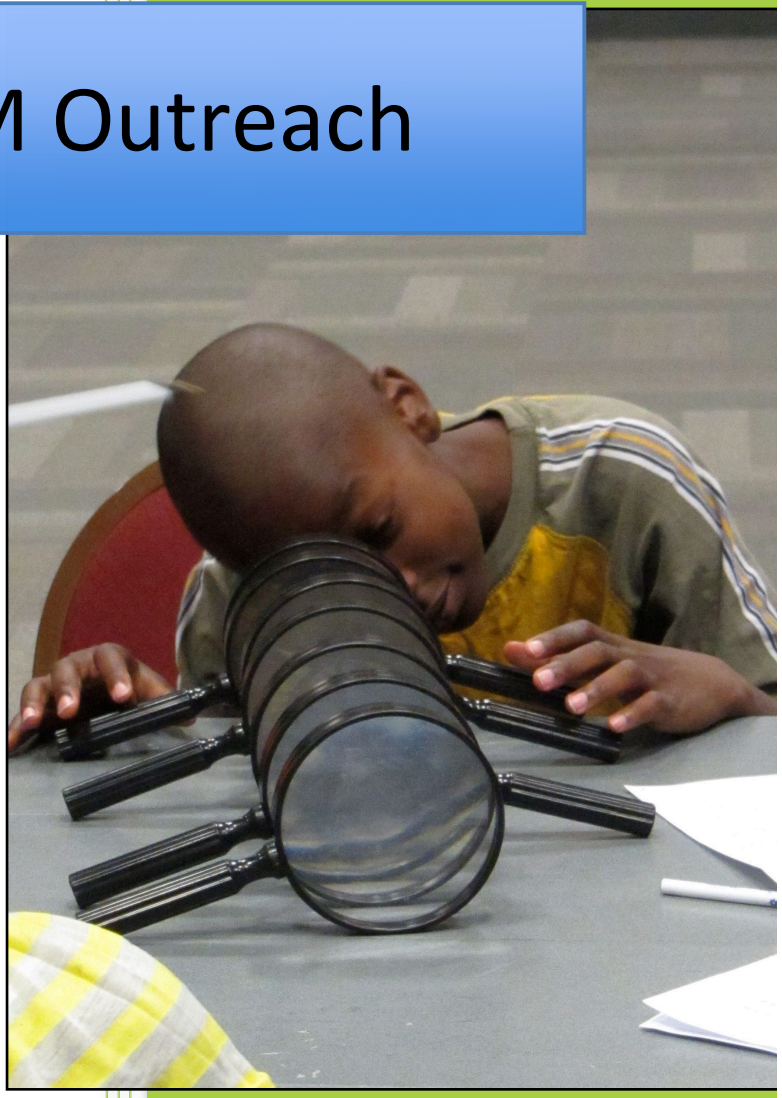
Community STEM Outreach



Summative Evaluation Report
Submitted to the Saint Louis Science Center

by
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Office of Naval Research

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Community STEM Outreach
Summative Evaluation Report

EXECUTIVE SUMMARY

The summative evaluation report provides an overview of the Community STEM Outreach Project at the Saint Louis Science Center (SLSC), funded by the United States Office of Naval Research (ONR) from October 2010 through September 2013. The summative evaluation was conducted by Klein Consulting under the leadership of Christine Klein, Principal, and with support from Carey Tisdal, Director, Tisdal Consulting.

The evaluation was designed to address three questions:

1. How does participation in the *Community STEM Outreach Program* impact its participants?
2. Does/how does the *Community STEM Outreach Program* meet its goals and objectives?
3. How does the addition of 50 or more teens per year affect the program's ability to meet its goals?

To aid in the evaluation and program documentation process, evaluators reviewed existing YES Program evaluations and related documents. Four themes emerged that helped guide the evaluation: the power of relationships, teaching children, STEM knowledge and expertise of staff, and sustainability.

PROJECT CONTEXT

Shortly after the Community STEM Outreach Project received funding, changes began at SLSC. The president, who had been in place since the beginning of the YES Program, resigned, followed by an interim president who served until a new president was hired. During this period of transition, the institution underwent financial restructuring and reorganization of staff, including many layoffs. During the last year of the project, the founder and leader of the YES Program resigned to take a position at another institution. Some of the effects of these changes are included in the evaluation findings, though many effects will never be truly understood.

PROGRAM DOCUMENTATION AND DISSEMINATION

In its original proposal to the ONR, the SLSC proposed to "create a strategic plan for national expansion of the SLSC *Community STEM Outreach Program*" and to "identify resources, including national partners, for national outreach." The original intent of the ONR in funding the Community STEM Outreach Project was to document a mature, successful youth development program, the Youth Exploring Science (YES) Program, and then, with additional funding, disseminate the model nationally to other science centers and museums. The trajectory of this initial plan was established to benefit SLSC, ONR, and the field of science

learning in out-of-school time (OST). Through the Community STEM Outreach Project, potential partners would come together to create a collaborative and plan for the dissemination of the model, including application for a new ONR grant.

Several environmental factors, leadership and staff changes, and the national economic and political landscape, influenced the need to adjust the initial trajectory. As part of the revised plan, in December 2012 SLSC contracted with Klein Consulting, in collaboration with Tisdal Consulting to document the YES Program model in a format that could be disseminated nationally as part of the evaluation, and to recommend a strategic plan for dissemination. Thus, the evaluation took on an additional focus. The result is the design of a multimedia tool, currently titled *Circles of Support*, described in the full summative evaluation report.

DELIBERATE DESIGN

Throughout each step of the Community STEM Outreach Program, the initial project PI, Diane Miller, then Vice President at SLSC, engaged in *Deliberate Design*, an approach that had been practiced since the inception of the YES program in 1998. With *Deliberate Design* each element of the YES Program sits on a foundation of research and best practices in youth development, STEM education, and Out-of-School Time (OST) education. Elements of the program are deliberate; there is a rationale behind each feature of the program. The design process is intentional, such that each program element aims toward an intended impact.

This *Deliberate Design* served as the foundation of the evaluation and the multimedia tool developed to support dissemination of the YES Program model.

FINDINGS – IMPACT ON PARTICIPANTS

Evaluation data include information on the 438 teens participating in the YES Program over the past three years, since funding from the Office of Naval Research began. We defined a participating teen as one who attended at least two days in any of the eight semesters since the beginning of the ONR project (Spring, Summer and Fall 2011 and 2012 plus Spring and Summer 2013). Tables and figures in the full summative report are based on these 438 teens.

Demographic data included information on gender (53% female), ethnicity (87% Black or African American), grade level in school (grades 7-12), cohort (a large influx in 2011 with ONR funding), and school type (most teens from public Missouri schools). Psychometric data included why teens joined the YES Program and why they kept coming back each year. The top three reasons for joining were related to the work experience and pay. The top two reasons for returning were also related to work and pay. The third most popular reason for returning was the work with the younger children – teaching them science.

Program outputs included twenty-two different “components”, or groups focused around a topic. Components focused on astronomy, biology/environmental science, chemistry, engineering/design, science

journalism, and teaching science to younger children, which was an additional component oriented toward new teens.

Short-term impacts included high school graduation for teens who completed their senior year in the YES Program at a rate higher than a weighted average for teens from the same area schools and districts. Figure 10 in the summative report depicts the difference between the comparison group (Area Students) and the YES seniors.

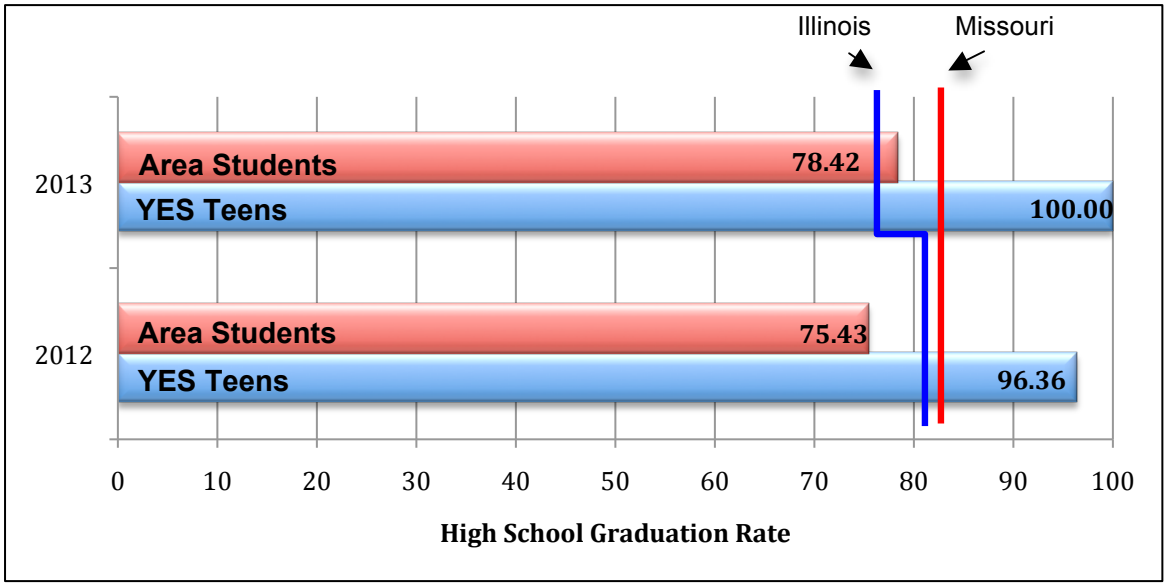

Figure 10. 2012 and 2013 High School Graduation Rate Comparisons

As described in the full summative report, comparison of high school graduation rates shows that YES Teens who remain in the program until their senior year in high school graduate at a higher rate than their peers in the same area schools. Critical is the phrase "YES Teens who remain in the program until their senior year in high school." School district and state graduation rates must include students who began as freshmen but dropped out of school before or during their senior year (and did not transfer). The YES Program does not keep attrition data and does not follow-up with teens that drop out of the program to determine whether or not they graduated from high school. Thus, when comparing high school graduation rates between YES seniors and weighted averages for area schools or states, the differing definitions of graduation should be noted.

Data on post-secondary plans of graduating seniors showed that 55% in 2012 and 46% in 2013 planned to attend a four-year college or university. Additional teens planned to attend two-year colleges, trade schools, and art institutes, resulting in 82% in 2012 and 70% in 2013 continuing their post-secondary education. Two teens in 2012 and one in 2013 joined the military. Details are in included in the full summative report.

With teens in the YES Program for four and a half or more years, long-term impacts include those impacts recognized after they have left the program and gone on to college, the military, and/or careers. To begin to measure the long-term impact of the program, an online survey was developed for former YES participants asking about their experiences during and after YES. Twenty-six individuals participated in the survey by the deadline, with 22 surveys completed by former YES Teens to the extent that they could be included in the results reported (N=22). The small number of responses can give a limited picture of the activities of YES alumni/alumnae, but caution should be exercised in drawing any conclusions about program impact.

When asked how well the YES Program prepared them for post-secondary education, alumni indicated that the program was "helpful" (3.80 average on a 5-point scale with 5 = greatly helpful). When asked how well the program prepared them for the workforce, the resulting average was "very helpful" (4.53 out of 5). When asked how influential the YES Program was on college and career choices, the average was 3.88.

Results indicate that networking, teambuilding, and teaching younger children were the aspects of the program that influenced respondents the most. When asked a slightly different question, "To what extent did these elements of the YES Program positively impact you?" rated from 1 (no positive impact) to 5 (high positive impact), teaching younger children and developing job skills received the highest averages, followed by earning an income and public speaking experiences.

> *I am forever grateful to the YES program. I love the program. The YES program influenced the work that I put forth in other positions I've held since leaving the program. It taught me work ethic and organizational skills that I'll never forget…. My participation in the YES program helped me stay in the sciences. It kept me motivated and kept me loving science and mathematics.* (1999-2003, female)

To measure changes in current YES Teens' attitudes toward science and scientists, evaluators used a modified version of the Test of Science-Related Attitudes (TOSRA) (Fraser, 1981) developed by Ledbetter & Nix (2002) – the TOSRA2.

The seven subscales were as follows:

- Social Implications of Science (S) – Do youth recognize the benefits and drawbacks of scientific advances to society?
- Normality of Scientists (N) – Do youth see scientists as real people rather than media-produced stereotypes?
- Attitude toward Scientific Inquiry (I) – Do youth view experimentation and inquiry as a way to gain understanding of the natural world?
- Adoption of Scientific Attitudes (A) – Have youth adopted the attitudes of scientists, such as open-mindedness and self-assessment?

- Enjoyment of Science Lessons (E) – To what degree do youth enjoy their lessons in school science classes?
- Leisure Interest in Science (L) – To what degree are youth interested in science out of school, and outside of the YES Program?
- Career Interest in Science (C) – Do youth have an interest in pursuing a science related career?

The matched pairs used for the analysis were scores from teens responding to both the 2012 spring pre-test and the 2013 summer post-test (N=44), which provided the greatest time between tests. As described in more detail in the full summative report, results suggest that respondents' attitudes changed in the following ways. After 16 additional months in the YES Program (i.e., 16 months between testing), youth were:

- More likely to recognize the benefits and drawbacks of scientific advances to society -- Social Implications of Science (S)
- More likely to see scientists as real people rather than media-produced stereotypes – Normality of Scientists (N)
- Less likely to view experimentation and inquiry as a way to gain understanding of the natural world (gender differences are described in the report) – Attitude toward Scientific Inquiry (I)
- Slightly more likely to have adopted the attitudes of scientists, though the adoption of attitudes was relatively weak (i.e. not significantly different) – Adoption of Scientific Attitudes (A)
- More likely to indicate enjoyment of their lessons in school science classes – Enjoyment of Science Lessons (E)
- More interested in science out of school, and outside of the YES Program – Leisure Interest in Science (L)
- Slightly less interested in pursuing a science related career (gender differences are described in the report) – Career Interest in Science (C)

Overall test scores showed a significant increase from pre-test to post-test.

The evaluators explored career choices of the YES Teens through multiple methods. From the surveys, TOSRA2, focus groups, and interviews, we found that while anecdotal evidence existed and stories were available, the vast majority of YES Teens either entered the program with career interests in mind and retained those interests, or entered the program with no clear career path in mind and left with remaining uncertainty. The YES Program did expose teens to careers that they had not previously considered, and it was not clear how many teens were influenced by that exposure. Further studies of former program participants would be needed to determine that impact.

DISCUSSION – GOALS AND OBJECTIVES MET

The Community STEM Outreach Program met many of the project's goals and objectives. Personnel and budget changes at SLSC created challenges for meeting others, as described in more detail in the full summative evaluation

report. Of the nine goals and 14 objectives, results indicate that the YES Program:

- Expanded the YES Program to reach more youth, though the increase was not sustained
- Increased diversity of the youth
- Strengthened STEM content focus
- Involved Navy personnel in the program as volunteers, though their participation was not systematized for ongoing engagement or to the extent that it could be replicated
- Involved members of the science community in STEM education programming, though this engagement was not systematized into an ongoing effort or to the extent that it could be replicated
- Strengthened the reflective practice of YES staff and SLSC educators through additional training and ongoing support.
- Supported the development of the *Circles of Support* multimedia tool
- Supported the evaluation to provide evidence of the success of the program and to identify challenges
- Held a meeting of representatives from nine science centers and museums across the country.

The full summative report provides further information on goals and objectives met and those not met.

Discussion – Impact of 50 Additional Teens

The addition of teens appeared to have required more formalized management structures and practices, such as increased manager time in scheduling and logistics. The larger number of teens increased the need for (1) formal professional development for consistent implementation of the *Deliberate Design*, (2) additional curriculum development, (3) consistent data management, and (4) renewed support for youth participation.

Conclusion

The *Deliberate Design* of the YES Program lays a strong foundation for youth development. Many positive impacts were found: higher than average high school graduate rates, large numbers of teens planning to continue their education beyond high school graduation, and alumni/alumnae who stated that the YES Program was helpful in preparing them for post-secondary education and very helpful in preparing them for the workforce. Participants improved their attitudes toward science and scientists.

At the same time, the program was challenged by personnel turnover, sometimes resulting in inconsistent application of the *Deliberate Design* of the program. Thus, we learned through the evaluation that consistent systems of

professional development and sufficient managerial staffing are needed to maintain the *Deliberate Design*. In addition, we learned the vulnerability of program functions with the loss of institutional memory due to staff turnover.

The YES Program, though challenged at times by a number of factors described in the summative evaluation, offers a model for other youth STEM programs. As with all programs, ongoing, sustainable funding for the program requires telling the YES story to stakeholders. Through the evaluation, we found that the development and maintenance of program records, which is key to this sustainability, needs to be a focus as the program moves forward.

This summative report provides part of the YES story at a moment of change and challenge. As the program continues to grow and change, this evaluation team recommends that the *Deliberate Design* of the program remains a solid foundation. This means that clear rationale, based on research and best practices, needs to be developed for any changes with an eye toward how these changes may affect impacts documented in this evaluation.

Feedback on this report and questions about the evaluation can be sent to Christine (Kit) Klein, evaluation consultant, at ckleinconsutling@gmail.com.

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Introduction And Background

The Community STEM Outreach Project at the Saint Louis Science Center (SLSC) received funding from the United States Office of Naval Research (ONR) from October 2010 through September 2013. Klein Consulting, with support from Tisdal Consulting, conducted the evaluation of the three-year project. This summative evaluation report provides an overview of that work.

Overview of Community STEM Outreach Project

The original proposal from the SLSC to ONR laid the foundation for the Community STEM Outreach Project by describing the institution (see sidebar) and its youth program, the Youth Exploring Science (YES) Program. Plans were underway to reach out to existing and new national partners to document and disseminate a successful, replicable, and scalable science, technology, engineering, and math (STEM) focused youth program, YES. The Community STEM Outreach Project was designed to use that dissemination "to meet the Navy's goal of outreach to the best prepared and brightest youth who will serve as the next generation of Naval recruits to serve our country" (SLSC, 2010).

The intent was not to use the program to recruit youth to join the Navy. Instead, the idea was to use the YES Program model to create a national collaboration and comprehensive approach to develop programs nationally that were "designed to effectively meet the nation's needs for the next generation of STEM experts and leaders" (SLSC, 2010), whether those experts and leaders are in the military, in STEM fields that support the military, or in fields that support the nation in other roles.

Saint Louis Science Center

The mission of the Saint Louis Science Center (SLSC) is "to ignite and sustain lifelong science and technology learning." Recognizing that science literacy is fundamental to national success and global competition in the 21st Century, the SLSC promotes high-quality education in science, technology, engineering and mathematics (STEM). Offering general admission at no charge to the public, SLSC serves more than one million visitors annually. In addition to the hands-on learning opportunities provided through interactive exhibits and innovative galleries, SLSC extends award-winning educational outreach programming to more than 200,000 students, teachers and other individuals within the bi-state region annually.

Deliberate Design

Throughout each step of the Community STEM Outreach Program, the initial project PI, Diane Miller, then Vice President at SLSC, engaged in *Deliberate Design*, an approach that had been practiced since the inception of the YES program in 1998. With *Deliberate Design* each element of the YES Program sits on a foundation of research and best practices in youth development, STEM education, and Out-of-School Time (OST) education. Elements of the program are deliberate; there is a rationale behind each feature of the program. The design process is intentional, such that each program element aims toward an intended impact.

This *Deliberate Design* served as the foundation of the evaluation and the multimedia tool developed to support dissemination of the YES Program model.

PROJECT GOALS AND OBJECTIVES

In the original proposal to the ONR, SLSC included three "central components" to be carried out over the three-year project, with nine project goals, and 14 project objectives. The evaluation focused largely on the first component since program staff focused their work on the YES Program expansion rather than outreach to schools and scientists or national expansion.

Central Project Components

1. Expansion of the Youth Exploring Science (YES) Program at SLSC by an additional 50 teens and related expansion of SLSC staff
2. Expansion of *Outreach to the Community* to additional high school teachers and counselors, scientists, Navy personnel, and science related members of the community
3. Exploration and implementation of National Expansion initiatives of the YES Program

Community STEM Outreach Project goals 2-9 received less attention by project staff than goal 1, though all were reviewed by project leaders quarterly. Each goal was included in the evaluation, and is addressed in the Discussion section of this report.

Project Goals

1. Expand the YES Program to reach more youth, increase diversity of the youth, and strengthen STEM content focus
2. Expand the SLSC outreach to schools, particularly high school science teachers and school counselors, to reach more students and teachers and to develop new models of outreach
3. Create a new model for partnership with the US Navy to include veterans as well as active duty and reserve personnel in STEM education outreach programming
4. Create and formalize a model for outreach to and inclusion of members of the science community in STEM education programming
5. Improve reflective practice of all educators at SLSC to create a cadre of leaders for national outreach to other science centers
6. Formalize processes and collect metrics to measure YES Program short-term and long-term success
7. Codify a system for community STEM outreach beyond YES
8. Conduct research and evaluation to provide evidence of the success of the program and to identify challenges
9. Create a strategic plan, resources and model for national expansion of the SLSC *Community STEM Outreach Program* and begin implementation

Project objectives further clarified the intent of project leaders. Midway through the project, objectives 10 - 13 were assigned to the evaluation team at Klein Consulting. Using the results of the evaluation, the evaluation team created a design for the multimedia documentation of the YES Program model, conducted the evaluation, identified research questions, and developed a strategic plan for expansion using the multimedia documentation. All objectives are addressed in the Discussion section of this report.

Project Objectives

1. Increase the number of teens participating in the SLSC YES Program by 50
2. Increase the staff size beginning to support the increase in YES teens, community outreach, and other expansion efforts
3. Increase the number of community partnering organizations to include organizations in St. Louis County with outreach to more diverse youth
4. Reach new school audiences with existing and new SLSC programming, focusing on school counselors and high school science teachers
5. Strengthen the STEM content focus of YES components to include stronger emphasis on STEM in existing components and addition of new components with content relevant to the US Navy
6. Develop new opportunities for partnership between SLSC staff and Navy personnel to support the YES Program and other SLSC outreach activities
7. Develop and formalize opportunities for involvement of practicing and retired scientists in the community
8. Strengthen the reflective practice of YES staff and SLSC educators through additional training and ongoing support
9. Train and support a cadre of STEM education leaders who can train others in effective strategies to build programs that are community relevant, youth development focused, and strong in STEM content
10. Create electronic, multimedia documentation of all *Community STEM Outreach* activities and staff reflections for support of expansion efforts
11. Conduct evaluation to support and provide evidence of the success of the program and to identify challenges
12. Identify research questions related to the *Community STEM Outreach,* and create strategies for moving forward with that research, including seeking additional funding for such research
13. Create a strategic plan for national expansion of the SLSC *Community STEM Outreach Program*
14. Identify resources, including national partners, for national outreach

During the course of the project, Objective 6, "Develop new opportunities for partnership between SLSC staff and Navy personnel to support the YES Program and other SLSC outreach activities," was dropped from some reports by SLSC to ONR.

PROJECT CONTEXT

Shortly after the Community STEM Outreach Project received funding, changes began at SLSC. The president, who had been in place since the beginning of the YES Program, resigned. The SLSC Board appointed one of its members as interim president, and during the second year of the project a new president was hired. During this period of transition, the institution underwent financial restructuring and reorganization of staff, including staff layoffs. During the last year of the project, the founder and leader of the YES Program resigned to take a position at another institution. Some of the effects of these changes are included in the evaluation findings, though many effects are likely to be long-term and the effects were not apparent during the course of this study.

YES PROGRAM OVERVIEW

The Youth Exploring Science (YES) Program began in 1998 under the leadership of Diane Miller at the SLSC with 15 teenagers meeting in a small warehouse space near SLSC. By the beginning of the Community STEM Outreach Project, the program looked very different with 216 teens. Yet, many of the same foundations remained.

Then as now, the YES Program serves St. Louis area teenagers ages 14-18 in a work-based, inquiry-based learning environment. YES Teens are recruited from over 65 partnering community organizations committed to serving low-income families in the metropolitan St. Louis area. Through the four-plus year program, educators strive to support these youth in gaining professional, academic, and real world skills to assist them in building self-confidence and personal success. They gain exposure to STEM-related academic and career pathways, and gain experience through their work for SLSC.

The YES Program looks very different in the school year and summer. Vignettes of each from the second annual evaluation report (Klein and Tisdal, 2012) are included in Appendix A for those readers unfamiliar with the program. During the school year, the focus is on learning the STEM content, developing workplace and 21st century skills, college prep activities, and team building. Teens then apply STEM content and skills in the summer. Thus, the primary difference between the school year and summer is the shift from learning to teaching. Teens teach others in the summer, with community members and SLSC visitors as their audiences. The *Deliberate Design* of the YES Program is based on the assumption that through this teaching YES Teens deepen their understanding of the STEM content and improve their 21st century skills.

Figure 1 provides an overview of the numbers of YES Teens participating during each semester of the project, with numbers from 2010 (prior to ONR funding) for comparison.

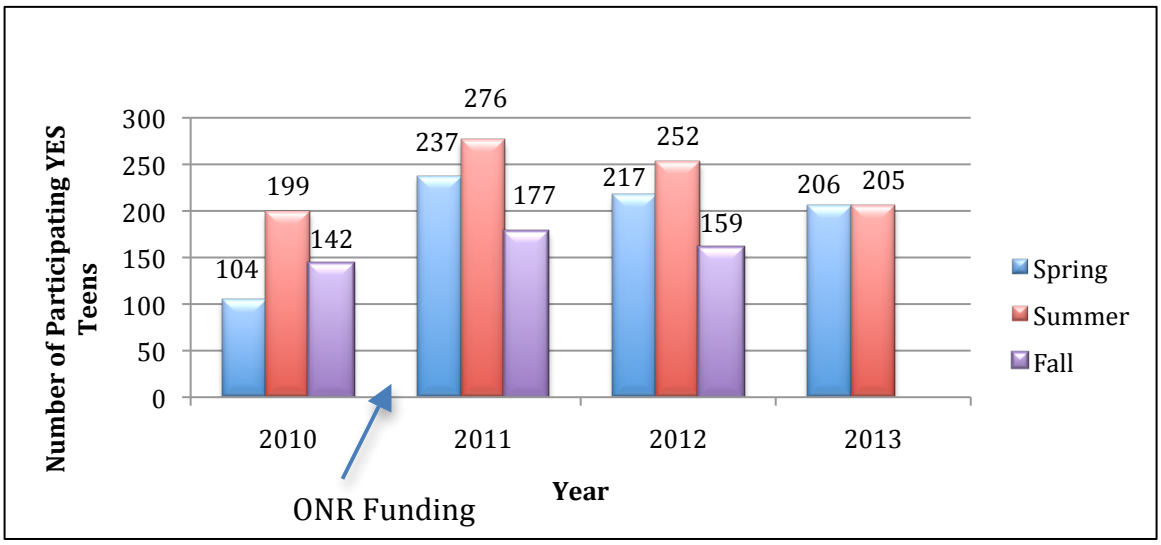


Figure 1. Number of YES Teen participants by semester

The lower number of participants in each fall represents the loss of the graduating seniors at the end of each summer, while the increase each spring represents the addition of new teens. The largest increase in new teens was in spring 2011 with the beginning of the ONR funding. That year 106 new teens joined the program instead of the typical 40-50. Each summer, participation increased as teens returned who had left the program during the academic year due to participation in sports or family issues.

PROJECT STAKEHOLDERS

Stakeholders for the *Community STEM Outreach Program* included national partners, local community groups, and individuals:

- YES Teens and Their Families
- Saint Louis Science Center
- U.S. Navy and Office of Naval Research
- Science Centers and Museums Across the U.S.
- Educators – In Schools and Out
- Community Organizations
- Scientists

ROLE OF EVALUATION IN THE PROJECT

The original plan for the evaluation called for internal and external evaluators to work together, with the internal team focused on guiding the project toward success by determining how to improve the program and the external team focused on providing evidence of overall success in meeting goals and objectives to prove impacts. As the project was beginning, this plan changed when the internal evaluator moved to a different role within the SLSC. Without a change in budget for the evaluation, the

external evaluator took on both goals: guiding the project toward success (formative evaluation) and providing evidence of success (summative evaluation). (Evaluation activities are listed in Appendix B, data sources in Appendix C.)

At the beginning of the first year of the project, the evaluation team took on another role, that of documenting the program. Since an original intent of the ONR in funding the Community STEM Outreach Project at SLSC was to document a mature, successful youth development program, i.e. the YES Program, it was decided that the evaluation team at Klein Consulting was well suited to provide that documentation. Beyond the written documentation, the team provided the design of a web-based multimedia tool for disseminating the YES Program model, as described in later sections.

Results of the formative evaluation efforts can be found in previous reports, listed in Appendix B. The multimedia tool will be made available later by the SLSC. This report provides the results of the summative evaluation.

Research regarding impacts of the YES Program was originally of interest to the ONR, though funding for such research was not included in this project. An additional role of the evaluation became to identify research questions and suggest further studies. The potential research that emerged is described in a separate document available from SLSC or the authors.

Thus, the purpose of the evaluation of the Community STEM Outreach Project was to study the impact of the program on participants, determine whether and how the program achieves its goals, and create the foundation for further research.

DEFINITIONS

As reported previously, a few definitions are necessary when telling the YES story and describing the program to people outside of the program. First, a "component" is a group of about 20 YES Teens working with one or more staff members on a STEM (science, technology, engineering and math) topic. "New Teens" is the term used to describe the YES Teens during their first spring in the program as they learn the ropes. The group "New Teens" is generally referred to as a "component" even though it focuses on science in general rather than a specific STEM content area. Teens split program time between "components" and "College Prep." College Prep is for same-grade groups of teens to work with staff on aspects of college planning and preparation. This group of semester-long components and college prep sessions are collectively referred to as Learning Labs.

SUMMATIVE EVALUATION OVERVIEW

The summative evaluation was conducted by Klein Consulting under the leadership of Christine Klein, Principal, and with support from Carey Tisdal, Director, Tisdal Consulting. To begin to understand program impacts, naturalistic methodology was

used. Through that approach and given the changing context of the project, the focus of the evaluation became the YES Program rather than outreach to schools and scientists, though all goals and objectives were reviewed.

Evaluation Questions

The evaluation was designed to address three questions:

1. How does participation in the *Community STEM Outreach Program* impact its participants?
2. Does/how does the *Community STEM Outreach Program* meet its goals and objectives?
3. How does the addition of 50 or more teens per year affect the program's ability to meet its goals?

YES Program Logic Model

In taking a close look at the YES Program, the evaluation team used the program theory logic model adapted from Weiss (1998) and the W.K. Kellogg Foundation (2004) in Figure 2 to guide the evaluation.

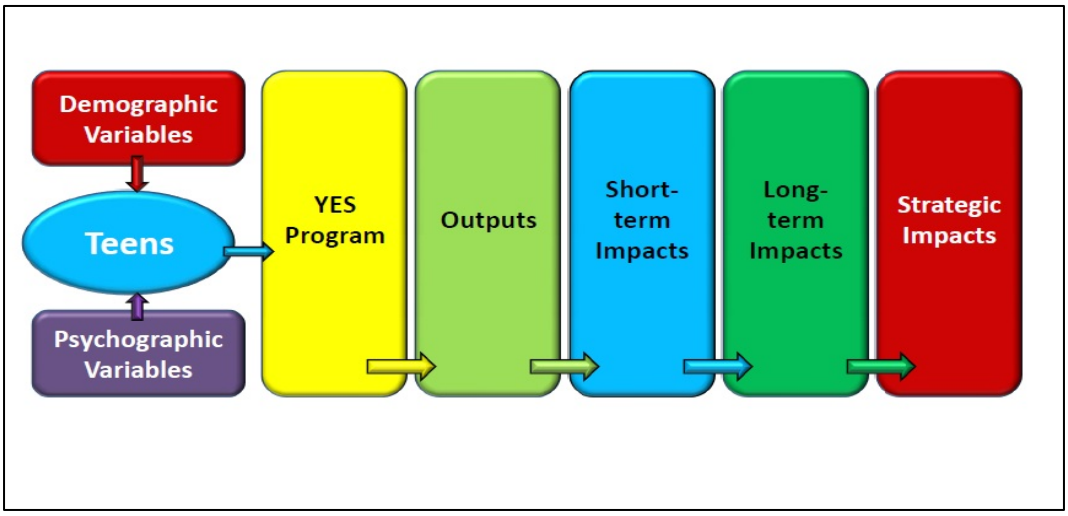


Figure 2. Program Theory Model

This logic model provides the framework for the findings of the summative evaluation.

Impact Matrix

The evaluation was guided by the NSF Frameworks set forth by the NSF Division of Research on Learning in Formal and Informal Settings (DRL) (Friedman 2008). Table 1 provides the impact matrix used.

Table 1. Impact Matrix for the Community STEM Outreach Project.

Target Audience	Impact Category	Participant Objectives	Measures	Methods
YES Teens	Behavior	Increasing numbers of teens will stay in the program for four years	Attendance records	Document analysis
		Increasing numbers of teens will graduate from high school	Graduation rates	Survey of graduates by YES Staff - data analysis
		Increasing numbers of teens will apply to and be accepted by two and four year colleges	College application and acceptance rates	Survey of graduates by YES Staff - data analysis
		Increasing numbers of teens will pursue STEM related degrees or careers	Self-report degree and career choice	Questionnaire data comparisons by year
	Attitude	Teens will become comfortable with STEM and see value in STEM	Attitude survey & observed behavior	TOSRA2; Observations
		Teens will become comfortable working with scientists	Self-report & observed behavior	Observations; Interviews
	Awareness, Knowledge or Understanding	Teens will deepen their understanding of STEM concepts	Interviews & observed behavior	Observations; Interactive Interviews
		Teens will gain exposure to many STEM academic and career pathways	Attendance & participation records	Document analysis
		Teens will make connections between YES investigations and STEM concepts studied in school	Self-report	Interviews and Focus Groups
SLSC Program Staff	Behavior	Develop new opportunities for partnership between SLSC staff and Navy personnel	Self-report; records of program offerings	Document analysis
		Become advocates for teens by addressing barriers and biases in schools and communities	Self-report	Interviews
		Create a strategic plan and budget for national expansion	Completed plan and budget	Document analysis

Target Audience	Impact Category	Participant Objectives	Measures	Methods
		Create training materials for staffs at other institutions	Completed materials	Document analysis
	Attitude	Develop comfort with STEM content	Self-report and observed behavior	Observations; Document analysis of meeting notes
		Develop a culture of reflective practice	Observed behavior	Observations; Document analysis of meeting notes
	Awareness, Knowledge or Understanding	Strengthen the STEM focus of programs	Records of program offerings and observed activities	Document analysis; Observations
	Skills	Develop reflective practice skills	Observed skills and written reflections	Observations; Document analysis of reflections
		Develop the ability to engage youth in STEM inquiry-based activities and investigations	Comparisons of observation data	Observations
		Develop the ability to train and support others in building similar programs in their home community	Observed skills and survey results from those trained	Observations; Surveys
YES Alumni	Behavior	Increase number of teens who graduate from college	Self-report	Surveys
		Increase number of teens who pursue STEM related careers	Self-report	Surveys
Science Center Professionals	Skills	Develop skills and strategies necessary to develop STEM programs built on the SLSC model in their own community	Self-report from participants after return home; observed skills during training	Observations of training; Surveys of participants at 1, 3 and 6 months post training

PRIOR EVALUATION REPORT SYNTHESIS

To aid in the evaluation and program documentation process, evaluators reviewed existing YES Program evaluations and related documents. Evaluators found that reports were not stored in one central location and no one staff member collected them. YES staff, the SLSC Research and Evaluation Department, and the Development

Department were able to locate the following reports. These were used in the analysis; however, other reports may exist.

- Summative Evaluation of Designing Youth: Teens Engaging Children in Design Engineering for the SLSC by Lorrie J. Beaumont (2006)
- Teenage Designers of Learning Places for Children: Creating After-School Environments for STEM Education by Christine Klein (2006)
- Learning Places Evaluation – Observations of Children at Torre: An Interim Report by Christine Klein (2007)
- Teenage Designers of Learning Places for Children: Creating After-School Environments for STEM Education - Summative Evaluation by Christine Klein (2010)
- Science Firsthand – Partners in Discovery Year One Evaluation Report by Sabra Lee (2005)
- Science Firsthand – Partners in Discovery Year Two Evaluation Report by Sabra Lee and Judah Leblang (2006)
- Science Firsthand – Partners in Discovery Year 3 Evaluation Report by Sabra Lee and Judah Leblang (2007)
- Science Firsthand – Partners in Discovery Year 4 Evaluation Report by Sabra Lee and Judah Leblang (2008)
- Science Firsthand – Partners in Discovery Year 5 Evaluation Report by Sabra Lee and Judah Leblang (2009)
- Science Firsthand – Partners in Discovery Year 6 Evaluation Report by Sabra Lee, Judah Leblang and Tracy Wallach (2011)
- YES-2-Tech: Youth Exploring Science to Technology Year 3 Evaluation Report by Joseph L. Polman (2007)
- Design IT! Building Design Challenges in After School Program Final Evaluation Report by Patricia B. Campbell, Lesley Perlman, and Earl Hadley (2002)
- The Legacy of YouthALIVE! Transformative Youth Programs Continue to Thrive in Science Centers by Cary Sneider and Meg Burke (2011)

Evaluation reports from the Community STEM Outreach project were not included in the analysis since the goal was to inform the project through prior evaluations. Additional publications relating to the YES Program were available, but were not included in the synthesis.

Of the studies included, three covered national programs of which the YES Program was one of several sites (Design IT!, Science Firsthand, and the Legacy of YouthALIVE!) Three of the studies focused on one component of the YES Program (Designing Youth, Learning Places, and YES-2-Tech). All included qualitative methods, some included additional quantitative methods.

From these evaluation reports emerged several themes that informed the evaluation of the Community STEM Outreach Program.

The power of relationships stood out as evaluators described the interactions among teens and between teens and staff. One study, Design IT! included the relationship

between the science center and community partners. In the Designing Youth report, Beaumont identified the characteristics of supportive mentor relationships between adults and teens as: “warmth, closeness, connectedness, good communication, caring, support, guidance, secure attachment, and responsiveness” (2006, p.11) The Science Firsthand project focused on mentor/mentee relationships and pointed to changes in mentors as an issue. For the Community STEM Outreach evaluation, we explored the various relationships. For example, we explored the impact of the unanticipated layoffs of staff with established relationships with teens and community partners.

Teaching children, which we are calling the Learn to Teach - Teach to Learn strategy, was described as a central component in the Designing Youth and Learning Places evaluations, and was described in the YES-2-Tech report as a summer focus of the program. In each case, the value of teens teaching younger children was described, as were challenges. The primary issue raised was the understanding of the STEM concepts by the teens at a level suitable to teach others. If the goal was to teach STEM concepts to younger children, then how could the teens successfully teach something they didn’t fully understand? On the other hand, if the goal was to engage children in STEM activities to show them that STEM could be fun, the teens were well placed to do so. For the Community STEM Outreach evaluation, we explored the way learning to teach STEM concepts to younger children impacted YES Teens’ understanding of STEM concepts.

STEM Knowledge and Experience of Staff was called into question by some evaluations. As the evaluation of Designing Youth found, the STEM understanding of educators varied widely. At the same time, they found that staff grew confident in their ability to engage youth in inquiry investigation. In the Learning Places evaluation, one theory that emerged from the Grounded Theory approach stated:

> *Guiding children and teens in investigations to create rich STEM experiences requires after-school program educators who understand inquiry and are comfortable with the STEM content and materials. Guiding those educators to lead such experiences requires additional personnel, in this case at the museum, who have the skills to train educators in leading investigations and who have a high degree of STEM comfort themselves.* (Klein, 2010, p 54)

By the time of the Community STEM Outreach evaluation, the YES Program leaders had begun hiring educators with strong STEM backgrounds as part of the *Deliberate Design*. Some of these new educators came with Masters level science degrees; another was an engineer.

The sustainability of the projects was described in the summative reports. In each case, evaluators described how the project would be incorporated into the YES

Program. The inclusion of lessons learned and best practices from these projects, then, became part of the foundation for the *Deliberate Design* of future iterations of YES. For the Community STEM Outreach evaluation, we explored the foundations of the program model.

METHODOLOGY AND METHODS

METHODOLOGY

Naturalistic methodology (Lincoln & Guba, 1985; Guba & Lincoln, 1989) was the overarching methodology used to design the study and develop conclusions. Evaluators collected and analyzed data using a variety of qualitative and quantitative methods. In order to develop metrics for key indicators of success, evaluation was guided by the National Science Foundations' (NSF) Frameworks set forth by the NSF Division of Research on Learning in Formal and Informal Settings (DRL) (Friedman, 2008).

Responsive constructivist evaluation using naturalistic methodology aims to provide a holistic understanding of phenomena by looking at it from several angles in a real-life setting using a systematic approach for collecting and analyzing data in the context in which it occurs. In responsive constructivist evaluation, processes and activities are captured through a variety of sources from multiple perspectives of various stakeholder groups, and presented through deep descriptions. The impacts of the program are captured through this process, and are connected to these processes and activities through the viewpoints and perspectives of the people involved. In responsive constructivist evaluation, data collection and analysis are iterative processes. This provided stronger validity and credibility for decision-making and allowed decision makers to understand how conclusions were reached and the evidence upon which they were based.

METHODS

Methods to identify key project issues and outcomes and to assess project impacts included: surveys, focus group interviews, information interviews of key project stakeholders, in-depth interviews of selected participants, interactive interviews with selected youth, document analyses, observations, and the Test of Science-Related Attitudes (TOSRA).

Surveys were completed by YES Teens each semester. Data included: schools attended; high school STEM courses taken; plans for high school graduation, college and career; mentors and their post-secondary experiences; and feedback on the teens' YES experiences. A pilot survey of YES graduates explored trends in college graduation and career choices.

Focus Group Interviews with YES Teens and community partners allowed the evaluation team to ask focused questions of groups of 8-12 participants in each category. Focus groups of YES Teens provided data on teens' attitudes, interests, and understanding. Focus groups of community partners who recruited teens into the

program provided additional perspectives on the value of the program to the teens and community.

Information Interviews with representatives of key stakeholder groups allowed the evaluation team to collect perceptions and opinions and was used to identify issues and patterns. These interviews laid the foundation for additional interviews.

In-depth Interviews of selected participants provided data on participant attitudes, beliefs, and behaviors. Interviews of staff provided data on the SLSC-Navy partnership, activities involving scientists, staff comfort with STEM content, and their reflective practice.

Interactive Interviews with selected youth were used to identify the depth of their understanding of the inquiry process. These interviews built on techniques developed in the Learning Places project in which teens were asked to engage in new inquiry activities to determine transfer of understanding of the STEM concepts covered in their program.

Document Analysis of attendance records of teens provided evidence of participation in the program and additional opportunities to identify trends. Document analysis of curriculum templates, recruiting materials, and other program records provided evidence for the triangulation of findings.

Observation strategies built on methods and techniques adapted from previous observational research (Polman, 2000, 2004). The evaluation team collected observational data in multiple locations that constituted the learning community of the project. The observational data included direct observation, field notes, and selected videotaped episodes of educational activities involving youth, staff, scientists, and OST educators in after-school sites, as well as the professional development activities and YES Program facilitation at the SLSC.

Test of Science-Related Attitudes (TOSRA) (Fraser 1981) was designed to measure secondary science students' attitudes toward science. The original test consisted of 70 statements with seven subscales using a 5-point Likert Scale (strongly agree, agree, not sure, disagree, and strongly disagree). TOSRA has been used with youth around the world, and has been shown to be valid and reliable for American teens. A modified version (TOSRA2) developed by Ledbetter and Nix (2002) was used in this study to reduce the time needed for completion. TOSRA2 consisted of 35 pre-test items and 35 post-test items with negatively and positively phrased items balanced on each test. The same seven subscales were used: Social Implications of Science; Normality of Scientists; Attitude toward Scientific Inquiry; Adoption of Scientific Attitudes; Enjoyment of Science Lessons; Leisure Interest in Science; and Career Interest in Science.

DATA ANALYSIS

For this study, Klein Consulting analyzed qualitative data using a modified inductive constant comparison approach (Lincoln & Guba, 1985), whereby each set of data was

compared with previous data sets to direct the focus of subsequent data collection. Quantitative data was initially analyzed using descriptive and inferential statistics. In order to develop findings and draw conclusions both qualitative and quantitative data were triangulated.

TOSRA2 scores were recorded in an Excel spreadsheet and imported into an SPSS program for analysis. Scores for each of the seven categories and a total were calculated for each respondent on each test. Analysis was conducted using descriptive statistics, two-tailed t-tests, one-way ANOVAs, and Pearson Correlations on matched pairs. In this analysis, matched pairs were scores of the same teens taking both the 2012 spring pre-test and the 2013 summer post-test. This provided the greatest time between tests.

PROGRAM DOCUMENTATION AND DISSEMINATION

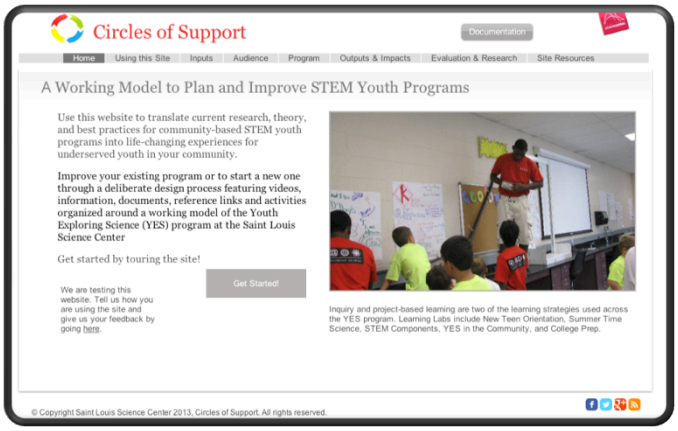
In its proposal to the Office of Naval Research (ONR) dated August 4, 2010, the Saint Louis Science Center (SLSC) proposed to "create a strategic plan for national expansion of the SLSC *Community STEM Outreach Program*" and to "identify resources, including national partners, for national outreach." The original intent of the ONR in funding the Community STEM Outreach project at SLSC was to document a mature, successful youth development program, the Youth Exploring Science (YES) Program, and then, with additional ONR funding, disseminate the model nationally to other science centers and museums. The trajectory of this initial plan was established to benefit SLSC, ONR, and the field of science learning in out-of-school time (OST). Through the Community STEM Outreach Project, potential partners would come together to create a collaborative and plan for the dissemination of the model, including application for a new ONR grant.

Several environmental factors, leadership and staff changes, and the national economic and political landscape, influenced the need to adjust the initial trajectory. After hiring part-time summer staff to document the program in 2011, results fell short of expectations, and SLSC contracted with Klein Consulting, in collaboration with Tisdal Consulting, to document the YES Program model in a format that could be disseminated nationally as part of the evaluation, and to recommend a strategic plan for dissemination. The result is the design of a multimedia tool, currently titled *Circles of Support* (www.yescirclesofsupport.com).

CIRCLES OF SUPPORT

The *Circles of Support* web-based multimedia tool design brings together audio, video, photos, and text to share the story of the YES Program. Organized around the YES Program's logic model and growing out of the evaluation of the YES Program, the tool design allows users to look at the broad ideas that serve as the program's foundation and to zero in on specific program aspects, like the learn to teach - teach to learn philosophy.

This multimedia tool was designed to meet two needs: to strengthen the existing YES Program at SLSC by creating a record of the program's underlying rationale for new staff, and to provide the creation of a tool to support expanded opportunities for youth nationally based on the YES Program model. The tool presents elements of the YES Program as a working model to allow other institutions to select and adapt the ideas, research, and best practices that fit the context of their local area. Target audiences for the tool are community-based organizations and science centers interested in starting a new program or improving an existing program. Units about each program element include a video introduction, documentation of the YES Program element, sample program documents, and references. An alpha version of the tool, available through a website, was available for testing at the conclusion of the grant period along with a print documentation available in PDF on the website or by request.



Dissemination

The proposed dissemination plan involved three phases: 1) testing and revision of the *Circles of Support* multimedia tool design; 2) broad dissemination of the URL for the website; and, 3) professional development of staff using the website and related resources as a foundation. To distribute the URL for the website after any necessary revisions, it was recommended that SLSC utilize the Science Beyond the Boundaries[sm] network, ISEN listserv, ASTC's Youth Program Network, and the ONR Stem2Stern program. At the time of the writing of this summative evaluation, it was too early to determine what path SLSC would take for disseminating the results.

Findings

Using the YES Program Logic Model (Figure 2, page 7) as a guide, quantitative data are grouped in the By The Numbers section by demographic data, psychometric data, program outputs, short-term impacts, long-term impacts, and strategic impacts. These are followed by a closer look at qualitative analysis results for Attitudes toward Science and Scientists and results on Career Choices.

By the Numbers – Summary Data

The data described in this section were based on the 438 teens participating the YES Program over the past three years, since funding from the Office of Naval

Research began. We defined a participating teen as one who attended at least two days in any of the eight semesters since the beginning of the ONR project (Spring, Summer, and Fall 2011 and 2012 plus Spring and Summer 2013). Throughout this report, unless stated otherwise, we used 438 as the number of teens (i.e. *N* = 438) in all tables and graphs. It should be noted that after an initial semester of participation, some teens may not have participated for a semester or two to work another job or participate in other activities, and then returned to the program at a later time. Unless a teen officially withdrew from the YES Program, staff members kept everyone as part of their database in order to communicate and maintain relationships. Relationship was a key element of the YES Program. This means that there was a difference between the number of "all teens in the program" at any given time, and "participating teens."

Demographic Data

Demographic Data are presented in the following figures and tables to describe the YES Teens in the program. While there is a balance between males and females in the program, ethnicity remains predominately African American. Because data span three years, grade level data are indicated by high school graduating class.

Gender Data

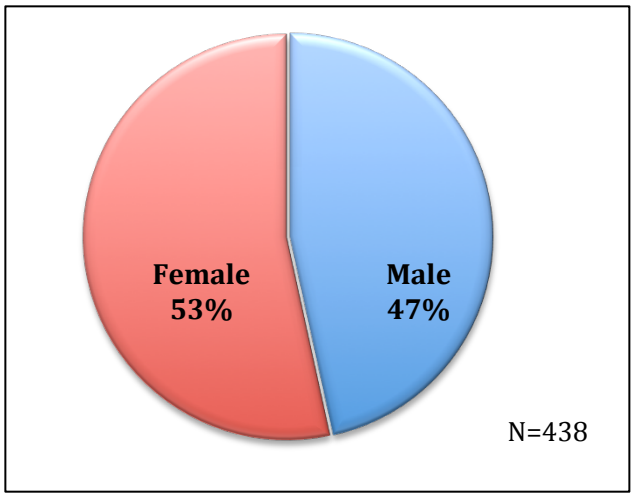


Figure 3. Gender of Participating YES Teens

Table 2. Gender of Participating Teens

Gender	Total
Female	234
Male	204
Total	438

Ethnicity Data

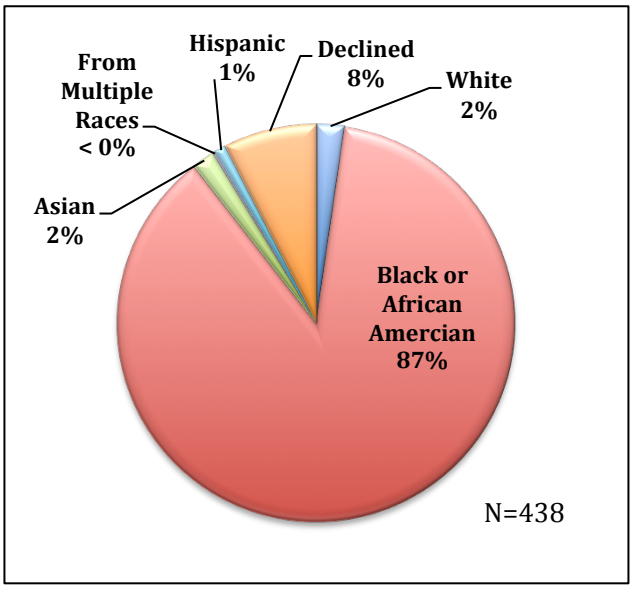


Table 3. Ethnicity of Participating Teens

Ethnicity	Total
Black or African American	382
White	10
Asian	8
Hispanic	4
Multiple Races	1
Declined to Provide Data	33
Total	438

Figure 4. Ethnicity of YES Teens

It should be noted that ethnicity data are collected by YES staff from the teens, some of whom decline to provide that information. Traditionally, teens that were recent immigrants self-reported a variety of very specific ethnic groups. To keep the data in Figure 4 simple and easy to read, evaluators grouped teen self-report data into the US Census categories.

Grade Level Data

Youth can join YES as early as age fourteen, which means YES Teens can be in grades 6-12. Figure 5 and Table 4 show the number of teens participating by grade level over the past three years. Numbers in cohort groups and grade levels do not remain consistent for year-to-year comparisons such that the number of freshmen in 2011 are not necessarily the sophomores in 2012. Incoming New Teens may be in any grade level. Additionally, teens occasionally have another job, family issue, or school activity that prevents participation in a YES Learning Lab during one year even though they return to the program to participate in the next.

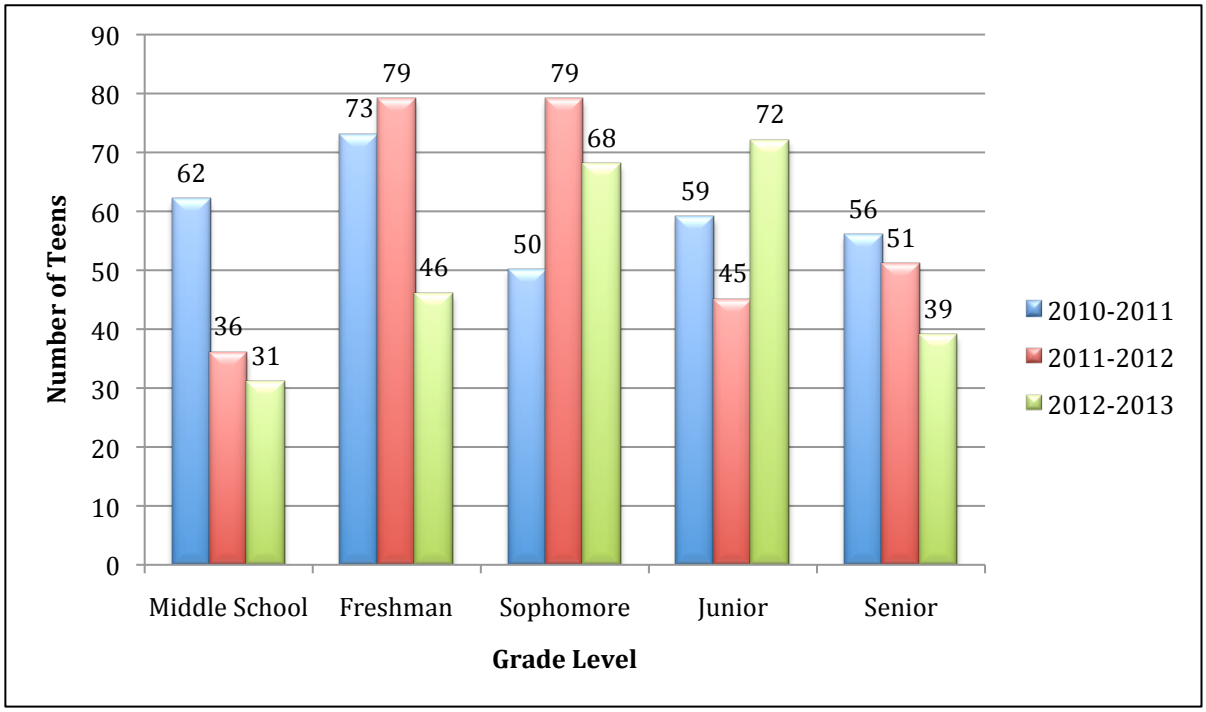


Figure 5. Grade Levels of YES Teens in 2010-2011 (N = 300), 2011-2012 (N = 290), and 2012-2013 (N=256)

Table 4. Grade Levels of YES Teens by Year of Project

	2010-2011	2011-2012	2012-2013
Middle School	62	36	31
Freshman	73	79	46
Sophomore	50	79	68
Junior	59	45	72
Senior	56	51	39
Total (N)	300	290	256

Cohort Data

Figure 6 tells us that the group of teens entering the program in 2011 (Cohort 2011), when funding from the Office of Naval Research was received, is the largest group represented in YES. SLSC leadership chose to recruit smaller numbers of incoming teens in the springs of 2012 and 2013. Totals include only those teens that participated more than one day, and not teens that joined the cohort and left after their first Learning Lab.

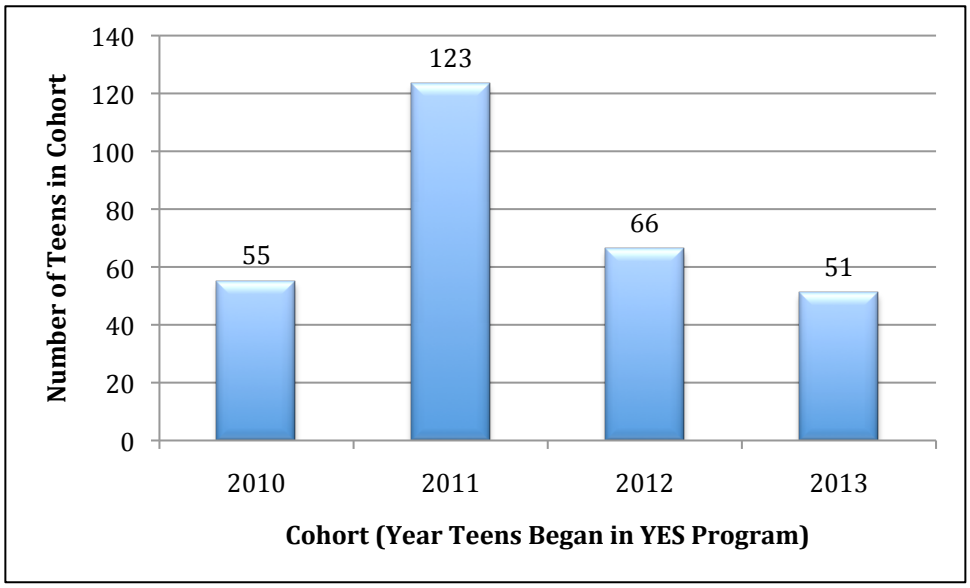


Figure 6. Number of Participating YES Teens by Cohort

School Data

YES Teens attended a wide variety of schools – public, private, homeschool, and others, in Missouri and Illinois. Since some of the teens changed schools frequently, data in Figure 7 were based on the most recent high school or middle school attended. Of the 438 participants, only 415 provided information about the school they attended on their program application or on questionnaires.

While YES Teens attended a wide variety of schools, the program drew substantially from several public school districts in the St. Louis area. Table 5 shows the six school districts from which over 50% of YES participants came. These percentages were based on the total number of participants.

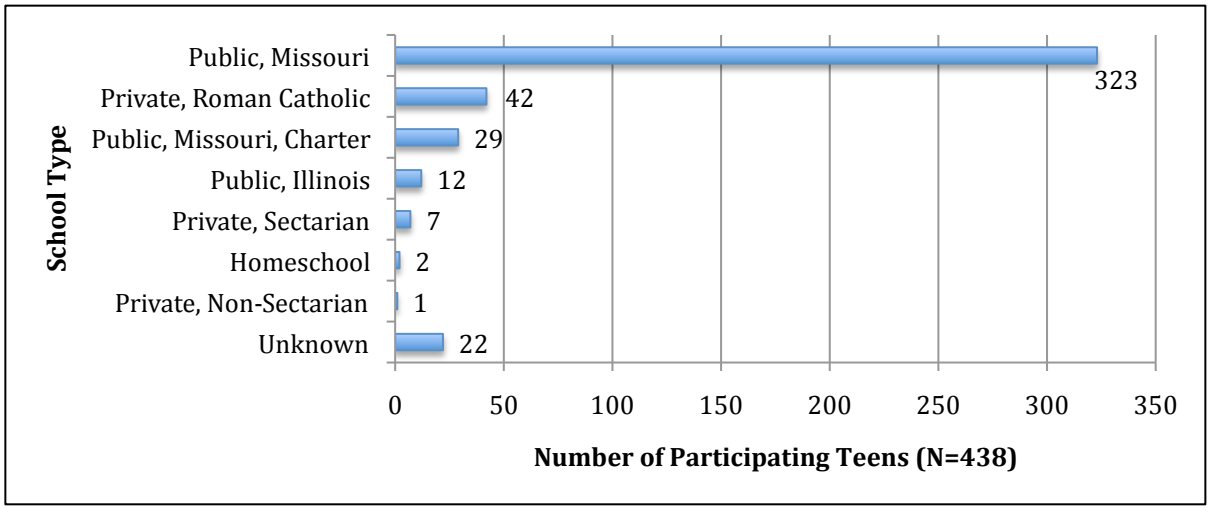


Figure 7. Number of Participating YES Teens by School Type

Table 5. Six School Districts Totaling over 50% of Participating YES Teens (*N* = 438)

School District	Percent
St. Louis City	31.1%
Hazelwood	7.5%
Ferguson-Florissant R-II	4.8%
Normandy	3.9%
Parkway C-2	3.7%
Ritenour	3.0%

Psychometric Data

Psychometric data tell us about YES Teens' motivations and attitudes. Why did they join the YES Program, and why do they keep coming back each semester? Findings regarding the teens' attitudes toward science and scientists are covered in a separate section.

Data on Why Teens Join YES

As 109 New Teens entered the program in Spring 2011 (as the ONR funding enabled the SLSC to bring in a larger pool of participants), they were asked why they joined the YES Program. Ninety-five responded to the survey.

The survey asked New Teens: What is your main reason for wanting to join the YES Program? They were asked to check one of the following, or to write in something under "other".

□ My family wanted me to
□ My mentors wanted me to
□ I love science
□ I needed a job
□ The money
□ The laptop
□ I wanted work experience
□ My friends said it was fun
□ Other

At the time the teens joined YES, the graduating seniors were given a laptop. This practice ended with the Interim President and financial restructuring of SLSC, before most of the respondents graduated.

On the survey, many teens selected more than one response. Since it was difficult to tell which one category was most important, all responses were counted. Data collected from the New Teens are summarized in Figure 8.

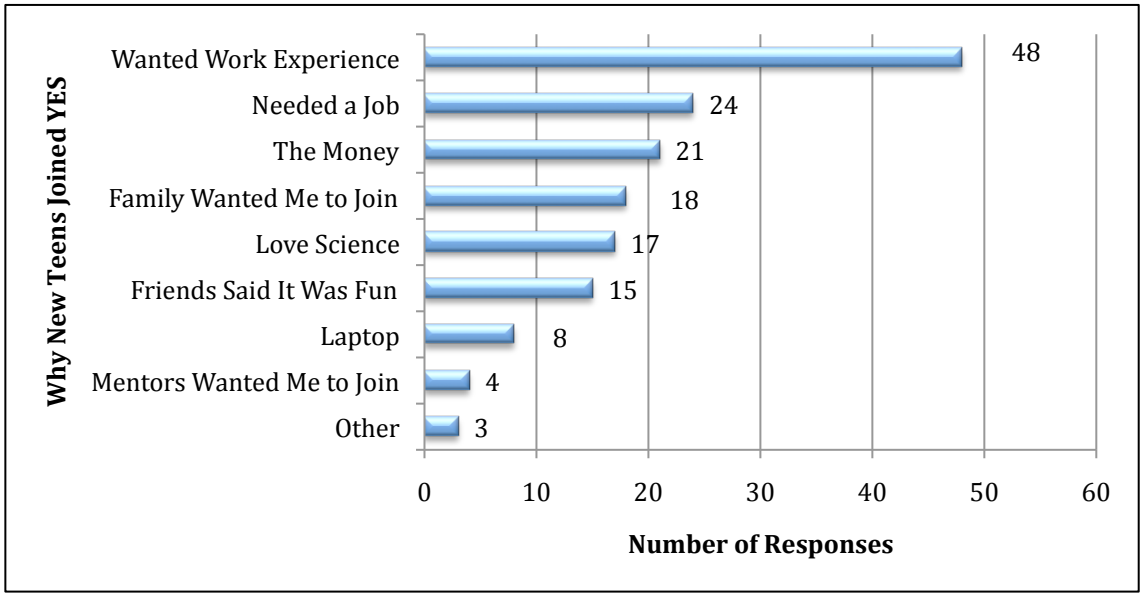


Figure 8. New Teens' reasons for joining YES

The three teens checking "other" had these reasons (in their own words):

- For future career
- I felt like it was an opportunity to better myself
- It was something I never heard of and wanted to try

Data on Why Teens Keep Coming Back to YES

In the spring of 2013, returning YES Teens were asked why they kept coming back to the YES Program (N=122). Again, they were asked to check one of the following options, but many selected several. Responses are summarized in Figure 9.

☐ My family makes me
☐ I love science
☐ I need a job/money
☐ I like the work experience
☐ I like teaching the kids
☐ Other

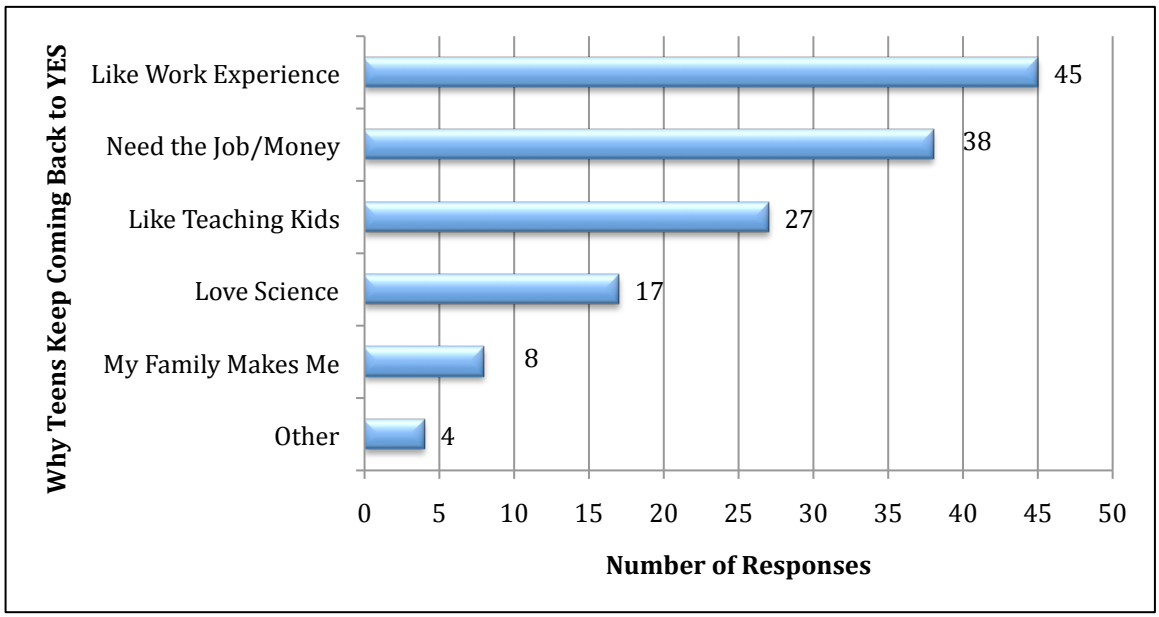


Figure 9. YES Teens' reasons for coming to return to YES

The four teens checking "other" and three who added comments in the same space said the following (in their own words):

- family tradition
- I like the people
- I love being around my friends and Matt
- I make myself come
- some supervisors
- something to do on the weekends (and summer) so I don't have to lay around the house
- The motivation in doing what I want to do - preparing me for the real life in the future.

Data indicate the work experience and pay bring teens into the program and keep them coming back.

Program Outputs

Each year, sometimes each semester, YES educators offer different STEM components based on a variety of factors, including interests of staff and available funding (e.g. specific grants). Table 6 provides a list of components and the number of participating teens per component. (Participating teens are defined as those who attended more than one day in that semester.)

Table 6. Components Offered by Semester with Teen Participants

	Spring 2011	Summer 2011	Fall 2011	Spring 2012	Summer 2012	Fall 2012	Spring 2013	Summer 2013
School Year Component Groups								
New Teens	105	-	-	61	-	-	48	-
Agriscience	-	21	34	35	24	-	-	14
Astronomy	-	-	28	34	23	-	-	11
Atmospheric Science	-	-	-	-	-	29	25	-
Biofuels & Energy	-	-	22	35	28	35	23	-
C3 (Climate Change)	14	-	-	-	-	-	-	-
Design IT	18	-	-	-	-	32	28	10
Health	10	-	-	-	-	-	-	-
HOSCO	-	-	-	-	-	-	-	16
Learning Places	21	-	-	-	-	-	-	-
Neuroscience	-	-	24	3	-	31	35	-
Plant Biochemistry	-	-	25	-	-	-	-	-
Robotics	18	-	38	41	22	-	-	-
SciJourn	8	13	6	8	11	-	-	-
Science Corner	25	-	-	-	-	-	-	-
Sea Perch	18	-	-	-	-	-	-	-
Mystery of Matter	-	9	-	-	8	32	31	16
Summer Component Groups								
Summertime Science	-	96	-	-	60	-	-	60
Exhibit Lab	-	-	-	-	71	-	16	10
Main Building	-	67	-	-	-	-	-	-
Offsite	-	60	-	-	5	-	-	53
Science on the Go	-	10	-	-	-	-	-	-
Science of Learning	-	-	-	-	-	-	-	15
Total	237	276	177	217	252	159	206	205

Two components were funded through the National Science Foundation (NSF). SciJourn received NSF funding through the University of Missouri-St. Louis and served as a separate component in the school year and supported all components in the summer. Mystery of Matter received NSF funding through AAAS, and supported the other components during the 2011-2012 academic year, though was a separate component in other sessions.

Table 7 combines the figures above into categories based on the STEM content.

Table 7. STEM Content Offered by Semester with Teen Participants

	Spring 2011	Summer 2011	Fall 2011	Spring 2012	Summer 2012	Fall 2012	Spring 2013	Summer 2013
New Teens	105	-	-	61	-	-	48	-
Astronomy	-	-	28	34	23	-	-	11
Biology/Env Science	49	21	105	73	52	95	83	30
Chemistry	-	9	-	-	8	32	31	16
Engineering & Design	75	-	38	41	93	32	44	20
Journalism	8	13	6	8	11	-	-	-
Teaching Science	-	233	-	-	65	-	-	128
Total	237	276	177	217	252	159	206	205

Attendance remained a concern of the evaluation team throughout the project. In the early years of the YES Program, as part of the Deliberate Design, educators regularly contacted teens that were absent to be sure they were well and were coming back. In recent years, many educators did not follow the same protocol. Based on interview data and staff meeting observations, this appeared to be connected to changes in professional development and management practices that did not set expectations for ongoing contacts, and to lack of monitoring of staff members to hold them accountable for this responsibility. After this issue was brought out in the formative evaluation (year 2), the administrators began to address the issue.

Table 8 provides an overview of YES attendance since the evaluation began in Spring 2011. Row 1 shows the number of Learning Lab opportunities (number of days sessions were held in each semester). Row 2 shows the total number of participating teens in each of these semesters, and row 3 shows the percentage of attendance for each semester. Percent attendance was calculated using the sum of the number of teens in all sessions that semester divided by the total participating teens times number of days.

Table 8. Learning Lab Opportunities in and Percent Attendance from Spring 2010 through Summer 2013

Semester	Spring 2011	Summer 2011	Fall 2011	Spring 2012	Summer 2012	Fall 2012	Spring 2013	Summer 2013
Days	15	36	11	14	32	11	17	19
Participating Teens	237	278	177	217	252	159	206	205
Percent Attendance	67.9%	82.4%	71.1%	52.6%	83.4%	70.8%	60.4%	78.6%

Attendance in most semesters is affected by teens participating in sports, school and community-based extracurricular activities and family emergencies. The lower level of attendance in Spring 2012 coincided with layoffs of staff. Teens form relationships with individual staff members, and as evident in focus groups and interviews with teens, some had strong feelings when their component leader lost her/his job. When two components were cancelled, only two teens immediately left the program; however, lower levels of attendance

throughout the semester and conversations with teens indicated that budget cuts with associated staff layoffs disrupted the staff-teen relationships which underlie regular program attendance.

Short-term Impacts

Several stakeholders focus on high school graduation rates and post-secondary plans as indicators of success. They asked for rates of YES Teens compared with other teens in the region. However, what appears to be a simple calculation and comparison is actually full of challenges.

High School Graduation Data

When calculating the high school graduation rates, the following challenges arose.

- YES Teens attend a wide variety of private schools and public school districts in Illinois and Missouri.
- Complete high school graduation data from area school districts in Missouri and Illinois were only available for 2011 and earlier.
- YES Program staff members have only collected data from seniors in 2012 and 2013, not 2011.
- Data are missing from YES 2012 and 2013 seniors that staff members were unable to reach.
- Names and numbers of seniors differed between those kept by the YES staff and those in the evaluators' database, which were based on survey data and program records.

To address the challenges and still arrive at comparison numbers, the following assumptions were made.

- Graduation rates for school districts can be weighted based on the percent of YES seniors attending each district.
- School district rates are stable enough to compare 2011 rates with YES graduation rates from 2012 and 2013.
- Differences between YES staff data and the evaluation database were minimal, such that high school graduation data could be used from YES staff, and school district data could be used from the evaluation database for comparison rates.
- To address missing YES senior data, including only seniors contacted (i.e. those not reached are excluded) can provide an accurate estimate for comparison.

Weighted rates for comparison were calculated much like weighted grades in a high school class.

1. Number of YES seniors per public school district or private school were obtained from the evaluation database
2. High school graduation rates from public school districts and private schools were obtained from the Missouri and Illinois departments of education.

3. Percent of YES seniors attending each district or school were calculated
4. Results from 2 and 3 above were multiplied to create a weighted percent for each district/school
5. The total from 4 above was calculated to give the comparison rate – one based on seniors from 2012 and a second from 2013 seniors

Table 9. Comparisons of high school graduation rates

Groups	2012	2013
YES Seniors (missing data excluded)	96.36	100.00
Area school weighted comparison	75.43	78.42
Missouri state average*	82.40	83.10
Illinois state average*	80.40	77.70

* State averages were obtained from www.americashealthrankings.org/ALL/Graduation/

From the results in Table 9 and Figure 10, it is clear that YES Teens who are seniors in high school graduate at a rate higher than their peers from the same area schools and from the states of Missouri and Illinois. Visually, in looking at Figure 10, the difference between the comparison (Area Students) and the YES seniors when excluding unknowns from the calculations (YES Teens) is impressive.

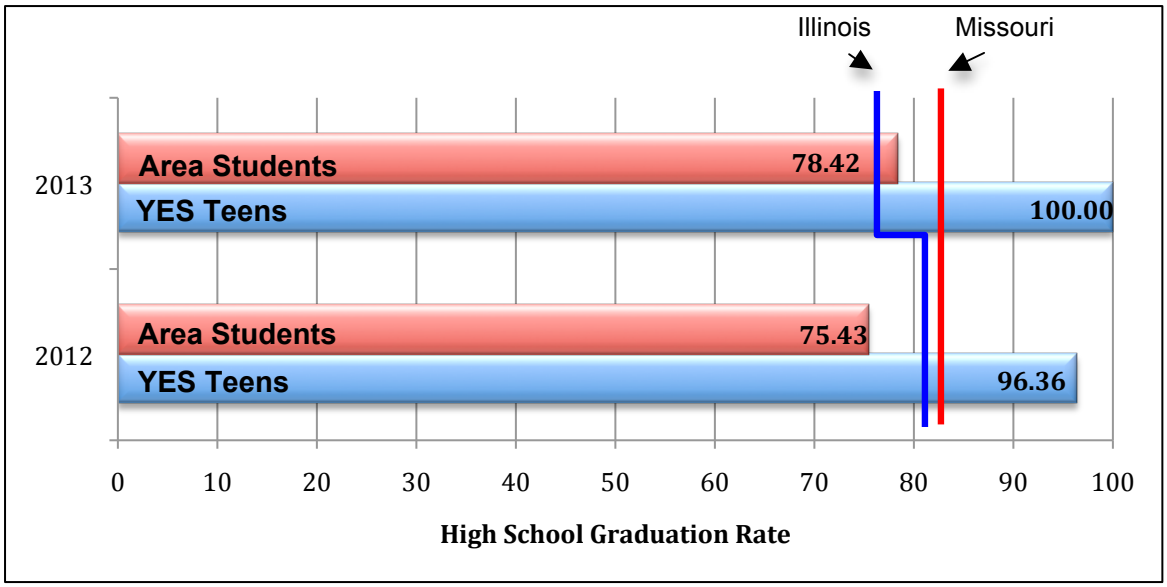


Figure 10. 2012 and 2013 High School Graduation Rate Comparisons

By making assumptions in the calculations to address the challenges faced by missing data from the YES Program and the states, the comparison of high school graduation rates shows that YES Teens who remain in the program until their senior year in high school graduate at a higher rate than their peers in the same area schools.

Critical is the phrase "YES Teens who remain in the program until their senior year in high school." School district and state graduation rates must include students who began as freshmen but dropped out of school before or during their senior year (and did not transfer). The YES Program does not keep attrition data and does not follow-up with teens that drop out of the program to determine whether or not they graduated from high school. Thus, when comparing high school graduation rates between YES seniors and weighted averages for area schools or states, the differing definitions of graduation should be noted (i.e. the comparison is between apples and oranges).

Post-secondary Plans

In addition to knowing the graduation rates, it is helpful to know the plans of the YES Teens for their post-secondary education. To measure short-term impacts, surveys of participating teens included questions about their plans for after high school – job, college, trade school, or military.

As Figure 11 shows, over half of the seniors in the graduating class of 2012 planned to attend a 4-year college. Only 3% ("other") had not yet graduated from high school. YES staff members were unable to reach 12% ("unknown") of the graduating seniors in the summer of 2012.

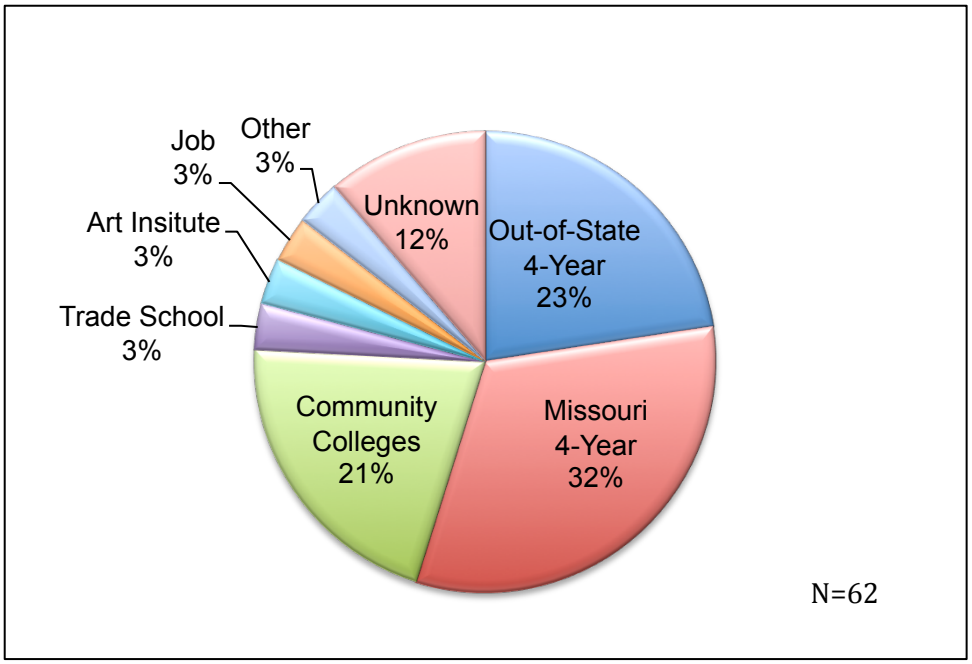


Figure 11. Post-High School Plans of Seniors in May 2012

In 2013, YES staff members were unable to reach nine of the graduating seniors, and it is unknown whether or not these teens graduated from high school. These nine teens are included in the unknown data in Figure 12. All teens contacted had graduated. Figure 12 shows that 46% of the seniors in the graduating class of 2013 planned to attend a 4-year college. Two teens had joined the military, one with the Navy and one with the Army.

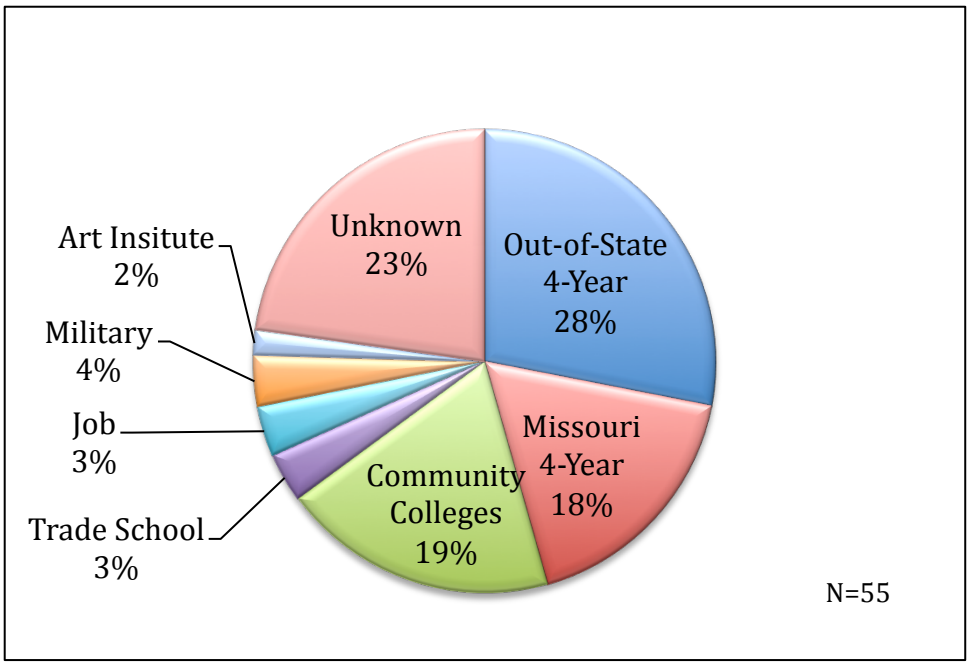


Figure 12. Post-High School Plans of Seniors in May 2013

Comparable data from 2011 were collected by program staff, however are no longer available due to staff turnover. Survey data collected by the evaluation team from a sample of the graduating class of 2011 in Summer 2011 indicated that 94% of respondents applied to a trade school, college, or university (though 2 had not heard back yet), while one teen joined the US Navy and one joined the Job Corps.

Long-term impacts

With teens in the YES Program for four and a half or more years, long-term impacts include those impacts recognized after they have left the program and gone on to college, the military, and/or careers. To begin to measure the long-term impact of the program, an online survey was developed for former YES participants asking about their experiences during and after YES. Twenty-six individuals participated in the survey by the deadline, with 22 surveys completed by former YES Teens to the extent that they could be included in the results reported here. The small number of responses (N=22) can give a limited picture of the activities of YES alumni/alumnae, but caution should be exercised in drawing any conclusions about program impact.

This pilot provided insights into collecting data from a highly mobile population that had not remained in contact with the program. As a small pilot, however, it could not provide evidence of the impact of the YES Program on all YES participants. In this report, we can only provide an overview of the data collected and the lessons learned in the process.

Of the 22 respondents, six did not provide demographic data. From data provided, ten were female and six were male. Fourteen were African American, one was Caucasian, and one was multiracial. One was a naturalized citizen while the rest were native US citizens. Five participated in the program less than three years, with the majority participating four or more years.

Twenty of the 22 respondents graduated from high school and two earned a GED (from cohorts 2006 and 2009). After high school, 18 of the respondents (82%) attended a trade school, college or university after high school. Five of those had graduated from college, with two in graduate school at the time of the pilot survey. Eleven were still in trade school (1 participant) and college (10 participants). Areas of study varied, as listed below. Business and engineering were the two most prominent among respondents.

- Biological and Biomedical Sciences = 1
- Business, Management, Marketing, and Related Support Services = 4
- Cosmetology = 1
- Education and English = 1
- Engineering = 3
- Fashion Design = 1
- Health Professions and Related Programs = 1
- History = 1
- Mathematics and Statistics = 1
- Nursing = 1
- Psychology = 1
- Sociology = 1
- Visual and Performing Arts, with Education = 1

Of the 22 respondents included in this analysis, 13 were students at the time of the survey. Most of these were employed. Table 10 provides the employment status of the alumni/alumnae in spring 2013. Table 11 provides the types of organizations for which they worked. All data were self-report, thus some discrepancies appeared.

Table 10. Employment Status of Respondents

Current Employment Status	Number
Full-time Employee	8
Part-time Employee	5
Unemployed & seeking employment	4
Internship	2
Self-employed and holding temp position	1
Work-study	1
Full-time student seeking part-time job	1

Table 11. Types of Organizations Employing Respondents

Type of Organization	Number
Private For-Profit Company	3
International Organization	3
K-12 School	2
State or Local Government	2
Self-employed	2
Work-study	2
Unclear	2
Federal Government	1
Unemployed	5

The survey provided lists of categories respondents used to characterize the focus of their occupations (Table 12) and current positions (Table 13).

Table 12. Occupations of Respondents

Type of Occupation	Number
Sales and Related Occupations	3
Business and Financial Operations	3
Education, Training, and Library	2
Management	2
Community and Social Service	1
Food Preparation and Serving	1
Arts, Design, Entertainment, Sports, and Media	1
Architecture and Engineering	1
Healthcare Support	1
Healthcare Practitioners and Technical	1
Office and Administrative Support	1
None listed or unemployed	5

Table 13. Current Positions of Respondents

Position Categories	Number
Sales, marketing, advertising or public relations manager	4
Administrative support, clerical worker, secretary	3
Classroom teacher (K-12)	2
Engineer	2
Other creative profession	2
Human resources or labor relations professional	1
Manager, administrator, or management consultant	1
Visual artist or designer	1
Salesperson, broker, or agent	1
Medicine – other health services professional	1
No current position	4

Of the four unemployed respondents, one was seeking a position as an educator or in a managerial role. One was seeking a position as a nurse. Another was looking for managerial or financial positions. The fourth did not specify a type of position.

The survey asked about the types of knowledge and skills required by their positions (See Figure 13). Most required clear communication, collaboration, creative thinking, accessing and evaluating information, and using and managing information. While math skills were required by just over half of the respondents' positions, science and engineering were required by less than half.

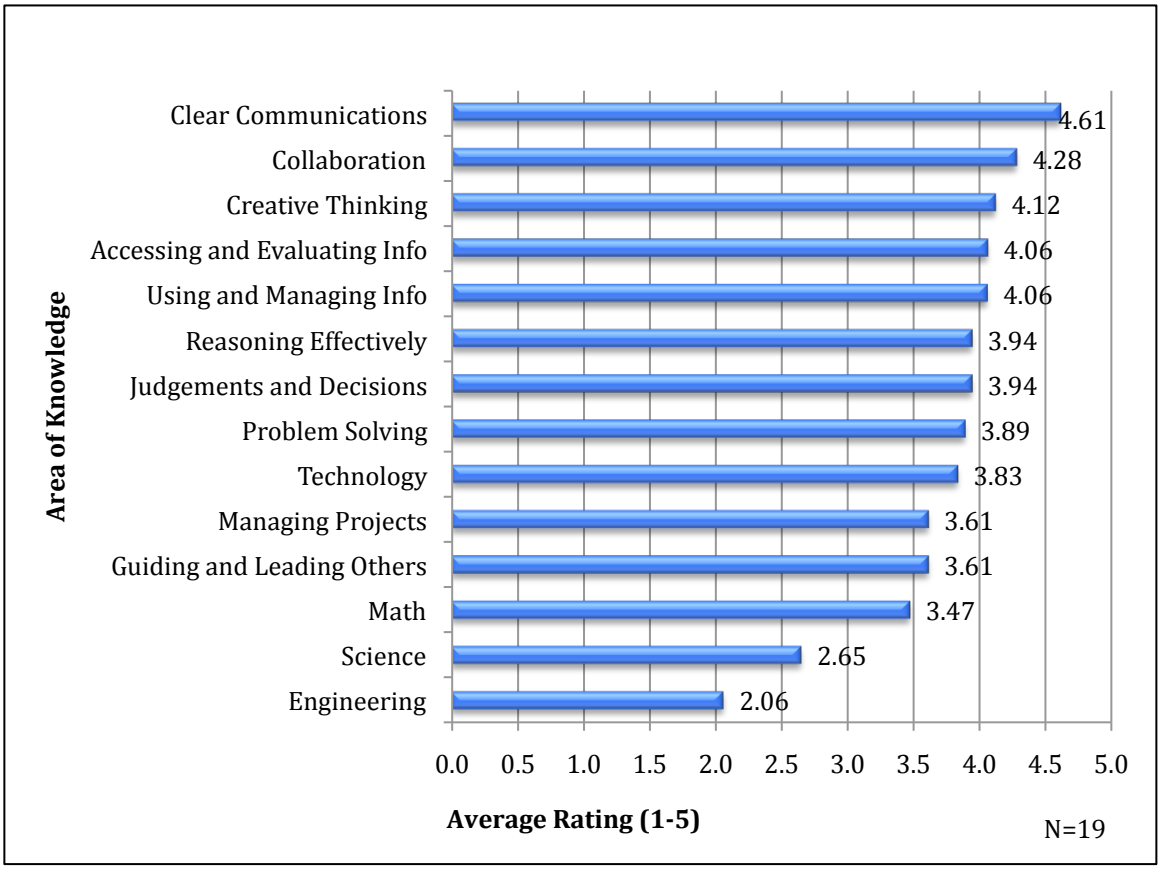


Figure 13. Average Rating of Knowledge Involved in Respondents' Current Positions (N=19)

When asked what influenced their choice of career, family and school experiences were most prominent with YES experiences a close third (Figure 14).

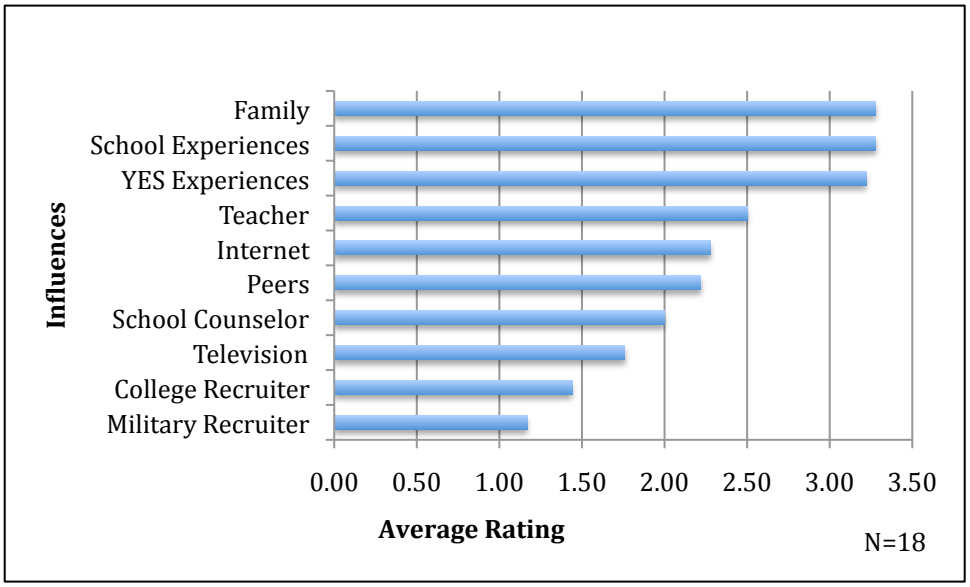


Figure 14. Average Rating of Influences on Respondents' Career Choices (N=18)

When asked how well the YES Program prepared them for post-secondary education respondents gave a 3.80 average on a 5-point scale with 5 as greatly helpful. When asked how well the program prepared them for the workforce, the resulting average was 4.53 on the same 5-point scale. When asked how influential the YES Program was on college and career choices, the average was 3.88.

Results indicated that networking, teambuilding, and teaching younger children were the aspects of the program that influenced respondents the most. When asked a slightly different question, "To what extent did these elements of the YES Program positively impact you?" rated from 1 (no positive impact) to 5 (high positive impact), teaching younger children and developing job skills received the highest averages, followed by earning an income and public speaking experiences.

When asked about the influence of the YES Program on their attitudes, results showed that the greatest influences were on attitudes toward adults, learning, young children, workplace policies and procedures, and teachers. "On a scale of 1 - 5, please rate to what extent the YES Program influenced your attitudes toward the following? 1 = have a more negative attitude to 5 = have a more positive attitude." Respondents were given the option to mark "not

applicable". Results are summarized in Table 14, from most positive influence to least positive.

Table 14. Influence of YES Program on Attitudes

Attitude Toward:	N	Average
Adults	16	4.40
Learning	16	4.38
Young Children	16	4.31
Workplace Policies and Procedures	16	4.19
Teachers	16	4.19
Other Professionals	15	4.13
Administrators (i.e. Bosses) in Any Work Setting	16	4.06
Science in General	16	4.00
Conducting Science Investigations	15	3.93
College	15	3.93
Professional Scientists	15	3.87
Formal Education (High School and College)	15	3.73
Informal Education (Museums, After School Programs, Educational TV, Etc.)	15	3.73
Recycling	16	3.88
Composting	14	3.71
Global Warming and Climate Change	14	3.64
Space Exploration	14	3.64
Cloning	14	3.36

The pilot survey provided direct quotes from the respondents; a couple of these related to impact on career and STEM follow.

> *YES taught me how to be a key role player in the work environment, it also taught me to never settle, there's always room for improvement in the work area and I can go as far as my dreams.* (2008-2012, male)

> *I am forever grateful to the YES program. I love the program. The YES program influenced the work that I put forth in other positions I've held since leaving the program. It taught me work ethic and organizational skills that I'll never forget…. My participation in the YES program helped me stay in the sciences. It kept me motivated and kept me loving science and mathematics.* (1999-2003, female)

Information collected from the 22 former YES Teens in this pilot online survey provided evidence of the type of impact data that could be collected and insights into how to improve data collection, with additional investment to provide incentive for response and identification of up-to-date contact information. A separate report (Klein & Tisdal, 2013) included a full discussion of

recommendations for future surveys.

Since YES Program staff do not maintain data on all former YES Teens, it is impossible to know if the 22 responses to this pilot survey were representative of the YES alumni/alumnae population. An additional challenge was the large number of survey respondents still in school.

Recommendations for future work included:

- Changes to the survey (detailed in the separate report)
- Creation of an ongoing data collection and tracking system for alumni/alumnae
- Incentives for survey completion
- Addition of open-ended questions on the survey or in follow-up interviews
- Surveys for teens who dropped out of the YES Program prior to high school graduation

Strategic Impacts

The Project Objectives state that project leaders will:

1. Create a strategic plan for national expansion of the SLSC *Community STEM Outreach Program*
2. Identify resources, including national partners, for national outreach

Toward these objectives, under the leadership of Diane Miller, SLSC identified national science center and museum partners with existing youth programs or plans for such programs. Representatives from these nine national partners joined SLSC staff, representatives from the ONR, and local partners on April 21-23, 2013 in St. Louis to discuss the YES Program model and its potential dissemination. Organizations represented included:

- The Office of Naval Research
- Bishop Museum
- California Science Center
- Great Lakes Science Center
- Lawrence Hall of Science
- Museum of Life and Science
- National Museum of American History, Smithsonian Institution
- New Mexico Museum of Natural History and Science
- Reuben Fleet Science Center
- Science Museum of Minnesota
- Saint Louis Science Center
- Missouri Botanical Gardens
- Saint Louis Zoo
- Daugherty Group
- Hosco Farms
- Klein Consulting
- Tisdal Consulting

On the second day of the meeting, three breakout groups met to begin discussing possible areas for collaboration: Science Learning, Youth Development, and Workforce Development. A conceptual model (Figure 15) was discussed, and the focus of discussion shifted to ways to bring the three together – to increase the "sweet spot" at the center.

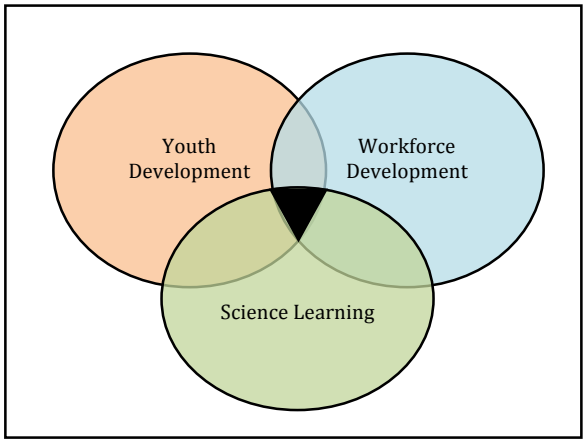


Figure 15. Conceptual Model

While there was no consensus, the group agreed to carry on the conversation through a Thinkfinity group discussion, to be organized by one volunteer from a national partner. The next step would be for SLSC leaders to develop action items and solicit feedback. After the April meeting, the Thinkfinity site was established but few meeting participants joined or commented. With lack of follow-up discussion from conference attendees and guidance from ONR regarding limited funding opportunities, the SLSC administration concluded that an appropriate role for the institution would be to create a tool for national dissemination (the *Circles of Support* website), rather than take a leadership role in obtaining federal funding or working toward consensus on a project with the national partners.

ATTITUDES TOWARD SCIENCE AND SCIENTISTS

To measure changes in attitudes toward science and scientists, evaluators used a modified version of the Test of Science-Related Attitudes, (TOSRA2). The TOSRA, designed by Fraser (1981) to measure secondary science students' attitudes toward science, consisted of 70 statements with seven subscales using a 5-point Likert Scale (strongly agree, agree, not sure, disagree, and strongly disagree). TOSRA has been used with youth around the world, and has been shown to be valid and reliable for American teens. A modified version (TOSRA2) developed by Ledbetter and Nix (2002) was used in this study, consisting of 35 pre-test items and 35 post-test items with negatively and positively phrased items

balanced on each test. Results are summarized here. Detailed results of this test can be found in Appendix D.

The seven subscales were as follows:

- Social Implications of Science (S) – Do youth recognize the benefits and drawbacks of scientific advances to society?
- Normality of Scientists (N) – Do youth see scientists as real people rather than media-produced stereotypes?
- Attitude toward Scientific Inquiry (I) – Do youth view experimentation and inquiry as a way to gain understanding of the natural world?
- Adoption of Scientific Attitudes (A) – Have youth adopted the attitudes of scientists, such as open-mindedness and self-assessment?
- Enjoyment of Science Lessons (E) – To what degree do youth enjoy their lessons in school science classes?
- Leisure Interest in Science (L) – To what degree are youth interested in science out of school, and outside of the YES Program?
- Career Interest in Science (C) – Do youth have an interest in pursuing a science related career?

The TOSRA2 was administered in YES Learning Labs on four different occasions as summarized in Table 15. Grade level in school was provided by most teens on the test; however, grade level could not be found in the YES staff's database for two of the teens (one joined YES in 2011; the other in 2012). For summer tests, grade level was defined as the level the YES Teen would enter in the fall.

Table 15. Count of TOSRA2 respondents in each grade level.

	Unknown	7-8th	9th	10th	11th	12th	Grad	Total
Pre-test, March 2012	0	21	47	34	21	10	0	133
Post-test, July 2012	1	3	18	63	54	29	27	195
Pre-test, April 2013	1	14	21	30	24	20	0	110
Post-test, July 2013	0	2	18	29	43	15	8	115

The matched pairs used for this analysis were scores from teens taking both the 2012 spring pre-test and the 2013 summer post-test, which provided the greatest time between tests. Table 16 summarizes the teens included in the matched pairs by grade level in school.

Table 16. Count of teens taking the spring 2012 pre-test AND the summer 2013 post-test by grade level at post-test.

	9th	10th	11th	12th	Grad	Total
Matched Pairs	1	8	26	7	2	44

Included in the matched pairs were 24 males and 20 females. Data included 39 African American teens, two Asian teens who were recent immigrants from Nepal, one Caucasian, one Hispanic, and one teen for whom no ethnicity data

were available. In addition to these variables and teens' grade levels, we included length of time (in months) that respondents had been in the program at the post-test date (Table 17).

Table 17. Count of teens taking the spring 2012 pre-test AND the summer 2013 post-test by length of time in the YES Program at post-test in months.

Months in YES at Post-test	Frequency
17	23
29	18
41	2
53	1

The findings include only those results from the matched pairs. Ethnicity was not used in the analysis due to the small numbers of non-African American teens in the sample. Analysis focused on gender, grade level as an indication of age and maturity, and length of time in the program. Length of time was not an indication of hours of participation, but rather the number of months a teen was associated with the program.

Matched Pair Results

Analysis of the matched pairs found that scores increased from pre to post-test in all but two categories (Attitude Toward Inquiry and Career Interest). Correlation coefficients were found to be significant in six categories and on the total scores. Two-sided paired t-tests found significant differences ($p < 0.05$) in five of the categories and the total scores. Table 18 gives means for each category and the total score with results from the analyses.

Table 18. TOSRA2 Pre- and Post-test means by TOSRA category

	Pre-Test	Post-Test	Mean Difference	Correlation Coefficient	t (2-sided)
Social Implications	17.05	18.23	-1.18	0.383**	-2.48*
Normality	15.59	18.45	-2.86	0.460**	-7.92**
Attitude toward Inquiry	19.43	18.16	1.24	0.352*	2.42*
Adoption of Attitudes	17.73	18.50	-0.77	0.290	-1.77
Enjoyment	16.95	18.14	-1.18	0.494**	-2.11*
Leisure Interest	14.55	16.27	-1.73	0.535**	-2.90**
Career Interest	17.00	16.16	0.84	0.500**	1.43
Total Score	118.30	123.91	-5.61	0.649**	-2.84**

** Significant at p<0.01
* Significant at p<0.05

These results suggest that between spring 2012 and summer 2013, respondents' attitudes changed in the following ways. After 16 additional months in the YES Program (i.e., 16 months between testing), youth were:

- More likely to recognize the benefits and drawbacks of scientific advances to society -- Social Implications of Science (S)

- More likely to see scientists as real people rather than media-produced stereotypes – Normality of Scientists (N)
- Less likely to view experimentation and inquiry as a way to gain understanding of the natural world (gender differences are described below) – Attitude toward Scientific Inquiry (I)
- Slightly more likely to have adopted the attitudes of scientists, though the adoption of attitudes was relatively weak (i.e. not significantly different) – Adoption of Scientific Attitudes (A)
- More likely to indicate enjoyment of their lessons in school science classes – Enjoyment of Science Lessons (E)
- More interested in science out of school, and outside of the YES Program – Leisure Interest in Science (L)
- Slightly less interested in pursuing a science related career (gender differences are described below) – Career Interest in Science (C)

Overall test scores showed a significant increase from pre-test to post-test.

Figure 16 provides a graphic image depicting these differences, including the negative change in means (i.e. the red post-test column is lower than the blue pre-test column) for Attitude Toward Inquiry and Career Interest.

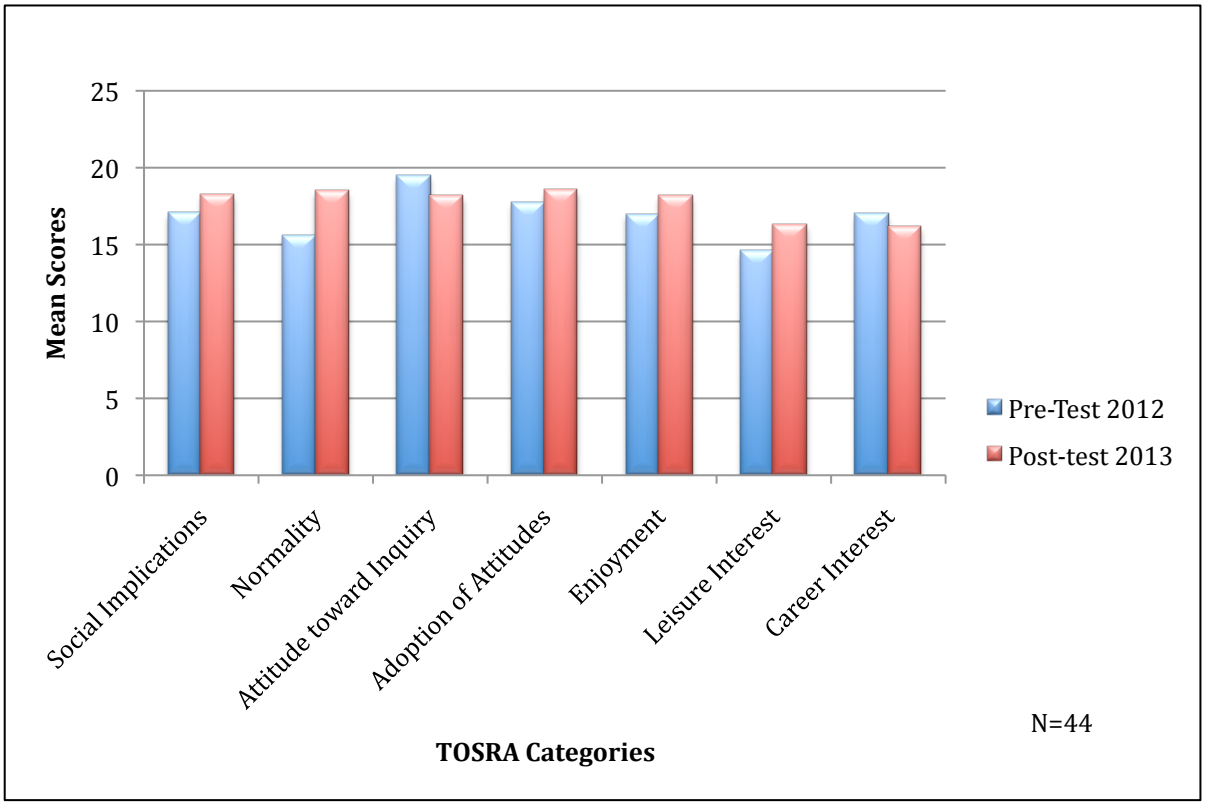


Figure 16. Mean scores for the spring 2012 pre-test and summer 2013 post-test.

Results of the matched pair analyses suggest that YES Teens changed their attitudes significantly in four categories and overall scores from the first pre-test given in March 2012 to the post-test given 16 months later in July 2013. Attitudes changed in the "positive" direction in the categories of Social Implications of Science, Normality of Scientists, Enjoyment of Science Lessons, and Leisure Interest in Science. YES Teens also indicated a slight positive change in an Adoption of Scientific Attitudes. Attitudes changed in a "negative" direction in the Attitude toward Scientific Inquiry and Career Interests in Science categories. The terms positive and negative refer to whether or not the change occurred in the direction anticipated by the goals of the YES Program and by the prevailing views of what scientifically literate citizens should believe about science and scientists. For example, one view dominant among scientists when the TOSRA was developed was that it is better to find answers through your own experimentation rather than through collaboration.

Analyses took into account a number of factors that could affect attitudes: gender, ethnicity, age/maturity, and time in the YES Program. The ethnic diversity of the matched pairs was similar to that of the YES Program, and did not have enough variation to draw conclusions about differences in attitudes based on ethnicity. No significant differences in attitude were found by gender on gain scores, though males tended to rate items lower in general than females and females rated Attitude Toward Inquiry significantly higher than males on the post-test. A significant difference was found between length of time in the program and Attitude toward Inquiry suggesting the longer a teen was in the YES Program, the less likely she or he was to view experimentation and inquiry as a way to gain understanding of the natural world. No significant differences were found based on age as an indication of maturity, though the 9th grader rated categories lower on the post-test and the two high school graduates rated all except two categories higher on the post-test than on the pre-test.

Findings from each subscale provide more detail and can be found in Appendix D.

CAREER CHOICES

In conjunction with the TOSRA2 subscale on career interests, teens were asked about career choices in surveys given each year. It should be noted that middle and high school youth vary in their approaches to career choices. Some know their career choice from an early age, and programs like the YES Program support that choice. Some don't know what career they want to pursue and may not decide until college or later. A few may have interests and find that OST

programs give them the information and career exposure they need to decide or narrow their options.

The surveys asked the YES Teens to list up to five careers they were interested in pursuing. Responses varied widely. Data included attendance, years in the YES Program, grade in school, and gender. We looked for trends in responses. Did responses get more specific over time? Did teens list fewer choices over time, indicating that they had narrowed their choices? Did teens list more STEM choices over time? No significant differences were found for any of these by any of the variables analyzed (using a χ^2).

Including all responses by teens to the surveys (N=294), Figure 17 provides the number of teens who listed at least one STEM, Science, Technology, Math, Engineering, and Education related career (columns). Male and female responses are indicated separately. Thus, out of 294 responses, 244 (83%) listed at least one STEM career (135 females and 109 males). Most of those were science related careers. Since the YES Program engages teens in teaching STEM activities to younger children, career interest in education fields was included in the analysis, resulting in 55 teens (39 female and 16 male) listing a choice in teaching or early childhood careers.

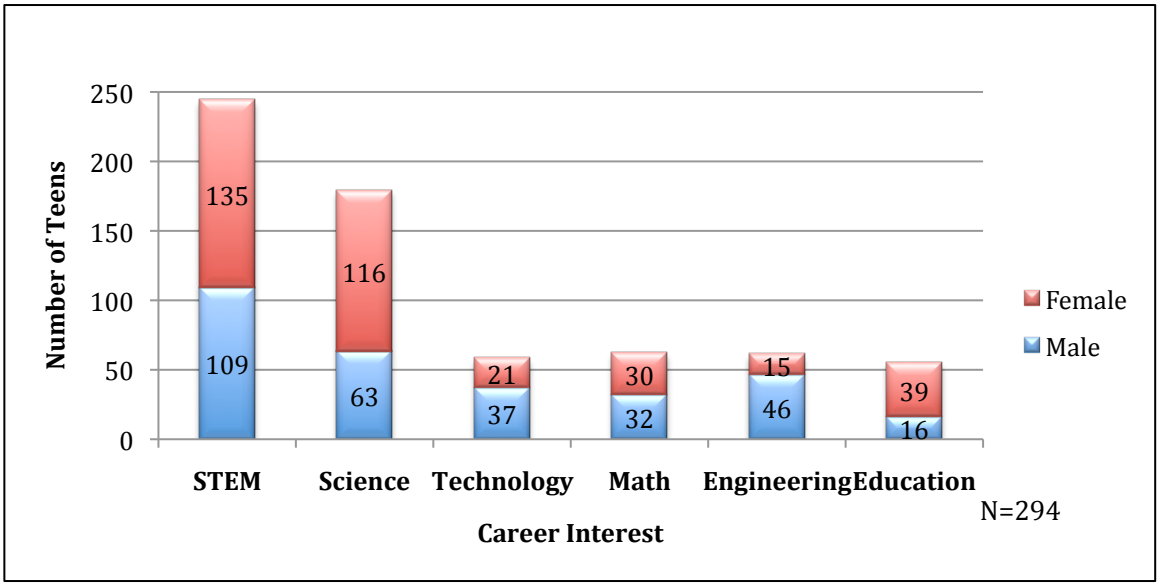


Figure 17. Career Interests by Category and Gender

To take a closer look at gender differences, Figure 18 indicates the percent male and female for each career category.

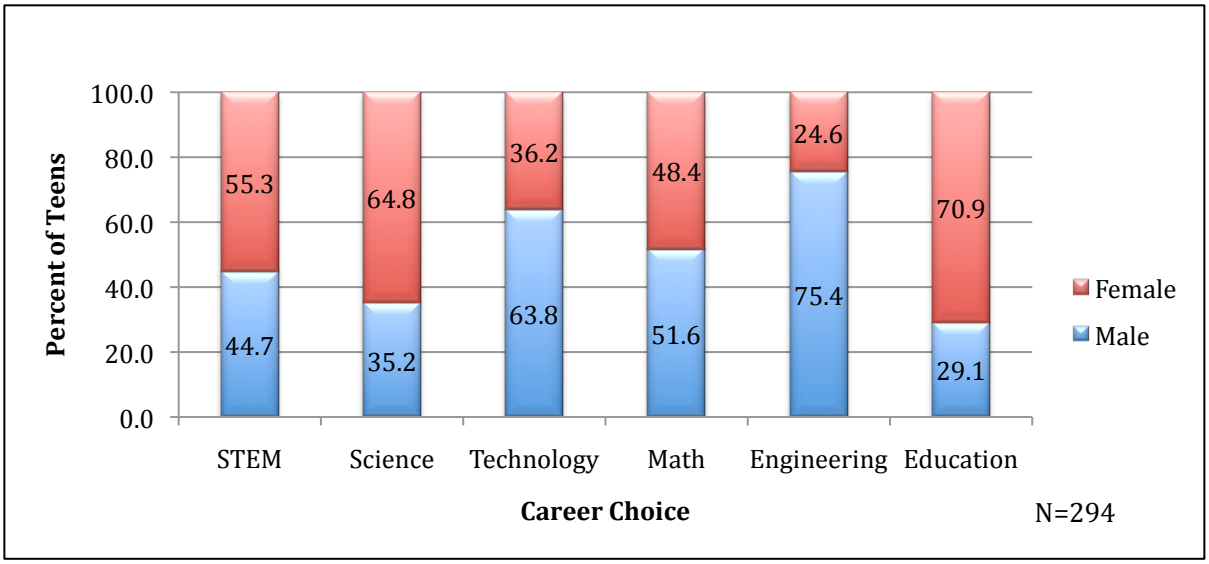


Figure 18. Career Choice by Percent Male and Female

On the Career Interest subscale of the TOSRA2 instrument, teens' scores differed by gender, though the difference was not significant. It is interesting to note that scores decreased for both male and female teens from pre-test to post-test, with a larger decrease among males (Table 19).

Table 19. Career Interest Scores on TOSRA2 by Gender for Matched Pairs

	Pre-Test 2012	Post-Test 2013	Gain
Male	17.29	16.00	-1.29
Female	16.65	16.35	-0.30

In addition to the surveys and TOSRA, teens participated in focus groups and interactive interviews. Career choices were a topic, though not all teens had decided on a career. Results indicated that very few teens changed their career interests due to their participation in the YES Program.

From the surveys, TOSRA2, focus groups, and interviews, we found that while anecdotal evidence exists and stories are available, the vast majority of YES Teens either enter the program with interests in mind and retain those interests, or enter the program with no clear career path in mind and leave with remaining uncertainty. The YES Program does expose teens to careers that they had not previously considered, and it is not clear how many teens are influenced by that exposure. Further studies of former program participants would be needed to determine that impact.

DISCUSSION OF GOALS AND OBJECTIVES

The Findings Section provided evidence to address the first evaluation question: 1) How does participation in the *Community STEM Outreach Program* impact its participants? This Discussion Section addresses the remaining two questions: 2) Does/how does the *Community STEM Outreach Program* meet its goals and objectives? and 3) How does the addition of 50 or more teens per year affect the program's ability to meet its goals?

HOW DOES THE COMMUNITY STEM OUTREACH PROGRAM MEET ITS GOALS AND OBJECTIVES?

We begin this section by matching the objectives (letters) to the goals (numbered). Each goal is then addressed separately.

Project Goals & Objectives

1. Expand the YES Program to reach more youth, increase diversity of the youth, and strengthen STEM content focus
   a. Increase the number of teens participating in the SLSC YES Program by 50
   b. Increase the staff size beginning to support the increase in YES teens, community outreach, and other expansion efforts
   c. Increase the number of community partnering organizations to include organizations in St. Louis County with outreach to more diverse youth
2. Expand the SLSC outreach to schools, particularly high school science teachers and school counselors, to reach more students and teachers and to develop new models of outreach
   a. Reach new school audiences with existing and new SLSC programming, focusing on school counselors and high school science teachers
3. Create a new model for partnership with the US Navy to include veterans as well as active duty and reserve personnel in STEM education outreach programming
   a. Develop new opportunities for partnership between SLSC staff and Navy personnel to support the YES Program and other SLSC outreach activities

Project Goals & Objectives

4. Create and formalize a model for outreach to and inclusion of members of the science community in STEM education programming
    a. Develop and formalize opportunities for involvement of practicing and retired scientists in the community
5. Improve reflective practice of all educators at SLSC to create a cadre of leaders for national outreach to other science centers
    a. Strengthen the reflective practice of YES staff and SLSC educators through additional training and ongoing support
    b. Train and support a cadre of STEM education leaders who can train others in effective strategies to build programs that are community relevant, youth development focused, and strong in STEM content
    c. Create electronic, multimedia documentation of all *Community STEM Outreach* activities and staff reflections for support of expansion efforts
6. Formalize processes and collect metrics to measure YES Program short-term and long-term success
    a. Conduct evaluation to support and provide evidence of the success of the program and to identify challenges
7. Codify a system for community STEM outreach beyond YES
8. Conduct research and evaluation to provide evidence of the success of the program and to identify challenges
    a. Identify research questions related to the *Community STEM Outreach,* and create strategies for moving forward with that research, including seeking additional funding for such research
9. Create a strategic plan, resources and model for national expansion of the SLSC *Community STEM Outreach Program* and begin implementation
    a. Create a strategic plan for national expansion of the SLSC *Community STEM Outreach Program*
    b. Identify resources, including national partners, for national outreach

Goal 1. Expand the YES Program to reach more youth, increase diversity of the youth, and strengthen STEM content focus

Goal 1 addresses three aspects of the YES Program – number of youth served, diversity of youth, and content covered. The matching objectives include an increase of staff to support these three aspects.

As seen in Figure 6 on page 19, the cohort of New Teens beginning in 2011 (after ONR funding began) was 123, a full 68 more teens than joined YES in 2010. Fifty of those were covered by ONR funding. The number dropped to 66 in 2012, and dropped to below previous levels with 51 in 2013. Thus, the Community STEM Outreach Program met its first objective of increasing the number of participating teens by 50 for the first year, but was unable to sustain the increase.

The diversity of the youth increased with the cohort of 2011 and ONR funding. Immediately prior to that, program staff's records indicate all YES Teens with known ethnicity were African American. A few had no ethnicity indicated. The data in Table 3 and Figure 4 on page 17 show evidence of increased diversity. Using the same definitions of ethnicity, Table 20 compares data collected on participants by cohort.

Table 20. Percent ethnicity of YES Teens by cohort

Ethnicity	2010	2011	2012	2013
Black or African American	94.5	73.2	80.3	90.2
White/Caucasian	0.0	4.1	3.0	5.9
Asian	0.0	4.9	3.0	0.0
Hispanic	0.0	0.0	0.0	2.0
Multiple Races	0.0	2.4	0.0	2.0
Data not available	5.5	15.4	13.6	0.0

It should be noted that these data are by cohort, so at any point in time there may be more or less diversity as teens choose to participate or not. The trends over time in Table 20 reflect the new partnership created with the International Studies Program at St. Louis Public Schools to bring in recent immigrants of Asian decent. It is unclear why these numbers declined in 2012 and returned to zero in 2013. Most of the teens that entered in 2011 and 2012 remained active in the program in 2013.

To support the increased number of youth in spring 2011 and the diversification of the participants, SLSC hired a project manager and added three full-time and three part-time educators in February 2011. As the educators began, they were sometimes treated differently and separated from the larger

group of long-time YES educators. In their first semester, these new staff members were assigned the New Teen group to develop curriculum and facilitate the Learning Labs. One of these new educators left during spring 2011 and another left in summer 2011; neither position was replaced. Sixteen part-time educators were hired for the summer to support YES teens working with younger children from community organizations, and to help document the YES program model.

The project manager position was added to oversee all aspects of the Community STEM Outreach project, including the community outreach and national expansion. Based on observations of meetings and Learning Labs, the manager focused on supervising new staff.

In spring 2012, the institution underwent financial restructuring which included the laying off of staff throughout the SLSC. Some YES educators and managers left the program through layoffs. A few resigned which, according to interviews with staff, was due to perceived lack of job security. Table 21 provides the staffing levels over time given in average Full-time Equivalent (FTE) by year. For the first year of the project, the YES Program increased number of staff to support the increased number of youth. This was not sustained in the following years.

Table 21. Total FTE over time

	Spring 2011	Spring 2012	Spring 2013
Educators	11.95	12.50	9.40
Managers	4.35	3.23	2.11
Support staff	2.74	0.24	1.01
Vice President	0.95	1.00	0.41
Total	19.99	16.97	12.93

Overall there were fewer administrators and support staff in the YES Program after restructuring, yet all the management functions remained (curriculum development, staff professional development and support, data management, grants management, and administrative roles within the larger SLSC organization). Many administrative responsibilities were distributed, primarily among the senior educators, who had also picked up more responsibility with increased numbers of YES Teens. At the same time, administrators picked up the responsibility of leading the New Teen Learning Labs and some of the tasks previously assigned to support staff.

As the new educators were hired in spring 2011 with funding from ONR, YES leadership made a conscious effort to hire staff with strong STEM backgrounds to strengthen the STEM focus of the program. These staff members came with undergraduate and sometimes advanced degrees in various STEM fields. By having educators with strong youth development experience work with educators with solid STEM content knowledge, the program strengthened its STEM focus.

To support the development of math skills among YES Teens, who were often tracked into lower level math courses instead of college prep courses, SLSC leadership suggested YES Teens work through Khan Academy lessons. These lessons are individual math lessons in which students can work at their own pace. This idea was implemented without a strong educational plan in place to support it, and without adequate staff preparation. It was difficult to determine impact of this aspect of the program. Some educators continued to have YES Teens in their component work through Khan Academy lessons into 2013.

Goal 2. Expand the SLSC outreach to schools, particularly high school science teachers and school counselors, to reach more students and teachers and to develop new models of outreach

The SLSC continued to offer educational programs to schools throughout the ONR grant period. YES Program educators offered Family Math programs and other STEM long-term and short-term programs to area students and their families. Educators offered occasional professional development to teachers in some area school districts. At the same time, staff from the SLSC School Programs Department offered short-term programs to schools.

In early discussions to plan the Community STEM Outreach project, stakeholders expressed interest in bringing the YES and School Programs departments of SLSC together to reach more high school students and their teachers and school counselors. Part of this outreach was to provide school staff with access to STEM educational resources, including opportunities offered by the Navy. Movement toward this goal was sporadic, with occasional conversations and plans that fell short of the goal of “new models of outreach.”

Work toward this goal appeared to have been affected by staff layoffs in both the Community Science Outreach and School Programs departments, as well as, institutional reorganization and reassessment during the project timeframe.

Goal 3. Create a new model for partnership with the US Navy to include veterans as well as active duty and reserve personnel in STEM education outreach programming

Personnel from the US Navy and other branches of the military spoke with YES Teens on several occasions as guest speakers. While some volunteers that worked directly with the teens on a more sustained basis did have prior military experience, there was no active program to recruit, train, or support active, reserve or retired Navy personnel as volunteers in the YES Program.

In addition to adult volunteers, Navy involvement included two youth from the Navy’s Sea Cadet program as YES Teens. Additional YES Teens were students from Cleveland NJROTC High School, the St. Louis Public Schools’ Naval Junior ROTC school.

Goal 4. Create and formalize a model for outreach to and inclusion of members of the science community in STEM education programming

Members of the science community were involved in the YES Program in a number of ways. University students (undergraduate and graduate) volunteered in Learning Labs, particularly in the Neuroscience component. Parents, who were current or retired scientists, volunteered in Learning Labs, such as three mothers of YES Teens who assisted with the Biofuels and Energy component during the 2011-2012 school year. Volunteers from local organizations, like the Webster Groves Nature Study Society, helped with YES Teen projects, like identifying butterflies in the C3 component. Working professionals from area businesses spoke as special guests, such as an intellectual property attorney who spoke with teens about types of income, and received rave reviews from teens. Professionals from AT&T mentored and provided technical guidance to the Robotics component. Another example was a professional from Hosco Farms who began helping with occasional Learning Labs, then led a summer component, and began working with YES leadership on rethinking the curriculum to focus on issues around food, as he and groups of teens designed and built aquaponic, hydroponic, and aeroponic systems at the Taylor Community Science Resource Center (home to the YES Program).

In August 2012, a plan was in place to establish a formal program for recruiting scientists. When the Senior Educator in charge of that plan left the SLSC for another job, the plan was not implemented. Instead, during the evaluation period, educators of STEM components continued their practice of inviting scientists they knew through established networks and structures.

Thus, while scientists were involved in the YES Program, no new formalized model was implemented to recruit, train, or support volunteers from the science community.

Goal 5. Improve reflective practice of all educators at SLSC to create a cadre of leaders for national outreach to other science centers

The three objectives associated with Goal 5 cover different aspects of reflective practice, leadership, and expansion.

Objective A: Strengthen the reflective practice of YES staff and SLSC educators through additional training and ongoing support. Professional development (PD) of YES educators took several forms. Experts were brought in to provide training in some cases, such as Science Museum of Minnesota President Eric Jolly covering the community standard, of which summer interns spoke very highly. Additionally, staff from the Program in Education, Afterschool and Resiliency (PEAR) provided training on the Dimensions of Success (DoS) program observation tool. At times, educators were sent to workshops and PD elsewhere, such as staff going to NPASS (National Partnerships for Afterschool Science) training. A third form of PD occurred when educators led PD for each other, such as workshops led by the educator who attended the NPASS training and a book discussion group on John Dewey's work led by another educator.

Objective B: Train and support a cadre of STEM education leaders who can train others in effective strategies to build programs that are community relevant, youth development focused, and strong in STEM content. The reflective practice and PD described in relation to Objective A focused on inquiry and project based learning. As described in formative evaluation reports for the Community STEM Outreach project, training people to lead STEM activities is very different than training the trainers. For example, educators received PD to support them in facilitating inquiry-based STEM lessons with YES Teens. However, PD did not cover how to train YES Teens to lead activities for children.

Through modeling by Diane Miller and Colin Wilson, YES Educator and a Master Trainer (using NPASS) through the Missouri Afterschool Network, YES Educators did learn to train Community Partners to lead STEM activities with their own youth in their community programs.

Objective B was originally intended to develop YES Educators as leaders to train and support educators from other science centers and museums, so that other educators could build additional youth STEM education programs that were relevant to their own local situations and youth. This part of the objective was not implemented during the evaluation period.

Objective C: Create electronic, multimedia documentation of all Community STEM Outreach activities and staff reflections for support of expansion efforts. This objective builds on the previous objective and the intent to expand the Community STEM Outreach project's reach to other science center educators. In the summer of 2011, a large team of part-time staff was hired as "documenters" to record photos and videos of the program, and to make observations. While large numbers of photos and hours of video were recorded, the pulling together of the data into a cohesive whole became a challenge for YES leaders. In December 2011, the leadership contracted with Klein Consulting to create the documentation, now called the *Circles of Support* web-based multimedia tool (described on page 15 of this report).

Goal 6. Formalize processes and collect metrics to measure YES Program short-term and long-term success

Activities to accomplish this goal are covered throughout this summative report. The intent of this goal was to establish processes and to collect baseline data in preparation for national expansion efforts. The pilot of the alumni online survey was one example. In this case, the Klein Consulting evaluation team

piloted the survey and made recommendations for future alumni surveys and events.

Challenges arose when different staff members over time were assigned to collect and maintain program data, such as teen demographic data. Often these tasks were assigned to educators who, according to interviews and focus groups, placed curriculum planning and working with the teens as a higher priority than data collection and maintenance, suggesting the need for support staff to fill this role. The challenges faced in the calculations provided in this summative evaluation document highlight the need for the YES Program staff to establish and follow a more rigorous system of data collection if high school graduation rates and similar data will be needed in the future. A follow-up strategy to maintain current addresses and email addresses for alumni is needed. For example, some projects send birthday cards though the mail each year and those that are returned are targeted for email contact and address update. Recommended steps for future data collection and maintenance include:

- Maintenance of current high school data for all YES Teens (some data were missing from the current database and some actual schools differed from current records)
- Frequent contact with all YES seniors throughout their senior year to be sure they are on track for graduation (and their plans are known to staff)
- Maintenance of contact information and records for YES Teens who drop out of YES before or during their senior year (to allow for further comparison)

Keeping accurate records and high school graduation data for all YES Teens (including those who leave the program) would allow staff to better and more accurately address questions from funding agencies and donors regarding program success.

Goal 7. Codify a system for community STEM outreach beyond YES

To codify generally refers to creating or arranging a system, in this case a system to take the YES Program model to new youth programs or youth programs that want to learn from the YES Program model. The *Circles of Support* multimedia tool design was created by Carey Tisdal of Tisdal Consulting in collaboration with Klein Consulting to support this goal. While it was beyond the scope of work by Tisdal and Klein to codify a system, a plan was recommended and provided to YES leaders.

Goal 8. Conduct research and evaluation to provide evidence of the success of the program and to identify challenges

Again, evaluation activities to accomplish this goal are covered throughout this summative report. In addition to the evaluation, the specific, related objective states: *Identify research questions related to the Community STEM Outreach Program, and create strategies for moving forward with that research, including seeking additional funding for such research*. Klein Consulting provided the SLSC Leadership with a separate document outlining research questions that

emerged from the evaluation, and recommendations for moving that research forward. During the project, SLSC submitted two grant proposals to the National Science Foundation for related research, though neither was funded.

Goal 9. Create a strategic plan, resources, and model for national expansion of the SLSC *Community STEM Outreach Program* and begin implementation

The first step in this plan was to bring together representatives from science centers and museums across the country. After the April 2013 meeting, the lack of follow-up discussion from conference attendees and guidance from ONR regarding limited funding opportunities led the SLSC administration to conclude that an appropriate role for the institution would be to create the design for a tool for national dissemination (the *Circles of Support* website). A proposed dissemination plan, using the *Circles of Support* tool as a foundation, was developed as part of the contract with Klein Consulting. This plan was provided to SLSC Leaders with the summative evaluation report and the research document described above.

Summary of Goals and Objectives Met

Of the nine goals and 14 objectives, results indicate that the YES Program:

1. Increased the number and diversity of YES Teens (Goal 1, Objectives 1 and 2), although increases were not sustained in following years.
2. Increased the number of Community Partners (Goal 1, Objective 3)
3. Strengthened the STEM Content (Goal 1)
4. Strengthen the reflective practice of YES staff (Goal 5, Objective 8)
5. Supported the design for an electronic, multimedia documentation of the YES Program, the *Circles of Support* web-based multimedia tool (Goal 5, Objective 10)
6. Contracted and supported the evaluation to identify challenges and provide evidence of success of the project (Goal 6, Objective 11)
7. Identified research questions related to the project, sought additional funding (though unsuccessfully), and received recommended strategies to move forward with that research (Goal 8, Objective 12)
8. Identified a plan for national expansion beyond YES (Goal 9)

How does the addition of 50 or more teens per year affect the program's ability to meet its goals?

The addition of teens revealed issues of scale related to the need for more formal structures in professional development, curriculum development, data management, youth participation support, and a changed role for managers. These issues were identified in the Second Annual Evaluation Report. The

evaluation team, Klein and Tisdal, met with YES staff in December 2012 and January 2013 to discuss the issues.

Increased numbers of teens required an increased number of full-time and part-time staff members. Observations of Learning Labs indicated that new and summer staff were not always clear about some of the program learning strategies including the Learn to Teach - Teach to Learn strategy and the relationship between teaching topics and inquiry projects developed by the teens. For example, some of the part-time summer staff in 2011, hired to document the program, struggled to understand and document the learning strategies. Some of the newer summer staff in 2012 struggled to understand the philosophy of a work-based program and the importance of meeting the teens' development needs. Observations, and results of staff focus groups, indicated a lack of understanding of some YES Program learning strategies by both managers and part-time staff members.

These issues appeared to be related to scale; with a smaller staff, program design and strategies could be shared through informal communications. Larger numbers of teens, requiring larger number of staff members and increased time by staff to focus on those teens' needs, required the adoption of more formal Professional Development. The addition of a group of new educators at one time with the project start, rather than one or two new educators replacing educators who left the program through retirement and resignation, created an even stronger need for formalized Professional Development. The *Circles of Support* program documentation element and website could fill this need in the future.

Increased numbers of teens required changes to curriculum for the New Teen Learning Labs, College Prep, and STEM components to accommodate the larger numbers of participants. This revealed the need for changes in curriculum development, specifically an overall curriculum to align with YES goals and program framework, support for educators in the development of component and

College Prep curriculum, and someone to ensure quality and consistency of implementation. While such roles would normally be assigned to a single manager, after staff turnover this was assigned to various managers and Senior Educators resulting in inconsistent implementation, curriculum quality, and staff support.

As numbers of teens increased, so did the need to track data such as attendance records, payroll records, demographic data, and contact information. When the Community STEM Outreach Program began, one manager, one Senior Educator, and one support staff member filled these roles; however, with staff reductions these roles were filled by a variety of staff with resulting gaps in data.

In the earlier years of the YES Program, the educators called teens within a few days if they did not report for work or call to explain their absence. With the increase in number of teens and since some educators did not understand the importance of this strategy, educators dropped this practice, perhaps due to the increase in other priorities. As a result, follow-up with teens that missed Learning Labs or dropped out of the program was inconsistent.

Based on observations of staff meetings and interviews with managers and educators, it appeared that the addition of 50 or more teens also required managers to spend more time on program logistics; that is, handling the Human Resource interface, scheduling staff and teens, and reporting staff and teen hours for payment. Unfortunately, the number of program managers was cut at the point when additional management time was needed to support larger numbers of teens by providing increased staff professional development, curriculum development, and data management. While managers still dropped in and out of classrooms after the staff reductions, managers' focus shifted toward management and logistical issues rather than observing educator and teen interaction and providing feedback and support for teaching and learning issues.

In summary, the addition of teens highlighted the need for more formalized management structures and practices, increased manager time in scheduling and logistics, formal professional develop for consistent implementation, additional curriculum development, consistent data management, and renewed support for youth participation.

SUMMARY AND CONCLUSIONS

The evaluation of the Community STEM Outreach Program was designed to address three questions:

1. How does participation in the *Community STEM Outreach Program* impact its participants?
2. Does/how does the *Community STEM Outreach Program* meet its goals and objectives?
3. How does the addition of 50 or more teens per year affect the program's ability to meet its goals?

The Short-term Impacts of the program included high school graduation rates and post-secondary plans. We found that YES Teens who remain in the program until their senior year in high school graduate at a higher rate than their peers in the same area schools, with 96.36% of YES Teens that could be contacted graduating in 2012 and 100% in 2013. From the graduating class of 2012, 55% of YES Teens planned to attend a four-year college or university, and in 2013 the percent was 46. Two issues were identified in arriving at high school graduation and post-secondary plans data. The YES Program does not track teens that drop out of the program, and staff members do not maintain accurate contact information to contact teens after graduation. In 2012, 12% of high school seniors were not reached and in 2013 the number grew to 23%, perhaps accounting for the perceived decrease in percent of teens attending a four-year institution after high school graduation.

The evaluation team explored the impact of the program on attitudes toward science and scientists using a modified version of the Test of Science-Related Attitudes (TOSRA2). Results indicated that after 16 months of participation in YES, teens were more likely to 1) recognize the benefits and drawbacks of scientific advances to society, 2) see scientists as real people rather than media-produced stereotypes, 3) indicate enjoyment of their lessons in school science classes, and 4) be interested in science out of school and outside of the YES Program, and were slightly more likely 5) to have adopted the attitudes of scientists. After 16 months, YES Teens were less likely to view experimentation and inquiry as a way to gain understanding of the natural world, and were slightly less interested in pursuing a science related career.

The Long-Term Impacts of the YES Program were more difficult to assess. An online survey of former YES Teens received only 22 valid responses by the deadline. Results from the small sample showed great promise for future studies. Twenty of the 22 respondents graduated from high school and two earned a GED. After high school, 18 of the respondents (82%) attended a trade school, college or university. Five of those had graduated from college, with two in graduate school at the time of the pilot survey. Eleven were still in trade school (1 participant) and college (10 participants).

When asked what influenced their choice of career, family and school experiences were most prominent with YES experiences a close third. Respondents reported that the YES Program was “helpful” (an average of 3.80 on a 5-point scale) in preparing them for post-secondary education. When asked how well the program prepared them for the workforce, the resulting average was 4.53 on the same 5-point scale, indicating that the YES Program was “very helpful” in workforce preparation. When asked how influential the YES Program was on college and career choices, the average was 3.88, “helpful”. Results indicate that networking, teambuilding, and teaching younger children were the aspects of the program that influenced respondents the most. When asked about the influence of the YES Program on their attitudes, results showed that the greatest influences were on attitudes toward adults, learning, young children, workplace policies and procedures, and teachers.

The program met many of the project's goals and objectives. Personnel and budget changes at SLSC created challenges for meeting others. Some goals were met prior to those changes, but were not sustained.

Goal 1: The YES Program expanded to reach more youth, increase diversity of the youth, and strengthen STEM content focus, although the incoming number of youth and the diversity of youth began to return to pre-grant levels by the end of the grant period.

Goal 2: Expansion of outreach to schools focused on diversifying the YES Teens. Outreach to high school science teachers and school counselors to provide resources received minimal focus, perhaps due to the institutional changes.

Goal 3: Navy personnel were involved in the program, although a new model for partnership to include veterans as well as active duty and reserve personnel in STEM education outreach programming did not materialize to the extent that it could be replicated.

Goal 4: Members of the science community were involved in the YES Program in many ways, although a new, formalized model for outreach to and inclusion of members of the science community did not materialize to the extent that it could be replicated. Individual staff members within YES were very successful at involving scientists in STEM components, and YES staff engaged scientists in many activities involving the YES Teens.

Goal 5: The YES Program strengthened the reflective practice of YES staff and SLSC educators through additional training and ongoing support. The second objective to "train and support a cadre of STEM education leaders who can train others in effective strategies to build programs that are community relevant, youth development focused, and strong in STEM content" was originally intended to move YES Educators into a position to train and support educators from other science centers and museums, so that those educators could build additional youth STEM education programs that were relevant to their own situations and youth. With the restructuring of the SLSC, this part of the objective did not materialize. Klein Consulting prepared the *Circles of Support* multimedia tool to achieve the third objective, "Create electronic, multimedia documentation of all Community STEM Outreach activities and staff reflections for support of expansion efforts."

Goal 6: While some processes to measure YES Program short-term and long-term success were put into place, a formalized process for ongoing data collection and management was not accomplished.

Goal 7: The goal of codifying a system for community STEM outreach beyond YES was established to take the YES Program model to other youth programs. Toward that end, Carey Tisdal, with support from Christine Klein, designed the *Circles of Support* multimedia tool and recommended a plan for outreach.

Goal 8: The summative evaluation provides evidence of the success of the program and identifies challenges. Klein Consulting provided recommendations for future research.

Goal 9: The SLSC convened a meeting of representatives from nine science centers and museums across the country, though no strategic plan for national expansion emerged. Through a contract with SLSC, Klein Consulting proposed a dissemination plan with the *Circles of Support* tool as a foundation.

The addition of more than 50 YES Teens presented challenges that were further impacted by institutional changes. Roles of managers changed, and there were increased needs for formal structures in professional developed, curriculum development, data management, and youth participation support.

CONCLUSION

The *Deliberate Design* of the YES Program lays a strong foundation for youth development. Many positive impacts were found: higher than average high school graduate rates, large numbers of teens planning to continue their education beyond high school graduation, and alumni/alumnae who stated that the YES Program was helpful in preparing them for post-secondary education and very helpful in preparing them for the workforce. Participants improved their attitudes toward science and scientists.

At the same time, the program was challenged by personnel turnover, sometimes resulting in inconsistent application of the *Deliberate Design* of the program. Thus, we learned through the evaluation that consistent systems of professional development and sufficient managerial staffing are needed to maintain the *Deliberate Design*. In addition, we learned the vulnerability of program functions with the loss of institutional memory due to staff turnover.

The YES Program, though challenged at times by a number of factors described in the summative evaluation, offers a model for other youth STEM programs. As with all programs, ongoing, sustainable funding for the program requires telling the YES story to stakeholders. Through the evaluation, we found that the development and maintenance of program records, which is key to this sustainability, needs to be a focus as the program moves forward.

This summative report provides part of the YES story at a moment of change and challenge. As the program continues to grow and change, this evaluation team recommends that the *Deliberate Design* of the program remains a solid foundation. This means that clear rationale, based on research and best practices, needs to be developed for any changes with an eye toward how these changes may affect impacts documented in this evaluation.

Feedback on this report and questions about the evaluation can be sent to Christine (Kit) Klein, evaluation consultant, at ckleinconsutling@gmail.com.

REFERENCES

Beaumont, L. J. (2006) Summative Evaluation of Designing Youth: Teens Engaging Children in Design Engineering for the St. Louis Science Center. Unpublished evaluation report.

Campbell, P. B., Perlman, L. & E. Hadley (2002) Design IT! Building Design Challenges in After School Program Final Evaluation Report. Unpublished evaluation report.

Guba, E. G. & Lincoln, Y. S. (1989). *Fourth Generation Evaluation*. Thousand Oaks, CA: Sage Publications.

Fraser, B. J. (1981). *Test of science related attitudes*. Melbourne: Australian Council for Educational Research.

Friedman, A. (Ed.). (2008). *Framework for Evaluating Impacts of Informal Science Education*. Washington DC: National Science Foundation. (Available at: informalscience.org/images/research/Eval_Framework)

Klein, C. (2007) Learning Places Evaluation – Observations of Children at Torre: An Interim Report. Unpublished evaluation report.

Klein, C. (2010) Teenage Designers of Learning Places for Children: Creating After-School Environments for STEM Education - Summative Evaluation. Unpublished evaluation report. Downloaded October 1, 2013 from http://informalscience.org/images/evaluation/LP_Summative_Report-Final.pdf

Klein, C. & Tisdal, C. (2013) Community STEM Outreach: Proposed Research Agenda. Unpublished report. Available at www.yescirclesofsupport.com

Ledbetter, C. E., & Nix, R. (2002). *Instrument for external evaluation for National Science Foundation, Project SCORE*. Washington DC: National Science Foundation.

Lee, S. (2005) Science Firsthand – Partners in Discovery Year One Evaluation Report. Unpublished evaluation report.

Lee, S. & J. Leblang (2006) Science Firsthand – Partners in Discovery Year Two Evaluation Report. Unpublished evaluation report.

Lee, S. & J. Leblang (2007) Science Firsthand – Partners in Discovery Year 3 Evaluation Report. Unpublished evaluation report.

Lee, S. & J. Leblang (2008) Science Firsthand – Partners in Discovery Year 4 Evaluation Report. Unpublished evaluation report.

Lee, S. & J. Leblang (2009) Science Firsthand – Partners in Discovery Year 5 Evaluation Report. Unpublished evaluation report.

Lee, S., Leblang, J. & T. Wallach (2011) Science Firsthand – Partners in Discovery Year 6 Evaluation Report. Unpublished evaluation report.

Lincoln, Y. S. & Guba, E. G. (1985). *Naturalistic inquiry*. Beverly Hills, CA: Sage Publications.

Mountz, D.K. (2006). The effect of a science core sequence reform on students' attitudes toward science. Unpublished dissertation, Immaculata University.

Polman, J. L. (2000). *Designing project-based science: Connecting learners through guided inquiry*. New York: Teachers College Press.

Polman, J. L. (2004). Dialogic activity structures for project-based learning environments. *Cognition and Instruction, 22* (4), 431-466.

Polman , J. L. (2007) YES-2-Tech: Youth Exploring Science to Technology Year 3 Evaluation Report. Unpublished evaluation report.

Saint Louis Science Center (2010) Community STEM Outreach Program: A Local Model for National Impact. A proposal to the US Navy, Office of Naval Research.

Sneider, C. & M. Burke (2011) The Legacy of YouthALIVE! Transformative Youth Programs Continue to Thrive in Science Centers. Downloaded October 1, 2013 from http://informalscience.org/research/ic-000-000-003-083/The_Legacy_of_YouthAlive_Transformative_Youth_Programs_Continue_to_Thrive_in_Science_Centers

Weiss, C.H. (1998) *Evaluation: Methods for Studying Programs and Polices*. Englewood Cliffs, NJ: Prentice Hall.

W.K. Kellogg Foundation (2004) Logic Model Development Guide. Retreived October 7, 2013 from http://www.wkkf.org/knowledge-center/resources/2006/02/wk-kellogg-foundation-logic-model-development-guide.aspx

APPENDIX A – VIGNETTES FROM SECOND ANNUAL EVALUATION REPORT

The vignettes here are taken from the Community STEM Outreach Second Annual Evaluation Report. These are included in this summative report to provide a more complete picture of the program.

What happens in a typical component during the school year?

The following story comes from one morning component group on a cool, sunny Saturday in October 2011. George[1], with a social work background, and Doug, with a background in engineering, lead the teens through a series of activities.

School Year Component Experience Vignette

The YES teens slowly arrive in their red YES t-shirts and gather in the lobby of the TCSRC. Most struggle to look professional, though others prefer to dress and act more casual. Many take advantage of the cereal, milk, and fruit the staff laid out for them in the kitchen. At 8:30, nine members of the astronomy group sign an attendance sheet as they enter their classroom. They grab their journals from a milk crate and take a seat at a table. George and Doug greet them individually as they enter. George reviews the Word of the Day – apogee, and then discusses the Fact of the Day regarding Newton and the reflector telescope. A brainteaser follows with "H, I, J, K, L, M, N, O" written on the board.

Once everyone catches on, "H to O, oh I get it!", the group covers a few announcements and begins writing in their journals as George turns on the CD player. "For your journaling pleasure, we have a continuation of the Soulard Blues Band."

After they've written about experiences in their lives, their personal reflections, for about 10 minutes, George leads them through a review of previous activities on the angle of the sun. Today they will view sunspots he tells them. Once George has shown them the homemade tool they will use, the teens visit the supply table where Doug and George have laid out cardboard, foil, and tape. They work easily in pairs, chatting and teasing each other in a manner that demonstrates comfort.

By 9:00, with tools in hand, the group heads to the parking lot. The wind and chill in the air catch some off guard, and they don't hesitate to point it out. They quickly draw

[1] Pseudonyms are used for all characters even though most of the YES staff will recognize themselves and each other. Since other members of the learning community may read this report, and since we promised the Institutional Review Board (IRB), anonymity is maintained.

the sun's reflection on white paper and clipboards with the guidance of George and Doug, and then return to their classroom. George explains that they are prototyping activities they will use later with Science Center visitors, and they will collect data over time.

They shift quickly to another activity. Doug begins with a discussion about rockets – what are they, how do they work, what is inertia? He explains to the teens that this discussion is an assessment to learn what the teens know. He follows the discussion with a short article teens are asked to read from the netbook computers on each table. In their discussion, it is clear that most read the article. Equally clear are a few misconceptions held by the teens. One teen asks if people really went to the moon, and another says, "I think we need to do it again [go to the moon] so I can go and then I'd know [if they really went]."

Soon Doug reintroduces the Word of the Day as he and George tell the teens they will design, build, and launch their own rockets, and will measure the apogee. By 9:30, pairs of teens are creating rockets from colored paper, PVC tubes, and masking tape. George demonstrates how to make a nose out of the paper, but the teens design the rest of their rockets on their own. As they work, George and Doug move around the room asking questions about the science involved ("What is the point of sealing the top of the rocket?") and inquiring about their designs ("Why did you decide to use four fins?").

Once the rockets are ready to test, the teens walk across a busy intersection to Science Corner, a large lot owned by the science center and used by YES. In pairs, one teen holds their rocket while the other stomps on a two-liter plastic bottle to send their rocket soaring. George walks among the pairs asking about design features and suggesting they test other ideas. As teens compete to see which rocket will go highest and furthest, they try different ideas such as the angle of the launch.

Upon return to their classroom, George asks what design features worked and what didn't work, making lists on the board. After discussing many ideas, George tells the teens that this activity will engage multiple ages, thus bringing them back to the idea of testing these activities for use with visitors later.

Keeping the teens moving, Doug and George have the teens shift gears to focus on review of science articles with half of the group reading an article on a pee-recycling system used by NASA and half reading another regarding iPhones and the space shuttle. Each group reads and discusses their article, and then

summarizes the article for the rest of the teens. George challenges their thinking and asks questions to generate conversation around details in the articles.

At the request of one science center executive, components use the Khan Academy online to support teens in developing math skills. George has the teens individually log into the site on the netbooks provided. The attention of most of the teens appears to wander as they look around the room and at cell phones and occasionally talk with each other. They appear bored with this "school-like" activity, though George and Doug offer individual encouragement. Soon George has the group exit Khan Academy and begin to blog about the rocket activity and the articles they read.

After a 15-minute break, the teens go to their college prep groups and sign in. The freshman/sophomore groups are meeting together in the Jolly meeting room to play College Jeopardy. Projected on the screen are the categories Colleges, College Sports, $ for College, Fun Trivia, and Where Am I? A surprising number of teams know (or guess) the oldest college in the US, though one team suggests it is Harris-Stowe. Five teams know that Mizzou (the University of Missouri) "invented" homecoming.

Once the game ends, the morning group of teens leaves as the afternoon group goes to their component groups. It's been a busy day for the teens, and a long one for the staff.

WHAT HAPPENS DURING A TYPICAL DAY IN THE SUMMER?

YES teens worked in several different locations during the summer of 2012, yielding several different stories. Three stories are told here: one for the new teens working with community groups at the Taylor Community Science Resource Center (TCSRC) (the Summertime Science component), one for the teens in the main SLSC building working with community groups and visitors (the Astronomy component), and a third story for the teens developing exhibit prototypes first at Compton-Drew and then in the exhibit galleries (Exhibit Lab component).

Summertime Science

Summertime Science Vignette

By 8:45 on this June Wednesday, teens fill the lobby of the TCSRC as they wait to clock in at an electronic time clock. By 9:00, everyone is moving to their classroom to sign in and put on their official black YES aprons. Today is a big day, the first day that children from community organizations will participate in activities led by the YES teens.

In one classroom, Cheryl has 12 teens set up their activities. Each of three groups of teens has prepared an activity to share with the younger children, and the teens run through their plans before the children arrive. They begin their "rehearsal" with an introduction by a teen that hasn't had the opportunity to give

one yet. They discuss how they will separate the children into three groups to rotate through three different activities.

When Cheryl has to leave the room, the teens continue without her, preparing for the activities. The leaders for a bingo activity focusing on plants have the other teens line up and move into the hall just as they plan to do with the children. Back in the classroom, they quickly review the balloon and journal-creation activities as it approaches 10:00.

Soon the building is filled with children, including middle school students from nearby Compton-Drew and two day camps with elementary school aged children. Twenty-one of the middle school students join Cheryl's teens who divide them into three groups after explaining the rotations.

One group of seven students gathers around three tables to create balloon terrariums by filling balloons with soil, water, and seeds. The students struggle with blowing up the balloons and tying them off, but the YES teens offer help as needed. At another group of tables, seven more students work with YES teens to create a booklet about plants. In the hallway, the remaining seven. students play a game of plant bingo using terms from botany.

After moving this group of middle school students through three rotations, the community groups move to a new room and Cheryl's teens repeat their three activities with another community group. Once the children leave, the YES teens take a much needed lunch break.

After lunch, Cheryl facilitates a debriefing of the morning's activities. Much like George did during the school year story above, Cheryl leads the teens in a discussion of what worked and what didn't work before they begin to prepare for tomorrow's groups of children. Since this was their first day working with children, the teens are full of ideas for improvements to the activities and their introduction.

After they wrap up their discussion and take a short break, the teens write in their journals, saving their "Word of the Day" and "Quote of the Day" for tomorrow when they plan to have a little more time. Cheryl offers a writing prompt for their journaling, "Where would you like to go if you could go anywhere in the world and why

After putting their journals away, the teens clean the room and set it up for the next day, when they will repeat their three activities with two new groups of children.

Astronomy

Astronomy Summer Component Vignette

Inside the new Boeing Hall of the main SLSC building, 19 YES teens gather. Promptly at 9:00, George has them start writing in their journals for 10 minutes. Music is playing over the drilling from construction workers putting the finishing touches on the new exhibit hall. The teens are fortunate to have the otherwise empty hall for their summer activities, even though the large space is occasionally shared with the Exhibit Lab teens and with children in the SLSC's summer camp.

With journals remaining out, George turns off the music and spells out brainteasers for the teens to add to their journals. (They have adapted to the space and the lack of white boards.) They write "MEREPEAT" and "COTAXME", and George asks them what the words say. The teens discuss possible meanings at their tables, while three summer interns look on. George walks among the tables, encouraging a few teens that seem to have given up quickly. He finally gives them the first answer (repeat after me), and then several say they have the second (income tax). After additional brainteasers, now that they understand the concept, they stop and return their journals to the milk crate that serves as their storage.

Unlike the teens in Summertime Science who work with a different community group each day, the astronomy group sees the same children from the same community centers throughout the summer. Today the teens prepare for thirty of these younger children, which they will divide into three rotations. Teens are divided into four groups, one to lead each rotation with the younger children and one to go into the Planetarium to lead activities with visitors.

At 10:00, the teens wrap up preparations for the morning groups as George enters the large hall saying "show time!" The children from the one community organization follow him in. Half sit with YES teens at tables for "What is Life" activities, and half sit on the floor with their YES teen leaders for a "Lunar Lander" activity from NASA curriculum. A third group of YES teens wait for their group of children to arrive by van from their community center so they can lead the Life Science Lab rotation, and a fourth group of YES teens heads outside to Forest Park for outdoor inquiry activities with one of the interns.

After the community groups leave and the teens finish a lunch break, the teens leading the three morning rotations debrief and plan for the next day's activities. At the same time, about 12:15 PM, the fourth group of five teens goes to the Planetarium with an intern to lead activities with visitors. One teen helps a SLSC volunteer facilitate Mission Control activities. Another uses an iPad with a.

Mars rover simulation/game app to engage visitors in the Planetarium lobby and encourage them to see the actual rover tucked back beside the shop

The three remaining teens take over space in the hallway between Mission Control and the Planetarium lobby with demonstrations they developed themselves. One stands along the east wall with two suitcases, one as it would weigh on earth and the other demonstrating its weight on the moon. The other two teens demonstrate earth/moon/sun relationships.

"I'm the moon," says Delaney holding up a tennis ball as a family starts down the hallway. "I'm the earth," shouts Kelly. Without missing a beat, Delaney says, "We need a sun!" as she holds up a yellow balloon and looks right at the family. The little boy holds the balloon as the two YES teens demonstrate eclipses. Once finished, Delaney says, "Enjoy your visit!" As the family leaves, the mother says to the little boy, "You were the sun!" He replies, "Yes!" She then says, "You are our son."

At 12:45, the teen from Mission Control and the teen from the rover meet in the lobby to help visitors make paper airplanes and rockets. With supplies on a cart, the teens start to get organized as a large group from a YMCA summer camp walk up and ask to make paper airplanes. Darian and two YMCA counselors help the group of 10 elementary school aged children make the planes. Within a few minutes the children are flying planes across the lobby before the counselors can get them to write their names on the planes and move to a safe flying space.

Exhibit Lab

New in Summer 2012 was the Exhibit Lab component, which was designed to bring exhibit developers, production staff, and evaluators from the SLSC together with teens to design and prototype exhibits. The teens were divided into four groups, each led by three to four interns, many of whom were former YES teens. Teens began working in four classrooms at Compton-Drew Middle School, next

door to the science center's main building. Once the school had to focus on preparing the building for the school year, the Exhibit Lab teens moved in to the large exhibit hall to share space with the Astronomy component. The following story picks up as the teens actually begin to test their prototypes in the Human Adventure Gallery, and follows one group of teens led by Cheryl, Raymond, and Jim.

Exhibit Lab Component Vignette

After a morning of last minute preparations, at 1:10 PM on this typically crowded science center summer Tuesday, Andrea tells the group of YES teens to get ready to move their prototypes onto the gallery floor. Soon the four small groups move their carts into the gallery and prepare for visitors, consisting primarily of families with children and a few summer camp groups.

As visitors walk into the Human Adventure gallery, they are greeted by three teens standing in front of their prototype of a car simulator. They greet visitors and ask if they would like to try their demonstration.

One teen has a father hit his fist on the cart in a specific, yet complex pattern, and then explains the brain's response to multitasking. She concludes by pointing to the dangers of texting while driving.

A basketball exhibit prototype attracts a brother and sister who want to try for a basket.

At a music exhibit prototype, parents and children listen to music with headphones then discuss their experience with the YES teens as they explain the relationship between music, emotions, and the brain.

At a puzzle exhibit prototype, visitors walk up to try their hand at several puzzles.

Throughout the prototyping process, the teens ask for visitor feedback using surveys they created with the help of the science center's evaluation staff. Andrea, Raymond and Jim walk from exhibit to exhibit to offer support, but play a minimal role and let the teens take the lead.

APPENDIX B – EVALUATION ACTIVITIES

EVALUATION ACTIVITIES TO DATE

2010
- December – YES alumnae/alumni survey at event
- December – February 2011 – Evaluation team planning

2011
- January - November – Information interviews with stakeholders
- January - December – Observations of staff meetings
- January - December – Meetings with PI
- January - March – Observations of staff training & PD
- February - April – Observations of spring YES Program
- April – Spring YES Teen survey
- June - July – Observations of summer YES Program
- June – Summer YES Teen survey
- March - August – IRB application, meetings, and approval
- October – Observations of fall YES Program
- November – Fall YES Teen survey

2012
- January - April – Observations of spring YES Program
- January – December – Observations of staff meetings
- January - March – Information interviews with stakeholders
- January - December – Meetings with PI
- April – Spring YES Teen survey (with TOSRA2)
- April – Observations of staff PD
- May – Focus group with community partners
- June - July – Observations of summer YES program
- July – Summer YES Teen survey (with TOSRA2)
- July – Focus groups with teens and staff
- September – Information interviews with managers
- October-November – Observations of fall YES Program
- November – Fall YES Teen survey

2013
- January - April – Observations of spring YES Program
- January – May – Observations of staff meetings
- January - April – Meetings with PI
- February - March – Alumni online survey pilot
- April – Spring YES Teen survey (with TOSRA2)
- April – Participant observation of national partners meeting
- July – Summer YES Teen survey (with TOSRA2)

EVALUATION REPORTS SUBMITTED

- March 2011 – Evaluation Progress Report
- April 2011 – Summary of Spring YES Teen Surveys
- August 2011 – Summary of Summer YES Teen Surveys
- **September 2011 – Evaluation Progress Report**
- November 2011 – Summary of Fall YES Teen Surveys
- April 2012 – Summary of Spring YES Teen Surveys
- August 2012 – Summary of Summer YES Teen Surveys
- **November 2012 – Second Annual Evaluation Report**
- Fall 2012 – Summary of Fall YES Teen Surveys
- April 2013 – Summary of Spring YES Teen Surveys
- April 2013 – Summary of YES Alumni Surveys
- August 2013 – YES Program High School Graduation Rates
- October 2013 – Dissemination Plan
- October 2013 – Research Agenda
- October 2013 – Summative Evaluation Report

APPENDIX C – DATA SOURCES

This appendix discusses the sources for data presented in this report. Data sources include surveys, observations, interviews (in-depth interviews, interactive interviews, and focus groups), and program records.

Evaluators used two types of surveys to collect data from YES Teens participating in the program. Both types of surveys involved population samples. The population number for each survey is the number of participating YES Teens for the semester in which the survey was administered. We defined participating teens as those who attended at least twice during the semester. Printed surveys were distributed to respondents during YES Program Learning Labs. Table C.1 shows the response rate for each survey.

Teen Surveys were developed by the External Evaluator. Several items were consistent from semester to semester to allow comparison and other items provided snapshots about specific topics relevant to ongoing evaluation issues and concerns.

The Test of Science Related Attitudes (TOSRA) survey, a standardized instrument, was developed by Fraser (1981) and used internationally. The instrument was designed to measure secondary science students' attitudes toward science, using 70 statements with seven subscales and a 5-point Lickert Scale (strongly agree, agree, not sure, disagree, and strongly disagree). TOSRA has been used with youth around the world, and has been shown to be valid and reliable for American teens. A modified version (TOSRA2) developed by Ledbetter and Nix (2002) was used in this study, consisting of 35 pre-test items and 35 post-test items with negatively and positively phrased items balanced on each test.

The seven subscales are as follows:

- Social Implications of Science – Do youth recognize the benefits and drawbacks of scientific advances to society?
- Normality of Scientists – Do youth see scientists as real people rather than media-produced stereotypes?
- Attitude toward Scientific Inquiry – Do youth view experimentation and inquiry as a way to gain understanding of the natural world?
- Adoption of Scientific Attitudes – Have youth adopted the attitudes of scientists, such as open-mindedness and self-assessment?
- Enjoyment of Science Lessons – To what degree do youth enjoy their lessons in school science classes?
- Leisure Interest in Science – To what degree are youth interested in science out of school, and outside of the YES Program?
- Career Interest in Science – Do youth have an interest in pursuing a science related career?

This science attitude survey was administered four times during the project.

The population for surveys, as shown in Table C.1, was all teens attending the program at least once. A few teens that attended only one time were present on days when the survey was conducted. Readers should note that this population definition is different from that used to figure attendance. In figuring attendance, participating teens were defined as those who attended at least two times.

Table C.1. Surveys

Surveys	Name of Data Set	Respondent Group(s)	Population N	Respondent N	Response Rate (%)	Date
Teen Surveys	Teen Survey Data-Spring 2011	Semester Participants	246	186	75.6	Spring 2011
	Teen Survey Data-Summer 2011	Semester Participants	280	220	78.5	Summer 2011
	Teen Survey Data-Fall 2011	Semester Participants	176	122	69.3	Fall 2011
	Teen Survey Data-Spring 2012	Semester Participants	216	109	50.4	Spring 2012
	Teen Survey Data-Summer 2012	Semester Participants	251	194	77.3	Summer 2012
	Teen Survey Data-Fall 2012	Semester Participants	167	111	66.5	Fall 2012
	Teen Survey Data-Spring 2013	Semester Participants	162	122	75.3	Spring 2013
	Teen Survey Data-Summer 2013	Semester Participants	195	124	63.6	Summer 2013
Test of Science Related Attitudes (TOSRA)	TOSRA, April 2012	Semester Participants	216	128	59.2	April, 2012
	TOSRA, July 2012	Semester Participants	251	194	77.3	July, 2012
	TOSRA, May 2013	Semester Participants	162	110	67.9	May, 2013
	TOSRA, July 2013	Semester Participants	195	115	59.0	July, 2013
	TOSRA, Matched April 2012 with July 2013	Matched Pairs	310	44	14.2	July, 2013

Observations were conducted by the evaluation team and by the documenters hired for the Summer 2011 program. Only those by the evaluation team (KK and CT) were included in analysis for this report, as reported in Table C.2.

Table C.2. Observations

Observations	Name of Data Set	Respondent Group(s)	Respondent N	Observer	Date
Evaluator Observations of Staff Meetings and PD	Staff Meeting 032912	Staff Members	11	KK	3/29/12
	Community Partner Meeting 050812	Staff Members and Community Partners	27	KK	5/8/12
	Staff Meeting 030212	Stakeholder and Staff Members	16	KK	3/2/12
	Staff Professional Development 042512	Staff Members	8	KK	4/25/12
	Staff Storyboarding Meeting 051412	Staff Members and Stakeholders	15	KK & CT	5/14/12
	Staff Meeting 062012	Staff Members	55	KK	6/20/12
	Staff Meeting 090712	Staff Members and Stakeholders	13	KK	9/7/12
	Staff Meeting 121412	Staff Members	11	KK	12/14/12
	Staff Meeting 012913	Staff Members	16	KK	1/29/13
	Staff Meeting 030113	Staff Members	8	KK	3/1/13
Evaluator Observations of Learning Labs	College Prep Learning Lab 031712	YES Teens, Staff Members, Interns	17	CT	3/17/12
	Astronomy Learning Lab 031712	YES Teens and Staff Members	17	CT	3/17/12
	Robotics Learning Lab Summer 2012 062112 & 062212	YES Teens and Staff Members	18	CT	6/20-22/12
	Astronomy Learning Lab 062612	YES Teens and Staff Members	~18	KK	6/26/12
	Summertime Science Learning Lab 062012	YES Teens and Community Group Youth	27	KK	6/20/12

In-depth interviews, interactive interviews, and focus group interviews were conducted by evaluation team members and were transcribed for analysis.

Table C.3. Interviews

Interviews	Name of Data Set	Respondent Group(s)	Respondent N	Interviewer(s)
In-depth Interviews	Principal Investigator Interview 01/04/11	Staff Member--Education VP and Grant PI	1	KK
	Office of Naval Research Program Officer 1/25/11	Stakeholder--Funder	1	KK
	Manager Interview 03/18/11	Staff Member--Manager	1	KK, CT
	St. Louis Science Center Administrator 04/06/11	Stakeholder--Institutional Administration	1	KK
	St. Louis Science Center Board of Trustees Member 11/15/2011	Stakeholder--Board of Trustees Member	1	KK
	St. Louis Science Center President 03/06/12	Stakeholder--Institutional Administration	1	KK
	Staff Member Interview 03/21/11	Program Staff Member	1	KK, CT
	Staff Member Interview 07/19/11	Program Staff Member	1	KK, CT
	Manager Interview 07/19/11	Staff Member--Manager	1	KK, CT
	Manager Interview 09/05/12	Staff Member--Manager	1	KK, CT
	Manager Interview 09/15/12	Staff Member--Manager	1	KK, CT
Interactive Interviews	Interactive Interviews 7/23-24/13	YES Teens	10	KK
Focus Groups	Community Partner Focus Group 05/09/12	Community Partners	8	CT, KK
	Teen Focus Group 07/17/12	YES Teens	9	CT, KK
	Teen Focus Group 07/18/12	YES Teens	10	CT, KK
	Summer Staff Focus Group 08/02/12	Summer Staff Members	10	CT, KK
	Senior Educator Focus Group 08/21/12	Senior Educators	7	CT, KK

Program records were collected from staff members by the evaluators. Records included attendance data, demographic and other details on individual teens, and documents shared. The Career/College Readiness Interview was conducted by a Senior Educator by phone with recent graduating seniors.

Table C.4. Program Records

Program Records	Name of Data Set	Respondent Group(s)	Population N	Respondent N	Response Rate	Date
Career/College Readiness Interview	Career-College Readiness Plan	YES Teens-Seniors 2012	62	57	91.9%	Spring 2012
	Senior College Data 2013	YES Teens-Seniors 2013	57	46	80.7%	Spring 2013
Teen Database	ALL FORMER TEENS copy	YES Teens through 2010		627		4/21/12
	2010 Current Teen Information	YES Teens Full Roster		235		6/8/11
	2011 Current Teen Information	YES Teens Full Roster		333		7/27/12
	2012 Current Teen Information	YES Teens Full Roster		262		8/29/12
Attendance	YES Attendance Fall 2010	Teens Assigned to Learning Labs		218		12/13/10
	YES Program Summer 2010 Attendance	Teens Assigned to Learning Labs		209		10/7/10
	YES Attendance Spring 2011	Teens Assigned to Learning Labs		234		5/4/11
	YES Attendance Summer 2011	Teens Assigned to Learning Labs		301		8/15/11
	YES Attendance Fall 2011	Teens Assigned to Learning Labs		193		1/2/12
	YES Attendance Spring 2012	Returning Teens Assigned to Learning Labs		252		5/3/12
	NEW TEEN YES Attendance Spring 2012	Teens Assigned to Learning Labs		63		9/27/12

	YES Attendance Summer 2012	Teens Assigned to Learning Labs		252		8/2/12
	YES Attendance Fall 2012	Teens Assigned to Learning Labs		167		12/8/12
	YES Attendance Spring 2013	Teens Assigned to Learning Labs		162		5/18/13
	NEW TEEN YES Attendance Spring 2013	Teens Assigned to Learning Labs		49		6/4/13
	YES Attendance Summer 2013	Teens Assigned to Learning Labs		195		8/5/13

APPENDIX D – TOSRA2 ANALYSIS RESULTS

TOSRA was chosen to measure changes in YES Teen attitudes because it was found to be a reliable and valid instrument for teenagers in other settings. The TOSRA2 version was chosen due to the shortened time to complete the questions. Inconsistencies were found with TOSRA2; however, it is not believed that these inconsistencies affect the findings from the matched pairs presented in this report. Questions about uses of the test for this urban, American, 21st century population are covered below.

TOSRA2 scores were recorded in an Excel spreadsheet and used in an SPSS program for analysis. Scores for each of the seven categories and a total were calculated for each respondent on each test. Analysis was conducted using descriptive statistics, two-tailed t-test, one-way ANOVA, and Pearson Correlation on matched pairs. The matched pairs used for this analysis were scores from teens taking both the 2012 spring pre-test and the 2013 summer post-test, which provided the greatest time between tests.

The findings include only those results from the matched pairs.

Matched Pair Results

Analysis of the matched pairs found correlation coefficients to be significant in six categories and on the total scores. Adoption of Scientific Attitudes shows a trend toward positive gain with exact significance at $p < .056$. Positive gains from pre to post-test were found for five of the categories and for the total scores. Negative gains from pre to post-test were found for two of the categories (Attitude Toward Inquiry and Career Interest). Two-sided paired t-tests found significant differences ($p < 0.05$) in five of the categories and the total scores.

The distribution of means for the seven categories (subscales) on the pre-test, as seen in Table 18 and Figure 16 on pages 37-38, follows a pattern similar to that found by Mountz (2006) with Leisure Interest receiving the lowest scores and Attitude Toward Inquiry receiving the highest pre-test scores.

Gender

We found no significant difference between male and female respondents' gain scores (i.e. difference from pre to post-test) on all seven TOSRA categories and on total scores. However, we did note that males tended to answer lower on the five point scale than females in all categories, except Career Interest on the pre-test (not significant using a one-way ANOVA). The subscale scores on the post-test for females on Attitude toward Scientific Inquiry were significantly higher than scores for males (mean of 19.80 for females, 16.79 for males, with one-way ANOVA $p < 0.01$).

Grade in School as an Indication of Maturity

Using grade level (year of high school graduation) as an indication of maturity, no significant differences were found for all TOSRA categories and total scores for the 2012 pre-test and 2013 post-test using a one-way ANOVA. All total scores increased by grade level except for a decrease in the one 9th grade teen as seen in Figure D.1 and Tables D.1 and D.2. Total scores by fall 2013 grade level are shown in Table D.1. Changes in mean scores are shown in Table D.2 with negative changes shaded.

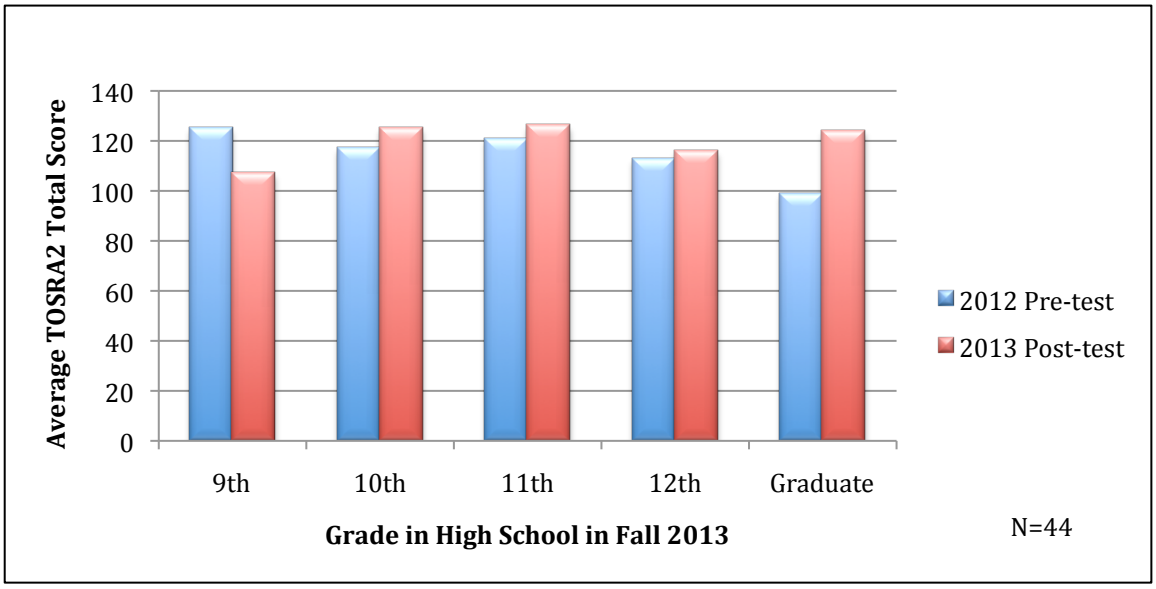


Figure D.1. Average total scores for the spring 2012 pre-test and summer 2013 post-test TOSRA2 by grade in school in fall 2013.

Table D.1. Average total scores by grade in school in fall 2013.

	9th	10th	11th	12th	H.S. Grad	Total
2012 pre-test average score	125	117	121	113	99	118
2013 post-test average score	107	125	126	116	124	124
Number in sample (N)	1	8	26	7	2	44

Table D.2. Change in mean scores by category and grade in school in fall 2013.

	S	N	I	A	E	L	C	Total
9th Grade	-1.00	0.00	-5.00	-1.00	-2.00	-6.00	-3.00	-18.00
10th Grade	1.25	3.63	-1.50	2.38	1.38	2.00	-0.88	8.25
11th Grade	1.04	2.65	-0.69	0.77	0.80	1.62	-1.23	4.96
12th Grade	0.71	2.71	-2.29	-0.43	1.00	0.86	0.29	2.86
Graduate	5.50	4.50	-2.50	-0.50	7.50	9.00	1.50	25.00

Length of Time in YES

A significant difference ($p < 0.05$) was found between length of time in the program and Attitude toward Inquiry using the Pearson Correlation. In correlating mean scores for each category with how long the teen had been in the program at the time of the post-test (Table D.3), results showed that the longer teens were in the YES Program, the lower their mean score on Attitude toward Inquiry. This is consistent with the mean score decrease from pre to post test overall. Thus, the longer a teen is in the YES Program, the less likely she or he is to view experimentation and inquiry as a way to gain understanding of the natural world.

Table D.3. Correlation results of TOSRA categories and length of time in the YES Program

		Length of Time in YES Program
GainS	Pearson Correlation	-.026
	Sig. (2-tailed)	.867
	N	44
GainN	Pearson Correlation	-.257
	Sig. (2-tailed)	.092
	N	44
GainI	Pearson Correlation	.309*
	Sig. (2-tailed)	.041
	N	44
GainA	Pearson Correlation	.154
	Sig. (2-tailed)	.318
	N	44
GainE	Pearson Correlation	-.229
	Sig. (2-tailed)	.135
	N	44
GainL	Pearson Correlation	-.228
	Sig. (2-tailed)	.137
	N	44
GainC	Pearson Correlation	-.189
	Sig. (2-tailed)	.219
	N	44
GainTotal	Pearson Correlation	-.126
	Sig. (2-tailed)	.413
	N	44
** Correlation is significant at the 0.01 level (2-tailed) * Correlation is significant at the 0.05 level (2-tailed)		

Analyses took into account a number of factors that could affect attitudes: gender, ethnicity, age/maturity, and time in the YES Program. The ethnic diversity of the matched pairs was similar to that of the YES Program, and did not

have enough variation to draw conclusions about differences in attitudes based on ethnicity. No significant differences in attitude were found by gender on gain scores, though males tended to rate items lower in general than females and females rated Attitude Toward Inquiry significantly higher than males on the post-test. A significant difference was found between length of time in the program and Attitude toward Inquiry suggesting the longer a teen was in the YES Program, the less likely she or he was to view experimentation and inquiry as a way to gain understanding of the natural world. No significant differences were found based on age as an indication of maturity, though the 9th grader rated categories lower on the post-test and the two high school graduates rated all except two categories higher on the post-test than on the pre-test.

The TOSRA was chosen to measure YES Teen attitudes toward science and scientists because it was found to be reliable and valid by researchers in the United States and elsewhere in the 1980s, 1990s and early 2000s. Results of TOSRA2 with YES Teens called into question the construct validity of TOSRA2 with urban teens in this time period. Did the test actually measure what it was supposed to measure?

The economic climate has shifted considerably since Fraser first developed the TOSRA, and some questions referred to money spent on science or education. Technology has changed and questions did not include attitudes toward technology or the use of technology in science. Of larger concern is the shift in scientific practices. Where scientists once worked independently, more and more work collaboratively. YES Teens are encouraged to see science as a field for collaboration, and scientists as people who enjoy working together.

With construct validity called into question, each category can be considered in light of findings and construct validity questions.

Social Implications of Science (S) was designed to measure attitudes toward the societal benefits and drawbacks of scientific advances. Findings indicated a significant increase in scores from pre-test to post-test for the 44 matched pairs (means from 17.05 pre to 18.23 post, N=44). Similar results were found using pre-test and post-test scores for all respondents of each test (means from 17.86 pre to 18.23 post, N=133 pre and N=115 post). Mean subscale scores increased for matched pairs at all grade levels except for the one 9th grade teen. Findings suggest that the YES Program leads to improved attitudes toward scientific advances.

Normality of Scientists (N). Teens may believe the media stereotypes about scientists when they enter the YES Program, but the Community STEM Outreach project was designed to introduce YES Teens to real scientists to expose them as real people. This TOSRA subscale was developed to measure changes in attitudes toward scientists. Findings indicate a significant increase in scores from pre-test to post-test for the 44 matched pairs (means from 15.59 pre to 18.45 post), the largest change of the subscales. Similar results were found using pre-test and post-test scores for all respondents of each test (means from 15.74 pre

to 18.46 post). Mean subscale scores increased for matched pairs at all grade levels.

Attitude to Scientific Inquiry (I). The YES Program is grounded in inquiry as a way to gain understanding of the natural world. Project goals include increasing YES Teens' valuing of inquiry and experimentation, and increasing their skills in the process of inquiry. TOSRA was designed to measure changes in attitudes (rather than skills). Results from the TOSRA2 showed a decrease in total and subscale scores for the matched pairs, and at each grade level. Change differed due to the length of time a teen was in the program, with those in YES longer having more negative change from pre to post. From this it would be easy to conclude that after 16 months or more in the YES Program, teens were less likely to value the inquiry process. However, a closer look at the statements on TOSRA2 calls into question the construct validity with this generation of teens. For example, the pre-test asks teens to rate "I would rather find out why something happens by doing an experiment than by being told how it works," with an average of 4.11 (high agreement) on a 5 point scale, N=133. The post-test says "I would rather find out about things by asking an expert than by doing an experiment," with an average response of 3.23 (slight disagreement), N=115. While these statements appear to be parallel and consistent with previous generations of scientists, there is a subtle difference. Results indicate that YES Teens would rather experiment and learn on their own through hands-on activities, but they are not opposed to seeking advice and answers from experts. Several statements on this subscale involved asking experts or teachers or seeking answers from other sources, making it difficult to draw conclusions from the findings. It could also be that having carried out their own experiments teens appreciated the time and effort required to reach sound conclusions and learned to trust and rely on information based on the experimentation of others. Gender differences, particularly the significant differences on the post-test, indicate that girls had a more positive attitude toward inquiry than their male peers after participating in the YES Program.

Adoption of Scientific Attitudes (A). The TOSRA2 was designed to measure whether teens adopted the attitudes of scientists over time, such as open-mindedness and self-assessment. Results from the matched pairs indicated a positive, though weak, change over time. Results by grade level in school indicated that the larger group of teens in grades 10-11 showed positive change, while those in grade 12 and the 2 recent graduates showed small negative changes. The one 9th grade teen showed a larger negative change.

Two pairs of statements for this category raise questions. Item 4 on the pre-test reads: "I find it boring to hear about new ideas" (with a mean score of 3.70, good agreement, N=133). This is paired with: "I enjoy reading about things which disagree with my previous ideas" (with a mean score of 3.11, neutral, N=133). This second statement would be scored low if a teen doesn't like to read or if the teen doesn't like her or his ideas challenged. Item 11 on the pre-test reads: "In science experiments, I like to use methods which I have not tried before" (3.83, agreement, N=115). The post-test item reads: "I dislike repeating experiments to

check that I got the same results" (3.04, neutral, N=115). While teens like to use new methods, perhaps they really don't care whether or not they repeat experiments since they enjoy doing them. Weak changes could be related to the wording of the questions on this subscale.

Enjoyment of Science Lessons (E) does not relate directly to the project or the goals of the YES Program. Instead, it could be an indicator of teen attitudes toward science. The TOSRA was designed to measure enjoyment of lessons in school science classes. Findings show a significant positive difference in scores from pre to post-test, with all grade levels except the one 9th grader showing positive change. It should be noted that the TOSRA2 used the term "science lessons" throughout rather than specifying science lessons in school. It is unclear whether YES Teens interpreted this as science lessons in school or in YES.

Leisure Interest in Science (L) is another indicator of attitudes, rather than being directly related to YES Program goals. Are teens more interested in science in their leisure time after an additional 16 months in the program? The answer is yes, for all grade levels except the one 9th grader. The highest positive change was with the two high school graduates.

Career Interest in Science (C) The TOSRA examines interest in pursuing a science related career. Change in scores was small suggesting a slight decrease in interest in science as a career. By grade level, change was negative for students in grades 9-11 at the time of the post-test and positive for those in 12th grade and the two recent graduates, suggesting more positive changes as teens mature. Females scored all subscales higher than males with the exception of Career Interest on the pre-test, indicating lower interest as they entered the program.

A closer look at the statements rated on this subscale raises questions in interpretation of results. For example, Item 7 on the pre-test, "I would dislike being a scientist" (with a mean score of 3.16, N=133) is paired with item 7 on the post-test, "I would like a career teaching science" (2.41, N=115). These are not parallel for YES Teens since teaching science is viewed as different from being a scientist. Another example is item 35. Pre-test states, "A career in science would be dull and boring" (3.47, disagreement, N=133), while the post-test states: "I would like a career as a scientist" (2.93, neutral, N=115). Perhaps the teens are willing to say a career in science would be interesting, while at the same time are not willing to commit to a personal interest in becoming a scientist.