that the project did not impact their ability to work collaboratively with undergraduates (42%) or faculty/consultants (69%). The high school students did indeed enjoy working with these groups, but they asked for opportunities like "ice-breakers" or team-building exercises to establish a more "personal" relationship with the older participants. To address this concern in future years, we have incorporated a "Team Identity Packet" into initial team meetings. With this packet, participants will create team-names and slogans, and design team-logos and T-shirts. In previous work, we found that this activity has a very positive effect on group performance as an "esprit de corps" emerges from this socialization [4].

**4. Training of Undergraduates:** The undergraduates unanimously agreed that they needed specialized training to work as effective mentors. Moreover, they felt that they were somewhat hands-off managers and not essential parts of their teams. For instance, much of the communication between the high school participants was done on their own time, at school, or via email, and the undergraduates felt left-out of this communication. One possibility, given the difficulty with the logistics of the two groups meeting regularly, is for the under-



Scenes from Event Day: Approximately 350 K-5 students from a major municipal school district attended a day-long educational program where undergraduate and high school volunteers unveiled their project deliverables.

graduates to have responsibility for reviewing all education components, ensuring their appropriateness for young children and that the activities are truly educational with age-appropriate instruction in STEM. This structure would serve to keep undergraduates better involved in the overall group process.

## Replication

The success of our project involves several components that allow it to be replicated at other institutions: (i.) Undergraduate and high school students are embedded in a “near-peer/mentor-apprentice” relationship, in multi-disciplinary, multi-generational teams. We accomplished this through a collaborative effort between a neighboring four-year college and high school, but nearby community colleges, industries, hospitals, etc. can be used. (ii.) Group guidelines are implemented to ensure all participants can contribute to group success and that no one is carrying a disproportionate amount of work. Teams operate under a minimal set of constraints to preserve the decision-making autonomy of each group. (iii.) Team formation centers around a community-based theme or issue, or one that is of unique interest to students, in our case, women’s contributions to aviation and space. (iv.) Deliverables are directly infused into an informal learning center; therefore, student-products make a direct impact on the community and area youths. (v.) Finally, institutional support is crucial to the recruiting process and implementation plan. For instance, schools can offer participating students academic credit, letters of recommendation, stipends, etc.

## Broader Impacts

Our project has four lasting impacts on the fields of STEM-education and informal-learning which extend beyond their direct impact on our target audiences. First, our project serves as a model of how neighboring institutions can collaborate to build strong “youth-development partnerships.” Our model is unique in that youth-development is driven by a multi-institutional partnership. Second, we trial-tested a new model for constructing a pipeline that recruits young women into STEM-based careers. Next, since our project is focused on a direct means to entice high school students into STEM-based careers, our project enables us to address questions involving the shortage of STEM-professionals in the U.S. Finally, since the project deliverables were created to align with national and state STEM-standards, they

can immediately be used by other museums and educational institutions.

## Contact Us

During the course of this program, we maintained a dissemination website at [www.wiseproject.info](http://www.wiseproject.info). This site contains descriptions, pictures, schedules, student-narratives, various reports, and videos that document the project’s progress.

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