



A Stellar Example of Out-of-School STEM Education

Outcomes and Impacts from 25 years of the Space Explorers Program

EXECUTIVE SUMMARY

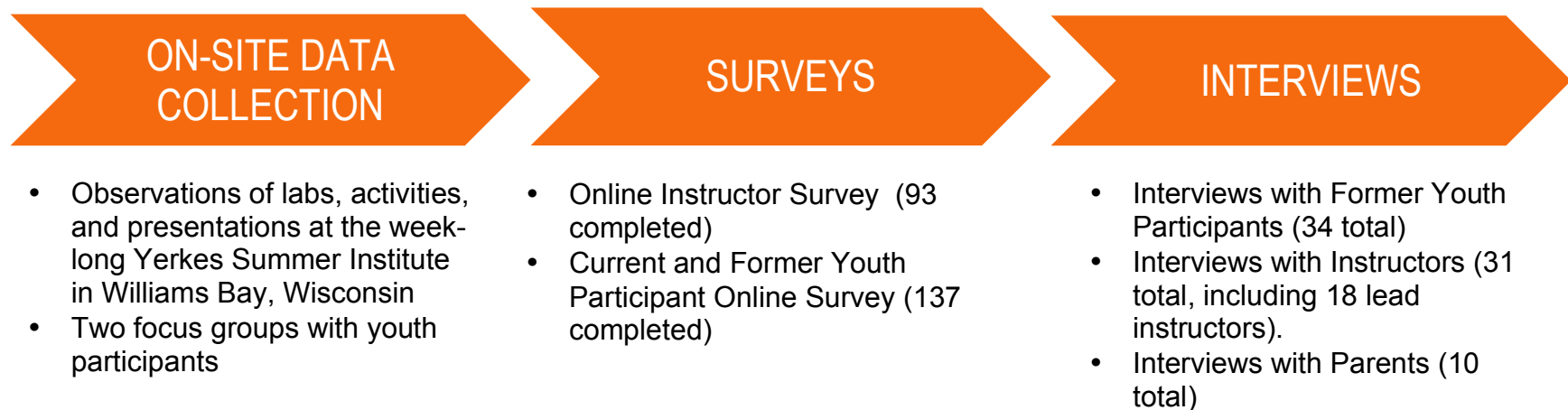
ROCKMAN ET AL

INTRODUCTION

The Space Explorers program started in 1991 and will be celebrating its 25th year in 2016. In order to understand the outcomes and impacts of the program over the course of its 25-year history, external evaluators from Rockman et al conducted a mixed methods evaluative study of the program. The resulting six-month study yielded a variety of significant outcomes and provided unique insights into the factors that have contributed to the success of this long-running out-of-school science program.

EVALUATION METHODOLOGY

The Evaluation effort employed a mixed-methods approach that included both quantitative and qualitative approaches to understanding program impacts and outcomes.



Notes on samples and responses rates:

Youth Participants: Current contact information was only available for 217 of the 443 Space Explorers youth participants. For a project that has been running more than two decades, being able to reach more than half of the participants and ultimately getting a 63% survey-response rate among the “reachable” participants (i.e., beyond response rates of 30-50% which are typical for online surveys of this nature).

Instructors: Over the lifetime of the program there have been 116 adults who have served as instructors. Of the 111 for whom current contact information was available, 93 responded to the survey—resulting in an 84% response rate.

EVALUATIVE FRAMEWORKS

This evaluation sought to examine elements of the Space Explorers program within the context of the NRC Framework, as presented in “Learning Science in Informal Environments: People, Places, and Pursuits” (2009) and summarized in the figure below. The evaluation and this summary also sought to contextualize findings in relation to the “Criteria for Identifying and Developing Productive STEM Out-of-School Programs” as presented in the National Research Council’s Report: “Identifying and Supporting Productive STEM Programs in Out-of-School Settings” (2015), and exploring the extent to which the program fostered longer-term interests in science and enhanced scientific literacy.

SPACE EXPLORERS

NRC FRAMEWORK (NRC 2009)



INTEREST

Participants experience excitement, interest, and motivation to learn about phenomena in the natural and physical world



KNOW & UNDERSTAND SCIENCE

Participants come to generate, understand, remember, and use concepts, explanations, arguments, models, and facts related to science



GENERATE & EVALUATE EVIDENCE

Participants manipulate, test, explore, predict, question, observe, and make sense of the natural and physical world



SCIENCE AS WAY OF KNOWING

Participants reflect on science as a way of knowing; on processes, concepts, and institutions of science; and on their own process of learning about phenomena



DO & DISCUSS SCIENCE

Participants participate in scientific activities and learning practices with others, using scientific language and tools



IDENTITY

Participants think about themselves as science learners and develop an identity as someone who knows about, uses, and sometimes contributes to science



CRITERIA FOR IDENTIFYING AND DEVELOPING PRODUCTIVE STEM OUT-OF-SCHOOL PROGRAMS (NRC 2015)



ENGAGING

Engage Young People Intellectually, Academically, Socially, and Emotionally

- ✓ Program provides first-hand experiences with phenomena and materials.
- ✓ Program engages young people in sustained STEM practices.
- ✓ Program establishes a supportive learning community.



RESPONSIVE

Respond to Young People's Interests, Experiences, and Cultural Practices

- ✓ Program positions STEM as socially meaningful and culturally relevant.
- ✓ Program supports young people to collaborate and to take on leadership roles in STEM learning activities.
- ✓ Program positions staff as co-investigators and learners alongside young people.



MAKE CONNECTIONS

Connect STEM Learning in Out-of-School, School, Home, and Other Settings

- ✓ Program connects learning experiences across settings.
- ✓ Program leverages community resources and partnerships.
- ✓ Program actively brokers additional STEM learning opportunities.

PROGRAM EXPERIENCE

The Space Explorers program has persisted in its mission to provide an exceptional scientific learning experience to youth in Chicago who have been underserved by traditional programs and learning opportunities, and despite its intensive and rigorous nature, the program remains—at its core—an informal science learning experience, providing learning opportunities that are not directly associated with formal in-school education. As part of their participation in the program, participants have opportunities to meet and work with scientists, to tackle problems and challenges together as teams, to develop and hone communication skills, and to utilize skills and knowledge they've acquired in school—often times advancing and deepening their understanding of scientific and mathematical concepts. Youth typically stay involved in the program for multiple years—more than half (i.e., 82%) were involved for more than one year; almost a third, (i.e., 32%), indicated they had been a part of the program for four or more years. Though some elements of the program have varied over the course of the past two and a half decades, other elements have remained consistent, including annual summer and winter institutes at the Yerkes Observatory in Williams Bay, Wisconsin and weekly lab sessions at the University of Chicago.

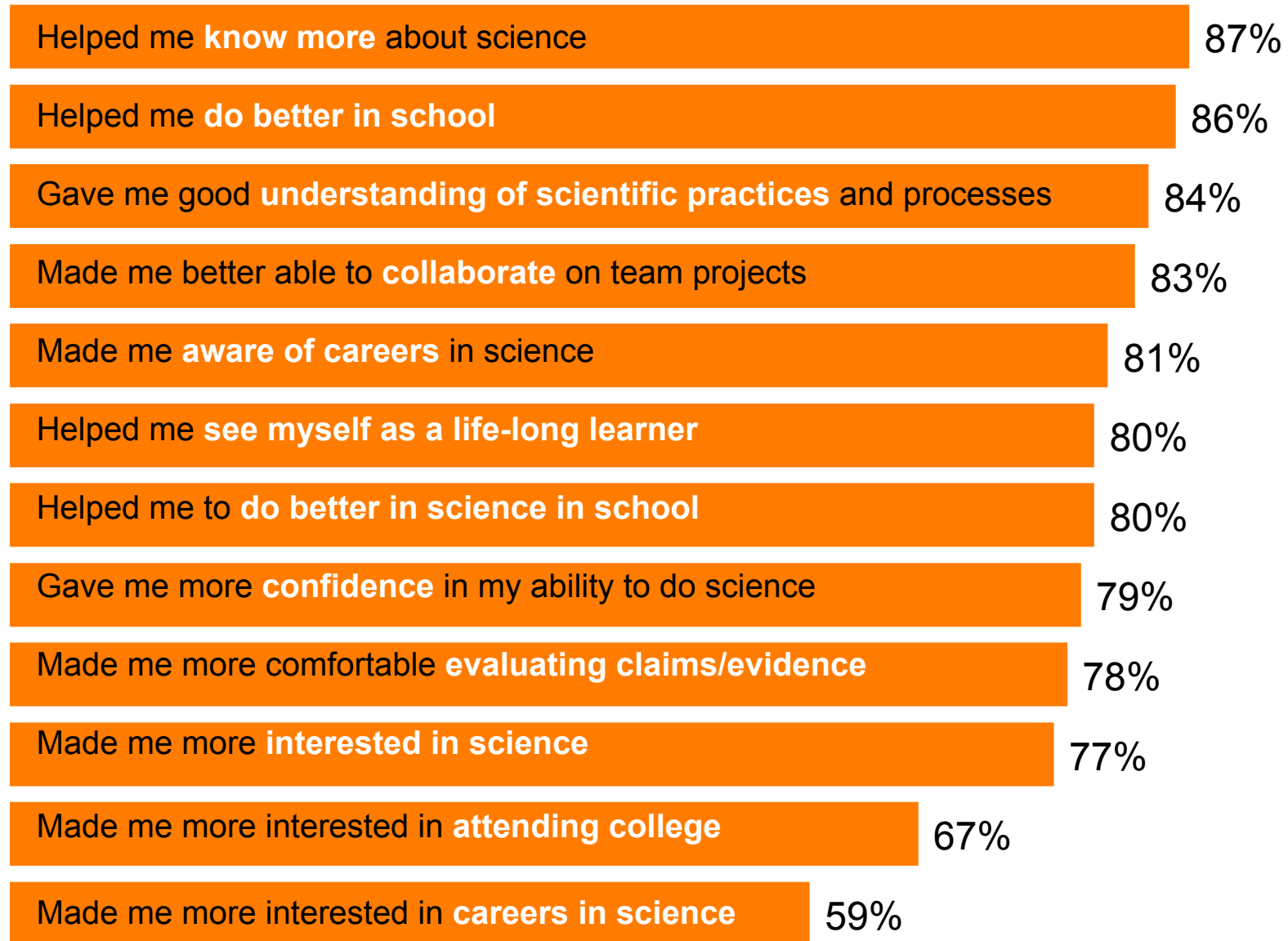






98% of Space Explorers participants said the program had an impact on them; **60%** thought it had a great impact.






IMPACTS ON YOUTH

The Space Explorers program has not merely had “some” impact; it is a program that has had a significant and longer-term impact on numerous participants’ lives. The vast majority of participants who provided input via surveys and interviews indicated that their experiences in the Space Explores program had had both short-term and longer-term impacts. Overall, all but a very small number of current and former participants said that the program had had an impact. 98% said that it had—with 60% saying that it had had a great impact. Specific impacts of the program reported by participants included increased knowledge and skills in science and math, greater confidence in their skills and abilities (in general, and with science specifically) and development of a life-long interest in science and astronomy. The figure on the following page summarizes the extent that participants experienced different outcomes.

PERCENTAGE OF PARTICIPANTS WHO AGREED & STRONGLY AGREED THAT SPACE EXPLORERS
HAD THE FOLLOWING OUTCOMES



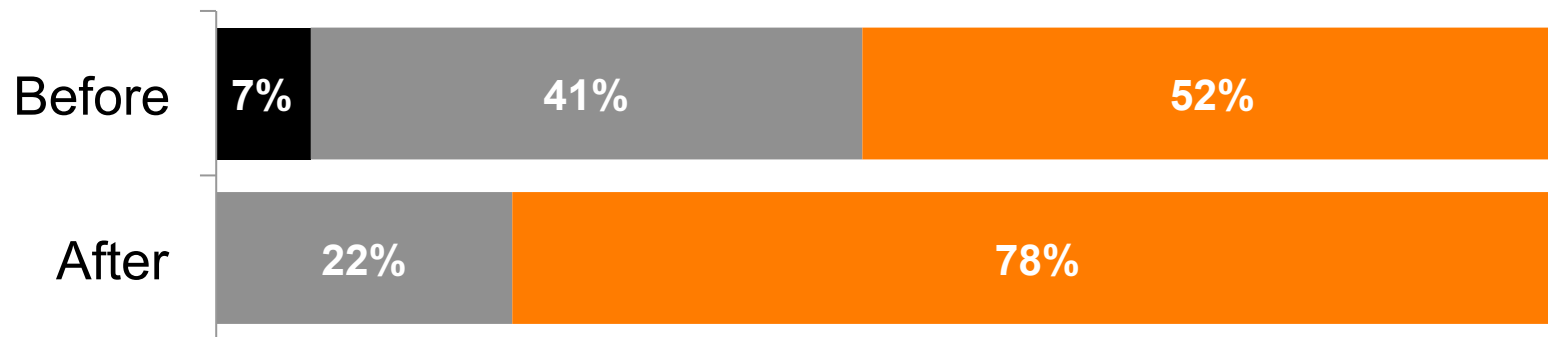
	OUTCOME CATEGORY	OUTCOMES	SOURCE OF OUTCOMES
	INTEREST	<ul style="list-style-type: none"> The program generated longer-term/sustained interest in science: 77% percent agreed that the Space Explorers program made them more interested in science (41% “strongly agreed”) Participants display genuine curiosity 69% percent agreed that the program helped to make them more persistent in their efforts (e.g., to solve problems/stick with projects). More than a third, i.e., 37% “strongly agreed” 	<ul style="list-style-type: none"> Instructors and other role models helped to foster participants’ interest The hands-on style of instruction/exploration was engaging Participants had a sense of agency in/ownership of the learning process Topics were engaging and often relevant to participants’ lives
	KNOW & UNDERSTAND SCIENCE	<p>Through Space Explorers, participants:</p> <ul style="list-style-type: none"> Gained scientific knowledge: 87% percent agreed that the program helped them know more about science; 50% “strongly agreed” Developed better understanding of scientific practices and processes: 84% indicated that the experience gave them a good understanding of scientific practices and processes, 45% “strongly agreed” Gained knowledge/skills that transferred to other activities and schoolwork 	<ul style="list-style-type: none"> 82% percent of Space Explorers who responded to the survey agreed that their instructors made them feel more confident in their ability to succeed in high school college, and beyond; 46% “strongly agreed” Real-world/hands-on experiences contributed greatly to participants’ knowledge and understanding of science
	GENERATE & EVALUATE EVIDENCE	<ul style="list-style-type: none"> There are ample opportunities for participants to collect and analyze data 78% percent agreed that the program made them more comfortable evaluating claims and evidence. 40% “strongly agreed” 	<p>Participants attributed outcomes in this area to activities that involved:</p> <ul style="list-style-type: none"> The Scientific Method The Engineering Design Process Problem-Solving Skills
	SCIENCE AS WAY OF KNOWING	<ul style="list-style-type: none"> Participants gain skills and greater knowledge about the scientific process and science as a way of knowing by reflecting on their experiences Through their experiences in the program, participants come to see science as an iterative process 	<p>Participants attributed outcomes in this area to activities that involved:</p> <ul style="list-style-type: none"> Writing/Reflecting in Lab Notebooks Discussions with instructors

	CATEGORY	OUTCOMES	SOURCE OF OUTCOMES
	DO & DISCUSS SCIENCE	<ul style="list-style-type: none"> Participants gain teamwork and collaboration skills Participants have opportunities to participate in authentic scientific discussions and communicate information about science 	<ul style="list-style-type: none"> Discussions between and among participants and instructors Presentations to family members and writing in Lab Notebooks
	IDENTITY	<ul style="list-style-type: none"> Participants come to have different perceptions of scientists—they come to see them as cool/interesting people who genuinely care about them The program also has an impact on participants' perceptions of themselves in relation to science 	<ul style="list-style-type: none"> Formal and informal opportunities to work, play and talk with scientists/graduate students that are doing and studying science
	ENGAGING	<ul style="list-style-type: none"> Participants have ample opportunities to engage with science through authentic, hands-on science experiences over multiple years Participants become a part of a scientific community with their peers and mentors 	<ul style="list-style-type: none"> Summer and Winter Institutes (residential programs held at the Yerkes Observatory) Weekly lab sessions
	RESPONSIVE	<ul style="list-style-type: none"> Participants find the experiences they have in Space Explorers to be real and relevant Participants have formal and informal opportunities to serve as leaders Participants were able to work/learn alongside instructors 	<ul style="list-style-type: none"> Participants have opportunities to learn alongside other youths from the south side of Chicago and graduate students at the University of Chicago who are actively engaged in designing and delivering experiences they find interesting and believe the participants will find to be interesting as well
	MAKE CONNECTIONS	<ul style="list-style-type: none"> The Space Explorers program has developed and sustained relationships between the University of Chicago (Kavli Institute for Cosmological Physics, Office of Special Programming & the Yerkes Observatory), students and teachers from local schools, local museums and national laboratories, and participants' families A sustainable infrastructure for delivering engaging Out-of-School STEM instruction 	<ul style="list-style-type: none"> All the partnering individuals and organizations have played a role in the development of a strong and sustainable educational infrastructure

SHORTER-TERM IMPACTS

Through their participation in the Space Explorers program, participants gained confidence in their abilities and a greater understanding of the need to persevere in order to solve challenging problems. In addition to other short-term impacts, the participation experience also had an immediate effect on participants' performance in school and many participants felt that the program had given them a leg-up over their peers.

■ Worse than most other students at my school ■ About the same ■ Better



On average, after participating in the Space Explorers program, participants were **26%** more likely to say that they were doing better than their peers at their school.

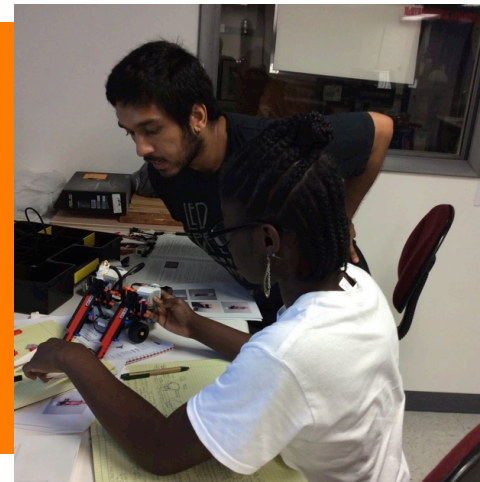
PURSUIT & ATTAINMENT OF CAREERS IN STEM

With high school graduation rates consistently near 100%, Space Explorers program participants have had higher rates of graduation than Chicago Public School students on average—ranging from 33% in 2006 to 40% in 2013, according to a 2014 report by the University of Chicago Consortium on Chicago School Research. Also, with nearly 100% of program participants enrolling in college at the completion of their high school careers, the rate of college attendance among Space Explorers is also much higher than it is for CPS students on average, (i.e., only 40% of CPS graduates went on to enroll in a four-year college program according to the University of Chicago Consortium on Chicago School Research).

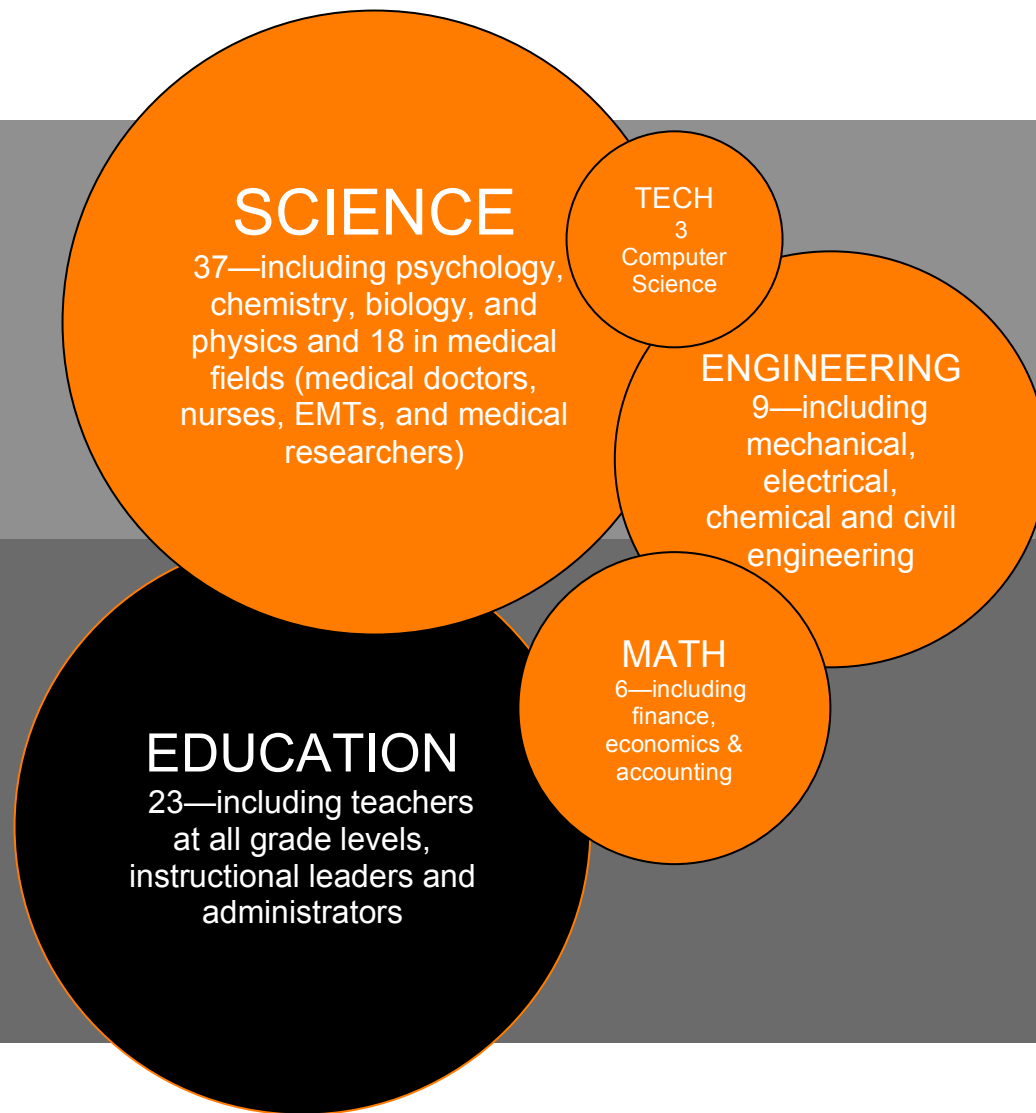
According to data obtained from the National Student Clearinghouse, 37 of 163 former Space Explorers (i.e., 23%), have gone on to study STEM in college. A comparative analysis was done with a subset of the Clearinghouse data (including 65 Space Explorers participants and 177 Upward Bound participants who did not participate in Space Explorers, entering or attending college during the same timeframe). We found that more former Space Explorers have gone on declare STEM majors or minors during their post-secondary studies than non-participants (i.e., 40% of Space Explorers have/had a STEM major or minor in college as compared to only 26% of non-participants). Statistical analysis indicated that this difference was marginally significant ($\chi^2 = 3.82, p = .051$). Some of these differences may be due to the fact that many Space Explorers participants have elected to participate or have been encouraged to participate in the program based on pre-existing interests in science and science-related careers, however, there is some evidence to suggest that their experiences in the program solidified that interest and gave them skills and experiences that ultimately helped with their subsequent success in their post-secondary STEM studies.

Exposure to real **scientists** and science **careers** broadened all participants' horizons and helped lead some to go into STEM careers.

40% of former Space Explorers participants have declared STEM majors/minors in college—as compared to only 26% in a comparable sample of non-participants.



Additional data compiled by staff members within the Office of Special Programming suggests that the number of former program participants who have studied STEM and/or gone on to obtain careers in STEM may, in fact, be much higher. Data suggests that many members of the program are also proactively contributing to STEM skills and interest among future generations by seeking degrees in, and/or working within the field of education.



“The Space Explorers program was what sparked my interest in science/STEM-related education and greatly influenced my course selection in college as well as my career path.”

– Former Space Explorer Participant

“I probably wouldn't have known how much I enjoy science and felt comfortable in a STEM field without the program. It was the first time I was encouraged to pursue scientific inquiry and was the beginning of my journey as an engineer.”

– Former Space Explorer Participant

IMPACTS ON INSTRUCTORS

The Space Explorers program runs successfully based in part on the considerable number of volunteers in addition to paid staff. The majority of instructors for Winter and Summer Institutes participate on a volunteer basis. Most are graduate students at the University of Chicago, however, other instructors include university faculty, post docs, and public school teachers. Each year, a graduate student is also hired to serve as the lead instructor. The lead instructor plays a key role in planning and implementing instructional activities throughout the academic year and in conjunction with the Yerkes Summer and Winter Institutes—in exchange for their considerable year-long efforts, the lead instructor also receives a full stipend and tuition support. In addition to the opportunity to make altruistic contributions to their community, instructors are able to reap great benefits from their Space Explorers experiences as well. “We get just as much out of it as the kids,” noted one former instructor.

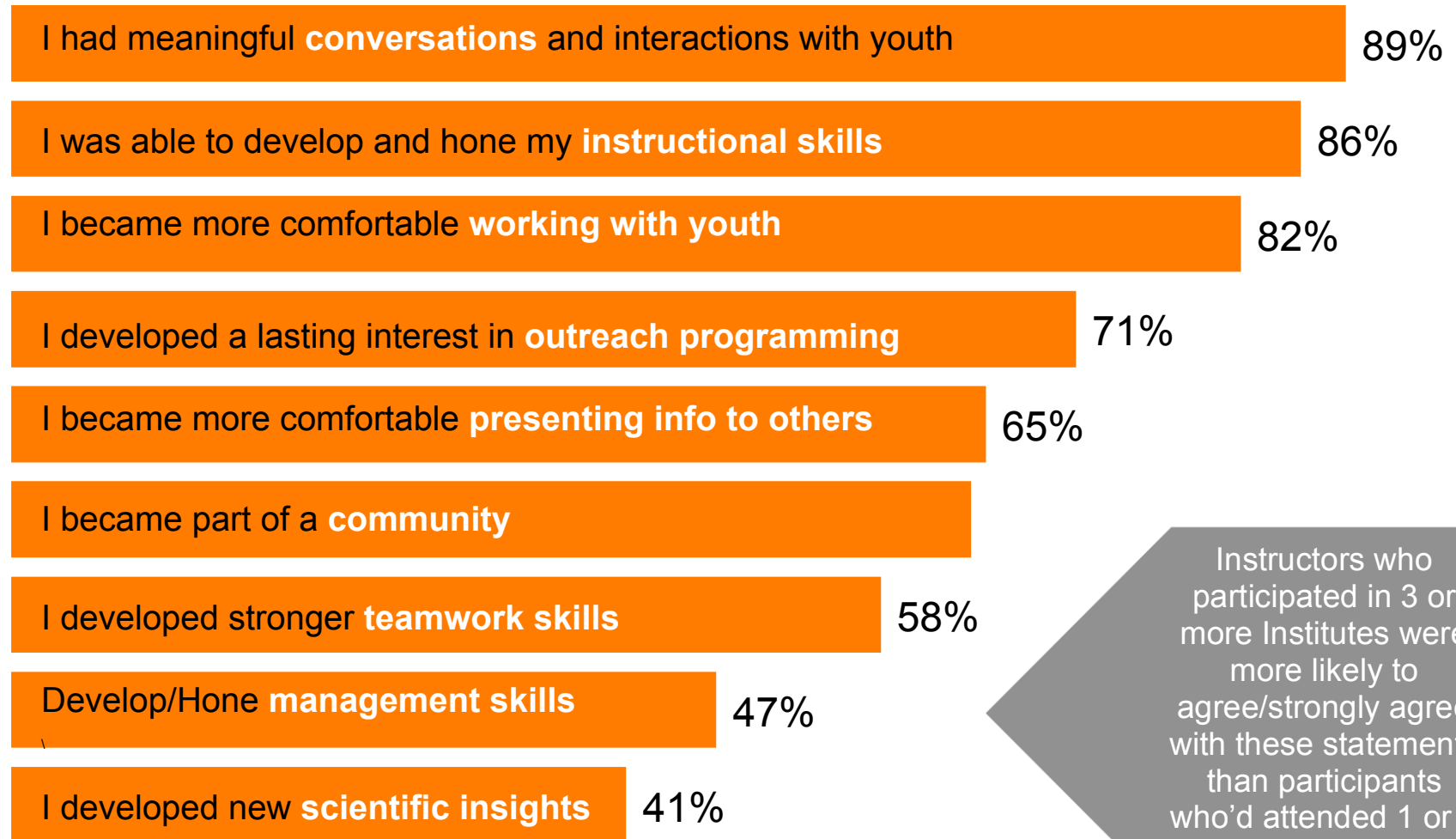
- Space Explorers presented opportunities for instructors to develop **instructional** skills and engaging curriculum - many of the instructors that we spoke with went on to use specific activities or general skills in other contexts.
- The program also presented opportunities for instructors to hone their skills for **communicating** scientific information to lay audiences - including the ability to focus in on the key parts and to gauge understanding.
- Experiencing “**ah-ha**” moments, when things clicked for youth participants inspired instructors and was an aspect of the experience that led some instructors to develop a **lifelong passion for outreach programming**.

“The best feeling came from watching the lightbulb go off in the students’ heads as they understood something. Having a successful learning exercise, where the students go the steps and actually understand the core concepts in the end is amazingly rewarding”

- A Former Space Explorers Instructor



PERCENTAGE OF INSTRUCTORS WHO AGREED & STRONGLY AGREED THAT SPACE EXPLORERS HAD THE FOLLOWING OUTCOMES



Instructors who participated in 3 or more Institutes were more likely to agree/strongly agree with these statements than participants who'd attended 1 or 2 institutes.

Other Instructor-Level Outcomes

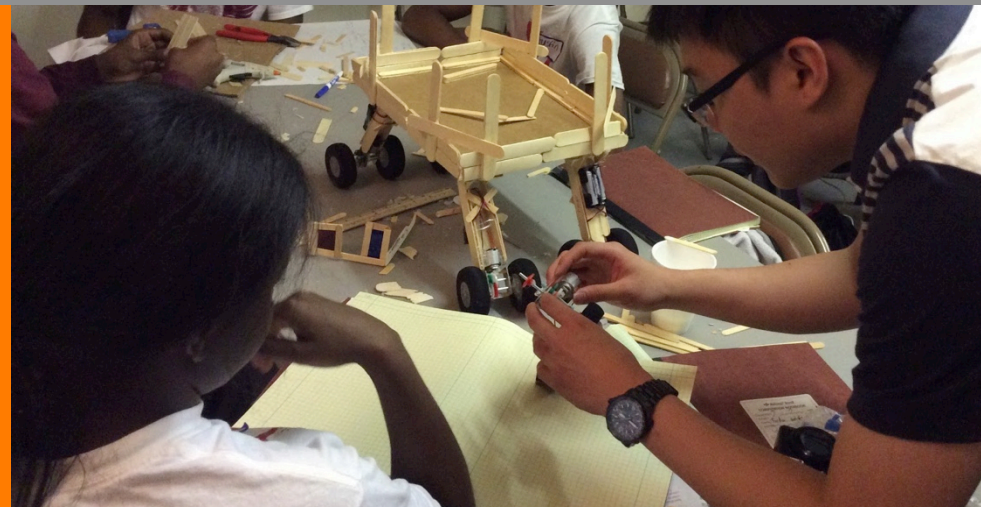
The evaluation effort revealed several instances where experiences as an instructor in the Space Explorers program led to longer-term interest in outreach programming. There was also evidence of the program having an impact on former instructors' career paths; many felt that their experiences with Space Explorers gave them a unique experience to reference when applying for subsequent jobs.

"Working with south-side Chicago high school students made me aware of how difficult it can be to be a minority. I have a better understanding of where these students are coming from, both academically and personally, which contributes to why there are so few black students in science fields. Many of them do not consider a career in science because...it is never presented as a possibility. Programs like Space Explorers are one step towards addressing this problem."

- A Former Space Explorers Instructor

83% of former Space Explorers instructors indicated that the program had had a positive impact on them professionally. **38%** strongly agreed.

Lead instructors were more likely to say that the program had an impact or great impact on them.



PROGRAM LEVEL FINDINGS

There are many elements of the Space Explorers program that not only make it somewhat unique within the realm of out-of-school science programs, but also seem to have contributed to its success. Among these elements are the following:

Long-Lasting Nature of the Program: Because the Space Explorers program has been running for nearly twenty-five years, it provides a unique opportunity to explore long-term outcomes, but it is also a programmatic advantage in so far as there is great momentum that makes it possible to generate excitement and helps to recruit volunteers and participants in each subsequent years.

Long-Term Measureable Impacts: With so many other things competing for their time and attention, the fact that youth typically stay involved with the Space Explorers program for multiple years on a voluntary basis is both an outcome of a well-run program and an important contributing factor in all subsequent programmatic successes.

Equal Impacts on Youth and Instructors: Youth participants and instructors alike benefit from their participation in the Space Explorers program. For both groups, being exposed to new people and new opportunities is of paramount importance and value. Youth are exposed to scientists and come to gain a broader perspective on college and career opportunities. Instructors are exposed to inner city youth and not only become better aware of the challenges they face, but also the strengths that they have. Ultimately, both groups succeed through the Space Explorers program by coming to realize their common ground and developing a mutual sense of respect for each other.

Broader Impacts on Family and Community: The program not only seeks to have an impact on the youth it directly serves, but also has indirect impacts on parents and families. Through their exposure to the Space Explorers, family members come to develop pride and a broadened sense of what is possible for their children. There are also benefits that trickle down to the school level (e.g., a small cohort of students who have heightened scientific skills and knowledge, as well as higher levels of motivation and engagement).

Key Factors in Program Success



PEOPLE

There is vast agreement that people are a key factor in the program's success including: Program Staff, Volunteers, and OSP Staff. Participants at all levels have bought into the program and its value; instructors give freely of their time and talents - youth show up even though it is a voluntary program.



TIME

The long-lasting nature of participant's involvement is not only a unique feature of the Space Explorers program in contrast to other out-of-school science programs, but is also a key factor in the program's success. More intensive and sustained treatment over time helps to make larger gains and more substantive impacts possible.



FORMAT

The hands-on nature of the program appeals to participants; they learn science by doing it. Instructors learn alongside participants and foster a love for scientific inquiry. Space Explorers offers a judgement and assessment-free environment that allows participants to embrace the scientific model of trial and error/experimentation and exploration.



RESOURCES

Even with large numbers of volunteers, there are still considerable costs to running a program like Space Explorers. Sustained funding as well as unique and well-suited venues for educational programming (like Yerkes Observatory), and other resources help to enable learning and contribute to the program's overall success.