Service-Learning
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High-Quality Service-Learning Opens the Door for Students' Entry into STEM Fields

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INTRODUCTION

The rationale behind the now decade-long emphasis on Science, Technology, Engineering, and Mathematics (STEM) subject areas in P-12 education is no less well-supported than when the movement began. Simply put, while the job market continues to demand greater numbers of employees with postsecondary degrees in STEM-related fields, schools and universities in the U.S. continue to fail to generate the student interest and achievement levels, as well as the necessary number of post-secondary credential holders, to meet workforce demands.[1] The ability of P-12 schools to foster student interest and learning in STEM-related fields is critical to the long-term economic health of the U.S.

In 2010, the National Center for Learning and Citizenship (NCLC) established Schools of Success, a national network of 19 schools that use service-learning as an instructional strategy.[2] Thanks to funding from the State Farm Companies Foundation and Learn and Serve America, the schools were part of a three-year project to examine how the elements of service-learning enhance student performance on key outcomes. Through this project, the NCLC has gathered information on the relationship between STEM-focused service-learning and student interest and performance in STEM-related courses and careers. The findings of this evaluation suggest that STEM-related service-learning is a powerful tool for schools to use to drive student performance and interest in STEM fields.

Key Findings:

- High-quality service-learning was shown to have a positive relationship with student interest and abilities in STEM content areas.
- High-quality service-learning was shown to have a positive relationship with student interest in STEM-related careers.
- This evaluation, combined with other similar evaluations, suggest that service-learning has the potential to have a substantial impact on student interest and ability in STEM fields.

National Center for Learning and Citizenship

BACKGROUND

The NCLC selected participating schools for the Schools of Success network based on their support of five elements critical to the successful, school-based integration of service-learning shown to lead to student achievement and success:

1) Vision and leadership
2) Curriculum and assessment
3) Professional development
4) Community-school partnerships
5) Continuous improvement.[3]

Each school received funding over three years ($5,000 per year), on- and off-site professional development opportunities, and ongoing technical assistance to expand and deepen existing service-learning initiatives and build greater capacity within their school and district. In return, the NCLC asked schools to test and learn from leadership strategies that integrate and sustain quality service-learning for all students to succeed in school and in their communities.

The Schools of Success network had two funders—the State Farm Companies Foundation and the Corporation for National and Community Service/Learn and Serve America. State Farm-funded schools included 10 schools that ranged from preschool to high school. These schools could implement service-learning in any school subject area. Learn and Serve-funded schools included nine middle schools, all of which were designated as Title I schools (high poverty) during the time of this program. In addition, service-learning projects in the Learn and Serve-funded schools required a STEM focus, and students in these schools were evaluated on STEM-related measures. Because this paper focuses on STEM outcomes, only data from Learn and Serve-Funded Schools, listed in Exhibit 1, are used in this analysis.

Exhibit 1: *Schools of Success Network Participating STEM Schools*

School	Location	Grade Level
Christian County Middle School	Hopkinsville, KY	6-8 Middle School
Detroit Edison Public School Academy	Detroit, MI	P-10 Public Charter School (only grades 6-8 participated)
Hopkinsville Middle School	Hopkinsville, KY	6-8 Middle School
MS 442	Brooklyn, NY	6-8 Middle School
New Foundations Charter School	Philadelphia, PA	P-10 Public Charter School (only grades 6-8 participated)
North Drive Middle School	Hopkinsville, KY	6-8 Middle School
School for Global Leaders	New York, NY	6-8 Middle School
Sutter Middle School	Fowler, CA	6-8 Middle School
Tupelo Middle School	Tupelo, MS	6-8 Middle School

RESEARCH METHODS

The NCLC contracted with RMC Research Denver[4] to examine the Schools of Success program's effects on schools, community conditions, students' academic and civic engagement, students' interest and abilities in STEM content areas, and students' interest in STEM careers. While the evaluation was wide-ranging, here we report on a subset of data gathered from a quasi-experimental assessment of the relationship between service-learning and key STEM-related student outcomes. Participating students (those in classes who took part in service-learning activities) and matched comparison students (those who did not take part in service-learning activities) took surveys at the beginning and end of the school year. The results reported below are based on data gathered from these pre- and post-test surveys administered during the 2010-11 school year.

RMC Research Denver (RMC) developed surveys to measure key variables of interest. Measures included subscales with high reliabilities that assessed students' STEM content area interest and abilities and STEM career interest. Exhibit 2 provides sample survey items for the STEM-related measures we discuss in this analysis. In addition to these STEM-related measures, the surveys also allowed RMC to assess students' academic engagement, academic competence, educational aspirations, acquisition of 21st century skills, and community engagement.[5] All items in the subscales were measured on a four-point scale with the following response categories: 1 = strongly disagree, 2 = disagree, 3 = agree, and 4 = strongly agree.

Exhibit 2: *Definition of Survey Measures for Student Outcomes*

Measure	Definition	Sample Item(s) from survey	Number of Items in survey
STEM content area interest and abilities	Student interest in science, technology, engineering, and mathematics and self-ratings of abilities in these content areas	• I am interested in math. • I am good at science.	9
STEM career interest	Student interest in careers that require skills in science, technology, engineering, and mathematics	• I am interested in careers that require technology skills. • I am interested in careers that require engineering skills.	4

Participating students' post-test surveys also included questions that allowed RMC to generate a measure of quality for the service-learning projects in which participating students engaged. RMC used the National Youth Leadership Council's *K-12 Service-Learning Standards for Quality Practice*[6] as the basis for its construction of student survey items related to service-learning quality. In a series of questions, students were asked to assess the extent to which their service-learning experiences: (1) provided opportunities for students to engage in meaningful service; (2) were explicitly linked to the curriculum; (3) provided multiple opportunities for student reflection; (4) promoted understanding of diversity and mutual respect; (5) emphasized youth voice in planning, implementation, and evaluation; (6) included partnerships between the school and community; (7) included ongoing progress monitoring; and (8) had sufficient duration and intensity.

RMC then used these student ratings of service-learning quality to separate the participating students into a group that participated in "higher-quality" service-learning and a group that participated in "lower-quality" service-learning.[7] Throughout the course of ongoing conversations, technical assistance, and site visits, NCLC staff members noted the varying extent to which the participating schools were implementing service-learning according to the *K-12 Service-Learning Standards for Quality Practice*. RMC's classification of students' service-learning experience according to quality helps to account for

this variation in implementation. The classification also allows for more fine-grained analysis between the pre- and post-test scores of various groups of students, including:

- Participant (service-learning) and comparison (no service-learning)
- Higher-quality service-learning and lower-quality service-learning
- Higher-quality service-learning and comparison (no service-learning).

RESULTS: STEM Content Area Interest and Abilities[8]

As shown in Exhibit 3, STEM-focused service-learning had little, if any, relationship with students' STEM content interest and abilities. While both service-learning and comparison students reported a gain on their survey scores over time, the differences between groups on this gain was not statistically significant and thus did not show any effect size.

Exhibit 3: *Student Differences over Time on STEM Content Interest and Abilities for Service-Learning and Comparison Groups*

Service-Learning			Comparison				
N	Pretest Mean	Posttest Mean	N	Pretest Mean	Posttest Mean	Significance	Generalized eta squared[9] (effect size)
519	2.92	3.03	136	2.93	3.12	.16	.000

A comparison between students in higher-quality STEM-focused service-learning programs with students in lower-quality STEM-focused service-learning programs, however, shows a statistically significant difference between these two groups, as displayed in Exhibit 4. Participating in a higher-quality service-learning program, as opposed to a lower-quality service-learning program, had a small, though statistically significant effect on students' STEM content interest and abilities.

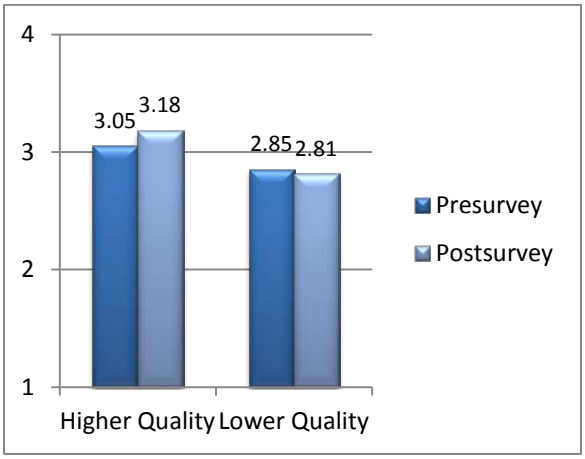
Exhibit 4: *Student ratings of Program Quality as a Moderator on STEM Content Interest and Abilities*

Moderator	Outcome Moderated	*df*[10]	*F*[11]	Significance	Generalized eta squared (effect size)
Student Ratings of Program Quality	STEM Content Interest and Abilities	1,379	21.118	.000***	.013

*** $p \leq .005$

Exhibit 5 shows the relative changes in students' survey scores for STEM content interest and abilities. While students in higher-quality service-learning programs saw a 0.13 score increase in STEM content interest and abilities, students in lower-quality service-learning programs saw a 0.04 score decrease.

Exhibit 5: *Service-Learning Quality as a Moderator for STEM Content Interest and Abilities*



RESULTS: STEM Career Interest

Exhibit 6 shows student differences over time on STEM career interest for service-learning and comparison groups. While both groups gained in their score on this variable, comparison students actually gained more than service-learning students at a statistically significant level.

Exhibit 6: *Student Differences over Time on STEM Career Interest for Service-Learning and Comparison Groups*

Service-Learning			Comparison				
N	Pretest Mean	Posttest Mean	N	Pretest Mean	Posttest Mean	Significance	Generalized eta squared (effect size)
526	2.74	2.79	132	2.71	2.94	.02*	.002

* $p \leq .05$

A comparison between students in higher-quality STEM-focused service-learning programs with students in lower-quality STEM-focused service-learning programs, however, shows a statistically significant difference between these two groups on STEM career interest, as displayed in Exhibit 7. Participating in a higher-quality program, as opposed to a lower-quality program, had a small though statistically significant effect on students' STEM career interest.

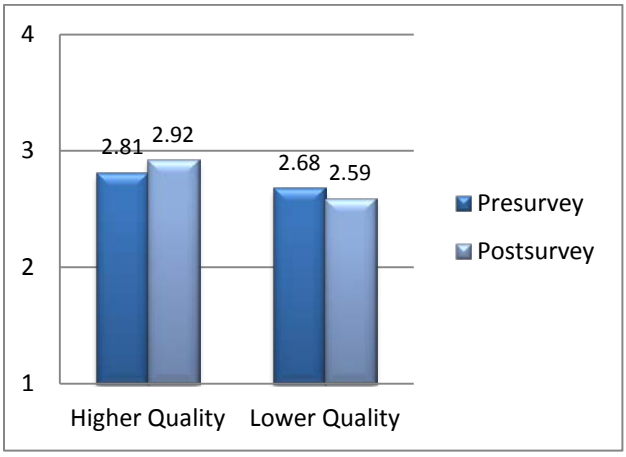
Exhibit 7: *Student ratings of Program Quality as a Moderator on STEM Career Interest*

Moderator	Outcome Moderated	*df*	*F*	Significance	Generalized eta squared (effect size)
Student Ratings of Program Quality	STEM Career Interest	1,349	14.368	.000***	.011

*** $p \leq .005$

Exhibit 8 shows the relative changes in these students' survey scores for STEM career interest. While students in higher-quality programs saw a 0.11 increase in their STEM career interest score, students in lower-quality programs saw a 0.09 decrease in this score.

Exhibit 8: Service-Learning Quality as a Moderator for STEM Content Interest and Abilities



CONCLUSIONS AND NEXT STEPS

The evaluation findings presented in this analysis show that high-quality service-learning has a clear, positive, and statistically significant relationship with students' STEM content interest and abilities and STEM career interest. As stated in earlier papers in this series, the findings of this evaluation clearly point to at least one cross-cutting implication: *quality matters*.

Some differences from site to site are to be expected with service-learning implementation. Service-learning is a complex pedagogical approach that helps to guide instruction, not a standardized, one-size-fits-all, scripted instructional method. Teacher judgment and expertise, as well as local resources, constraints, and conditions all play a role in how well teachers are able to align their implementation of service-learning with quality standards. For this reason, the finding of little difference in STEM-related outcomes between service-learning and comparison students should come as little surprise. Because most of the teachers at the Schools of Success STEM-focused schools were relatively new to service-learning, the service-learning these teachers implemented was likely of mixed quality. Rather than being indicative of the failures of service-learning to impact student outcomes, this finding likely points to the steep learning curve for teachers that accompanies any complex pedagogy, including service-learning.

When RMC divided site-level implementation of service-learning into "higher quality" and "lower quality," however, those students who indicated that they participated in higher-quality service-learning experienced greater gains at higher levels of statistical significance on most key outcomes than did students who participated in lower-quality service-learning or no service-learning. Because RMC used the National Youth Leadership Council's *K-12 Service-Learning Standards for Quality Practice* as the basis for its construction of student survey items related to assessment of quality, these results suggest that teachers, administrators, and policymakers should pay close attention to the quality standards when creating and implementing service-learning programs. These standards appear to offer critical guidance in the "how to" of service-learning, particularly when student outcomes are a key concern.

Further, the results presented here suggest that students may actually be harmed when service-learning is implemented poorly. The outcome scores for students who participated in lower-quality service-learning didn't remain constant from pretest to posttest; these scores declined.

In making sense of these findings, two other relevant pieces of information should be taken into consideration.

First, other organizations in the Learn and Serve cluster who also worked to implement STEM-focused service-learning and who used the same evaluation experienced similar or larger gains in students' STEM outcomes. For example, YSA's (Youth Service America) STEMester of Service program showed both statistically significant differences and large (some would say huge) effect sizes in service-learning and comparison students' survey scores. YSA also found similar results in their examination of students participating in higher-quality and lower-quality service-learning programs. Exhibits 9 and 10 display these data.

Exhibit 9: *Student Differences over Time on STEM Outcome Measures for Service-Learning and Comparison Groups Participating in YSA's STEMester of Service Program*[12]

	Service-Learning			Comparison				
Measure	N	Pretest Mean	Posttest Mean	N	Pretest Mean	Posttest Mean	Significance	Generalized eta squared (effect size)
STEM Content Interest & Abilities	1,007	3.03	3.06	341	2.97	2.86	.000***	.18
STEM Career Interest	935	2.88	2.91	310	2.89	2.76	.000***	.18

*** $p \leq .005$

Exhibit 10: *Student ratings of Program Quality as a Moderator on STEM Outcomes for Students Participating in YSA's STEMester of Service Program*[13]

Moderator	Outcome Moderated	*F*	Significance	Generalized eta squared (effect size)
Student Ratings of Program Quality	STEM Content Interest & Abilities	243.16	.000***	.86
Student Ratings of Program Quality	STEM Career Interest	119.626	.000***	.72

*** $p \leq .005$

The sizeable gains in students' STEM outcomes seen in YSA's STEMester of Service program suggest that while NCLC's Schools of Success only showed modest gains, the possibility for much larger gains exists. While additional research clearly is needed to confirm both organizations' findings and identify the reasons for the variation in outcomes, the potential for service-learning to generate student interest and foster higher levels of student performance in STEM content areas and career paths should not go unnoticed.

Second, while this research confirms a relationship between student STEM outcomes and service-learning, the service-learning field has for some time put forth several programs meant to use service-learning as a mechanism to foster student interest and performance in STEM-related fields.[14] Given the findings of this evaluation, service-learning leaders and practitioners must recognize that for these programs to stand a chance of bringing about desired outcomes, program quality must be of high

concern. Selective and piecemeal implementation of service-learning will not foster students' interest or performance in STEM areas.

While STEM-focused service-learning clearly has some benefit for students' STEM interest and performance, these outcomes may range from rather small to rather substantial. Whether small or large, however, in interpreting these increases, consideration of the length of the evaluation period (one academic year, or approximately nine months), and how increases may accumulate over time is necessary. For example, a student who participates in several consecutive school years of service-learning may very well accumulate these increases over time (e.g., a .12 gain for a single year may be a much larger gain over four years). As a next step in this line of research, longitudinal studies will be necessary to confirm whether or not this is the case. In addition, analysis of aggregated data from across similar STEM-focused service-learning programs, such as YSA STEMester of Service and NCLC's Schools of Success, is necessary to further solidify the findings shown here.

ENDNOTES

[1] National Science Foundation, *STEM Education Data and Trends*, http://www.nsf.gov/nsb/sei/edTool/timeLineButtonInfo.xml (accessed on May 7, 2013).
[2] The Schools of Success network was part of a larger evaluation study conducted by RMC Research Denver that used a set of common measures across a cluster of Learn and Serve states (Arizona, Hawaii, Louisiana, Michigan, Minnesota, Missouri, Ohio, and Wisconsin) and national programs (e.g., Youth Service America's STEMester of Service).
[3] T.Pickeral, T.Lennon, and J.Piscatelli, *Service-Learning Policies and Practices: A Research-Based Advocacy Paper* (Denver, CO: Education Commission of the States, 2008).
[4] RMC also conducted evaluations of other states and national programs in the Learn and Serve cluster.
[5] NCLC reports on these outcomes in other papers in this series.
[6] *K-12 Service-Learning Standards for Quality Practice* (Saint Paul, MN: National Youth Leadership Council, 2009).
[7] A median split was conducted on the student-rated service-learning program quality subscale. Two categories were created from the split (higher-quality and lower-quality programs).
[8] In an effort to keep this issue brief concise, NCLC does not provide all evaluation results here. Please contact Paul Baumann, NCLC Director, at pbaumann@ecs.org if you wish to receive copies of the complete evaluations.
[9] Generalized eta squared (η_g^2) is a measure of effect size, designed to measure the magnitude of treatment effect. Effect sizes can be defined as small = .01, medium = .06, and large = .14.
[10] Degrees of freedom (*df*) indicates the number of responses used in the final calculation of a statistic. This number is usually just slightly smaller than the overall sample size.
[11] The *F* statistic provides a basis to test for statistical significance when used in analysis of variance (ANOVA).
[12] Source: P. Baumann, S. Billig, S. Abravanel, and T. Dary, *Learning from the Past: Using the 2009 Learn and Serve Cluster Evaluation to Develop the Field's Understanding of Service-Learning Implementation and Outcomes*, presented at the 2012 IARSLCE Annual Conference, Baltimore, Maryland, September 25, 2012.
[13] Ibid.
[14] c.f., Kids Consortium, Integrating Scientific Practices and Service-Learning: Engaging Students in STEM (2012); and YSA (Youth Service America) STEMester of Service: Engaging Students through High-Quality Service and Learning (2013).

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