Wilder Research

STARBASE Minnesota long-term follow-up study

Overall results

STARBASE Minnesota provides fourth- and fifth-grade students with a challenging, week-long science, technology, engineering, and math (STEM) program in a technology-rich environment. The program aims to increase the STEM-related knowledge, skills, and interests of urban youth for greater academic and lifelong success. STARBASE Minnesota is part of a nationwide U.S. Department of Defense (DoD) program aiming to motivate students underrepresented in STEM to explore learning and improve their skills in those areas.

The program has promising short-term results showing increases in participants' STEM knowledge and skills, and contracted with Wilder Research to examine long-term program impacts. Wilder Research conducted its study in three phases from 2009-12. Using a rigorous quasi-experimental design, researchers assessed program impacts related to students' academic achievement in junior high and high school, on-time high school graduation, college enrollment, military enrollment, and interests and involvement in STEM following STARBASE. This summary provides an overview of the program, Wilder Research's study methodology, cumulative study findings, and study implications and recommendations.

Program background

STARBASE Minnesota emphasizes integrated and hands-on STEM learning, scientific-inquiry skills, mathematical concepts, engineering design skills, real-world applications, and exposure to a variety of STEM careers. Participants solve scientific and engineering challenges through a hands-on curriculum. The program takes place in a technology-rich aerospace environment at the Minnesota Air National Guard Base. Funding is provided in large part by the DoD STARBASE program, and supported by the Minnesota National Guard and a number of corporations in the community.

> STARBASE was my foundation for learning complex science and math skills that I didn't know of prior to the [program].
> – *Former* STARBASE *participant in high school*

More than 30 Minneapolis and St. Paul elementary schools partner with STARBASE Minnesota each year. The week-long program hosts entire grade levels within schools during the school year. Students are taught by teachers licensed in the state of Minnesota.

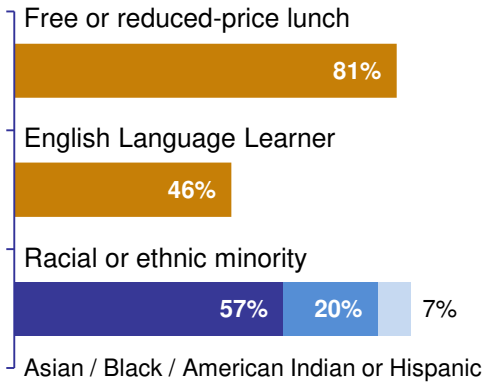
Study population

Wilder Research's study followed-up on three cohorts of Saint Paul Public Schools students who participated in STARBASE Minnesota in fourth grade. Study participants were enrolled as 10th-, 11th-, or 12th-grade students in Saint Paul Public Schools during the 2008-09 school year when the study began. Consistent with the program's mission, former STARBASE participants in the study represented a diverse population. The following chart depicts their demographic characteristics in fourth grade.

"STARBASE Minnesota is a 501(c)3 nonprofit organization whose purpose is to inspire and educate urban youth in science, technology, engineering, and mathematics."

— STARBASE Minnesota

STARBASE STUDENT PROFILES (N=442)



Methodology

STARBASE Minnesota developed a logic model connecting program services to intended short-term, intermediate, and long-term outcomes. Wilder Research's study examined indicators related to the program's long-term vision for its participants. The study's design and methods are summarized here and described in detail in the full report.

Quasi-experimental design

Former STARBASE students were matched one-to-one with demographically and academically similar peers who did not participate in the program. Student pairs were required to match on four characteristics: grade level in 2008-09, high school attended in 2008-09, third-grade math achievement test level score, and third-grade reading achievement test level score. Additionally, pairs needed to match on at least one of the following five characteristics in fourth grade: free or reduced-price lunch eligibility (as a proxy for income), English Language Learner status, special education status, gender, and race or ethnicity.

Based on these criteria, a total of 442 matched pairs were identified, for a total of 884 STARBASE and comparison students in the study. Most student pairs matched on all or most of these demographic characteristics. The matching technique used and the high match rate on all nine characteristics helped ensure that differences between the STARBASE and comparison groups were not likely due to demographic or academic characteristics.

Long-term program effects were examined through analysis of differences between the treatment (STARBASE) and comparison groups on student outcome measures. Differences were further explored based on cohort, demographic characteristics, and program dosage, meaning whether students participated in one or two grade levels. At the time of the study, STARBASE Minnesota was offered to fourth- and sixth-grade students, and most STARBASE study participants (81%) attended the 20-hour program in both grades.

Consideration to school differences

Wilder Research also examined possible school-level differences that might give an advantage to either the treatment or comparison group. Study participants could not have attended an elementary school with a special emphasis on STEM. Researchers also analyzed school-level differences on standardized reading and math tests, and did not find meaningful differences between STARBASE and comparison elementary schools.

Overall findings

Results from Wilder Research's long-term follow-up study indicate STARBASE Minnesota is a meaningful and memorable experience for students, even several years after they participated in the program. In both high school and college, former STARBASE participants provided favorable feedback on the program's impact on their interest in and understanding of STEM areas. When they were in high school, significantly higher percentages of STARBASE than comparison students reported interest in technology and joining the military.

Overall, results on long-term outcomes related to on-time high school graduation and college enrollment also favor the STARBASE group, although differences between STARBASE and comparison students on those measures are not statistically significant in most instances.

Taken together, overall results provide some evidence for long-term advantages for students who participated in the program. Additional evidence is provided by "perfect-match" analyses in which high school graduation and college enrollment results appeared more favorable for STARBASE among a subset of study pairs matching on all nine characteristics of interest. In the absence of strong and consistent statistical effects overall, however, the results should be treated as more suggestive of long-term program effects than definitive. Results for individual outcome areas are presented next, followed by a discussion of study implications and future study directions.

Interest in STEM

Wilder Research developed self-administered questionnaires to examine study participants' interest in and understanding of STEM areas, involvement in other STEM opportunities, and future career plans. A paper survey was administered to STARBASE and comparison group students in high school, and an online survey to those STARBASE participants who went on to attend college. Overall, results indicate that former participants perceive the program as a valuable experience which positively impacted their STEM interests and understanding.

> STARBASE was one of the few experiences that led me to explore the sciences.
> – *Former* STARBASE *participant in college*

Feedback in high school

When they were in high school, 507 STARBASE and comparison students completed the survey at four participating SPPS high schools, for a response rate of 71 percent. Depending on their study cohort, students were in 10th, 11th, or 12th grade at the time. Overall, results indicate STARBASE was a valuable experience that helped students learn about STEM areas and careers:

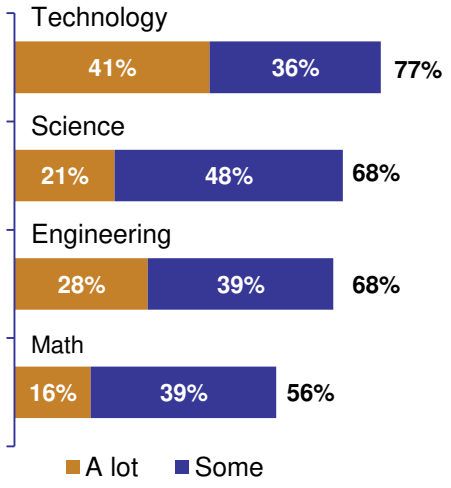
- 82% of former STARBASE participants reported that STARBASE was a valuable learning experience.
- 63% of former STARBASE participants reported the program helped them understand STEM better.
- 73% of former STARBASE participants reported the program helped them learn about STEM careers.

> STARBASE showed me a lot of things – not just building up my skills in math, technology, science, and engineering, but my leadership skills as well.
> – *Former* STARBASE *participant in high school*

As shown in the following chart, a majority of the former STARBASE participants also reported the program increased their interest in STEM subjects. This was especially the case with technology, with 77 percent reporting STARBASE increased their interest in technology. Additionally, when compared to the comparison group, significantly higher percentages of STARBASE students reported interest in technology and joining the military.

STARBASE PARTICIPANTS' FEEDBACK IN HIGH SCHOOL (N=155)

Did STARBASE increase your interest in…



Note. Due to rounding, numbers do not always add up to total.

Feedback in college

Wilder Research followed up with the former STARBASE participants again when they reached college. Researchers were able to identify contact information for 130 of the 234 former STARBASE participants across the three cohorts who enrolled in

college during the course of the study. A total of 81 students completed the online survey, representing 62 percent of those contacted. Students completed the survey during fall semester of their freshman or sophomore year.

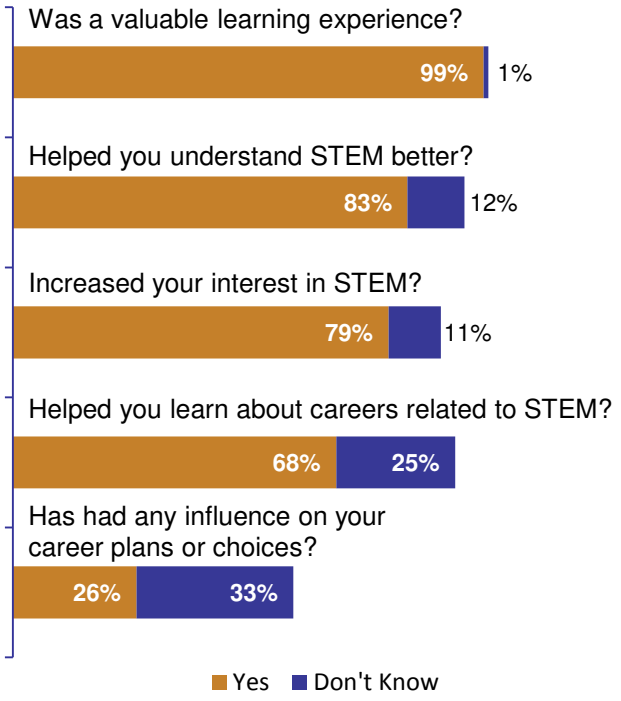
> I gained a confidence in myself with sciences.
> – *Former* STARBASE *participant in college*

As shown in the following chart, almost all college students completing the survey reported that STARBASE was a valuable learning experience. Most reported that the program helped them understand STEM better and increased their interest in STEM. A majority indicated STARBASE helped them learn about STEM careers, and about a quarter indicated the program had influenced their career plans.

> It really gave me an opportunity to peek into a field of professions I never would have been exposed to. … It ignited my curiosity.
> – *Former* STARBASE *participant in college*

STARBASE PARTICIPANTS' FEEDBACK IN COLLEGE (N=81)

Do you think STARBASE…



Academic achievement

Phase I of the study examined the courses taken and academic achievement of STARBASE and comparison students when they were in junior high and high school. Wilder Research looked at a number of indicators, such as students' course selection and academic performance in STEM areas, indicators of STEM momentum, and indicators of overall academic progress and motivation. The Saint Paul Public School District provided school records data on study participants, who were in 10th, 11th, or 12th grade at the time. Due to subsequent changes in district data-sharing policies, researchers were not able to continue assessing these academic indicators as study participants progressed through high school.

Overall results

In general, STARBASE and comparison students performed similarly on the indicators examined. There were statistically significant differences in favor of STARBASE students in the following three areas, although they could be due to chance given the large number of statistical tests performed:

- Junior high school grade average in science
- 10th-grade Algebra 2 completion, indicating a rigorous math schedule
- Senior high school attendance as a measure of overall academic motivation

Program dosage

Results were also analyzed based on program dosage. Students who attended STARBASE in fourth grade only constituted the lower-dosage group, and students who attended in both fourth and sixth grades the higher-dosage group. There was a modest pattern of higher-dosage STARBASE participants performing slightly better than lower-dosage participants on both the academic achievement measures and survey items in high school.

High school graduation

After high school, students' academic achievement was assessed in terms of on-time high school graduation and college enrollment. The Minnesota Department of Education provided aggregate data on students' on-time high school graduation rates, meaning graduation by the end of their fourth year of high school. Phase II of the study examined the high school graduation rates of Cohorts 1 and 2, and comparable data were added for Cohort 3 once available in Phase III.

Overall results

Looking at all three study cohorts combined, 77 percent of STARBASE and 74 percent of comparison students graduated from high school on time. The overall difference was not statistically significant.

ON-TIME HIGH SCHOOL GRADUATION (N=883)

Results varied by cohort, with Cohort 2 showing the strongest results and a statistically significant difference in favor of STARBASE. Graduation rates were slightly higher for STARBASE than comparison students in Cohort 1, and did not differ between STARBASE and comparison students in Cohort 3. Consistent with the earlier dosage pattern, higher-dosage students performed better than lower-dosage students in on-time high school graduation overall. Differences were significant in the comparisons between the higher- and lower-dosage STARBASE groups (79% vs. 68%) and between the higher-dosage STARBASE group and comparison group (79% vs. 74%).

Perfect-match analysis

High school graduation rate analyses were also performed on a subset of the study population: the 594 study participants (297 pairs) who matched on all nine characteristics of interest. Results were more favorable for the STARBASE group than in the analysis of all study participants. In the perfect-match analysis, 80 percent of STARBASE students and 74 percent of comparison students graduated from high school on time, and the difference was statistically significant. In establishing the study's matching criteria, researchers strove to balance the size and representativeness of the sample with similarity of matches. Although study pairs were very similar overall, results looked more favorable for STARBASE when demographic differences between STARBASE and comparison students were further controlled in the perfect-match analysis. This provides additional evidence of potential long-term program effects.

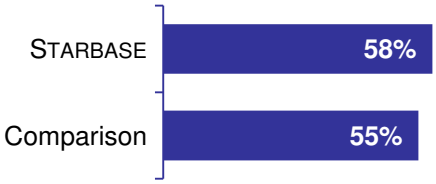
College enrollment

Wilder Research also examined STARBASE and comparison students' college enrollment, based on individual student-level data obtained from the National Student Clearinghouse. Data reflect whether study participants enrolled in college by fall 2011, which would have been just over two years after high school graduation for Cohort 1 if they graduated on time, just over a year after high school graduation for Cohort 2, and the fall after high school graduation for Cohort 3. Phase II reported college enrollment rates as of fall 2010 for Cohorts 1 and 2, and researchers obtained updated enrollment data for all three cohorts as of fall 2011 in Phase III.

Overall results

As with the on-time high school graduation analysis, overall results favored STARBASE but were not statistically significant. As of fall 2011, 58 percent of former STARBASE participants and 55 percent of comparison students had enrolled in college. Results varied by cohort in a pattern similar to the high school graduation data. The modest pattern observed in earlier analyses of STARBASE students with a higher dosage performing better than those with a lower dosage did not emerge in the college-enrollment analysis.

COLLEGE ENROLLMENT BY FALL 2011 (N=884)



College enrollment data were also analyzed based on college characteristics and students' demographic characteristics. A majority of both STARBASE and comparison students who enrolled in college enrolled in public and four-year universities, and almost all attended colleges in Minnesota. Overall, there were no significant differences in college enrollment between STARBASE and comparison students based on their demographic characteristics. However, although differences were not significant, there was a clear pattern of a higher percentage of STARBASE than comparison students enrolling in college within each demographic category.

Perfect-match analysis

As with the high school graduation data, college-enrollment data were also examined for the subset of STARBASE and comparison study participants matching on all nine characteristics of interest. In this analysis of only the 297 perfectly matched pairs, a 4-percentage-point difference separated the two groups (60% of STARBASE vs. 56% of comparison), vs. the 3-percentage-point difference in the analysis of all 442 study pairs. The difference was not significant, although results again appeared more favorable for STARBASE when demographic differences between STARBASE and comparison students were controlled to the extent possible.

Military enrollment

In assessing the program's impact on STEM career interests, Wilder Research also examined STARBASE and comparison students' military enrollment, including civilian and uniform military careers. Data were provided by a U.S. Air Force official. Based on searches in the DoD Global Directory Service, 3 percent of former STARBASE participants and 2 percent of comparison students were enrolled in the military in winter 2011-12. These data are considered to be conservative estimates and should be viewed with caution. In some cases, there was more than one person in the military database with the same name, and an exact match to study participants could not be confirmed.

Study implications and recommendations

The STARBASE program should be credited for undertaking a rigorous study providing an independent examination of long-term program outcomes. Demonstrating long-term impacts can be challenging, even when initial results are strong. Results of Wilder Research's study are favorable for the STARBASE program and suggest possible long-term program impacts, although there were not consistent statistical effects. This suggests it may be important to find ways of sustaining and building on participants' STEM interests and skills over time. Study results can inform the program's efforts to sustain program effects, as well as any future studies of its long-term impact.

Supporting long-term program impacts

Results of Wilder Research's surveys of former STARBASE participants in high school and college suggest they had relatively limited participation in other STEM activities after STARBASE, despite crediting the program with positively influencing their STEM interests. Finding ways to support students' continued STEM learning and exploration may be particularly important for a predominantly low-income population who may have limited access to other similar opportunities. The program has taken a number of steps to support participants' STEM learning beyond STARBASE.

STARBASE Minnesota provides school teachers with pre- and post-lessons for their classes at school and a curriculum overview with alignment to standards to help integrate programming into school curricula. Students can also participate in post-STARBASE "Clubhouse" activities via the STARBASE website, and earn lanyards and pins for successful completion of these STEM lessons. Beginning in the 2011-12 school year, STARBASE Minnesota also partnered with afterschool programs at some of its Minneapolis sites to implement the national DoD STARBASE 2.0 mentoring program. With the help of volunteer mentors from the community, STARBASE 2.0 aims to reinforce and build on STARBASE program concepts when students reach middle school. Looking to the future, STARBASE Minnesota is pursuing a STEM "Pathways" model, described below.

STEM Pathways model

In Phase II of the study, STARBASE Minnesota supported development of a STEM program inventory to identify other community organizations and programs able to support participants' STEM interests and learning after STARBASE. Wilder Research compiled a directory of 171 local STEM programs and organizations, now available on the STARBASE Minnesota website. Based on this information as well as relationships developed through the Minnesota STEM Network, STARBASE identified potential community partners for a STEM Pathways model.

The STEM Pathways model would link STARBASE Minnesota with local STEM collaborators to form a STEM pipeline for participants. STARBASE would partner with other community organizations to sustain and build on its participants' STEM interests and skills over time. In the model's initial design, STARBASE Minnesota would collaborate with at least five other local STEM programs to connect former STARBASE participants to informal STEM education opportunities from their time in STARBASE through middle school and to high school graduation. Additionally, if available at participants' schools, Pathways students would attend the STARBASE 2.0 mentoring program when they were in middle school.

The model's intent is to increase the likelihood of sustaining initial STARBASE program impacts over time. By collaborating with other programs, STARBASE would leverage existing community resources, thereby minimizing additional costs to any single program. Partnering programs would be reviewed by STARBASE to ensure they provide programming consistent with the STARBASE mission. Given its potential relevance to the national STARBASE program, the model would also be designed to be potentially transferrable to other locations.

Future study directions

STARBASE leadership have expressed a commitment to research. An ongoing evaluation at the national level assesses the program's short-term results, and leadership have expressed interest in continuing to assess the program's long-term impacts. Wilder Research's long-term follow-up study of STARBASE Minnesota points to possible directions and considerations for future studies.

Prospective study. One possible direction for a future study would be a prospective study in which program participants and comparison group students are followed from their time in the program forward. Wilder Research's initial study was retrospective in that it followed up on students several years after they participated in the program. A prospective study would enable researchers to assess changes in STARBASE-comparison group differences over time, and maintain better contact with study participants as they progress through school and beyond. A key study question which might be addressed moving forward is whether the STARBASE effect could be enhanced by STARBASE 2.0 and/or Pathways.

Additional details on how this question could be studied are provided in the summary in the full report document.

Additional impacts. It is possible that STARBASE has long-term impacts which were not reflected in the outcomes measured in this study. For example, there could be long-term impacts on students' college major, career choices, critical thinking skills, or motivation to learn. Wilder Research's study addressed college major and career interests to some extent, but only for STARBASE participants in college and not the comparison group. In its future planning, the program can use results of Wilder Research's study to consider what long-term outcomes should and can reasonably be expected and measured following STARBASE participation.

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For more information

This summary presents highlights of the *STARBASE Minnesota long-term follow-up study: Overall results* report. This report and other reports on related topics are available at www.wilderresearch.org.

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