AFTERSCHOOL STEM QUARTERLY RESEARCH REVIEW

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AFTERSCHOOL STEM HUB

Hello!

Welcome to the winter 2025 issue of the Afterschool STEM Quarterly Research Review (ASQRR). This publication from the Afterschool STEM Hub aims to provide you with the latest and most relevant findings from the field of out-of-school time (OST) science, technology, engineering, and mathematics (STEM) education.

Well-designed afterschool programs nurture positive youth development and build awareness of various career pathways without being prescriptive about which path youth should follow. This is why afterschool programs that engage young people in STEM are so important, especially today and for the foreseeable future. Operating outside the confines of the standard school-day structure and curriculum requirements, afterschool STEM programs offer a low-risk environment for project-based learning that empowers youth agency and skill-building in effective communication, teamwork, and problem-solving.

While afterschool programs often serve elementary school students, many also serve middle and high school youth. Attracting and retaining older youth in afterschool STEM programs, however, requires different incentive structures and support systems than for younger students. With this in mind, the Afterschool STEM Hub is developing a policy agenda that supports older youth and acknowledges their unique needs in afterschool. In this edition, we are highlighting two articles that focus on afterschool STEM programs effectively engaging middle and high school youth:

- Price, C. A., Tai, R. H., & La Nguyen, C. (2025). A longitudinal study of a museum-based out-of-school time program's impact on STEM career pathways. Journal of Applied Developmental Psychology, 100, 101854.
- Blanchard, M. R., Gutierrez, K. S., Swanson, K. J., & Collier, K. M. (2023). Why do students attend STEM clubs, what do they get out of it, and where are they heading? *Education Sciences*, 13, 480.

These articles demonstrate that implementing long-term programming that incorporates positive youth development principles, creates welcoming environments, establishes career connections with appropriate representation, and affirms youth agency is a model practice for attracting and retaining older youth. For each article, we present a general summary followed by implications for practice, research, and policy.

We hope you find the issue helpful and informative for your practice, research, or policy work in afterschool STEM education. We also invite you to share your feedback, suggestions, and questions with us at stemhub@afterschoolalliance.org. We would love to hear from you and learn more about how the ASQRR can support your interests and needs.

Thank you for reading and subscribing to the ASQRR. We look forward to bringing you more high-quality and timely research in the next issue. Until then, happy reading, learning, applying, and advocating!

Sincerely,
The ASQRR Editorial Team,
Anita Krishnamurthi, PhD
Leslie Brooks, DVM, MPH
Amanda Sullivan, PhD (National Girls Collaborative Project)
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STUDY REVIEW

A longitudinal study of a museum-based out-of-school time program's impact on STEM career pathways.

Price, C. A., Tai, R. H., & La Nguyen, C. (2025). A longitudinal study of a museum-based out-of-school time program's impact on STEM career pathways. *Journal of Applied Developmental Psychology*, 100, 101854. https://www.sciencedirect.com/science/article/pii/S0193397325001017

STUDY SUMMARY:

This study measured the lasting influence of a museum-based OST STEM program on adolescent youth as they matriculated through college. The museum program, rooted in Positive Youth Development (PYD) principles (a framework for adolescent development that emphasizes the strengths and potential of youth), focused on empowering youth to utilize their existing skills and initiative.

Typically beginning in 9th grade, youth in the program started as "Science Minors," visiting the museum for about five to six hours every Saturday for ten weeks. During these sessions, they participated in team-building and science communication activities that focused on a different scientific topic every ten weeks. At the end of the session, they presented their work to museum guests in an interactive gallery. Youth advanced to "Science Achievers" after completing their Science Minors program and completed at least 40 hours of volunteer service to the museum, usually by assisting guests on the floor. As Achievers, they participated in modular sessions—usually two to three ten-week sessions per school year—focused on topics like youth leadership, college readiness, communication, and one rotating science topic. They served as peer mentors on the museum floor, setting up activities and interacting with guests. In addition, there was also an optional, paid summer intern program focused on floor activities, led by program alums who returned from college during their summer break.

The authors found that program participants had significantly higher rates of overall college graduation and were 3.23 times more likely to pursue a STEM major compared to youth who did not participate in the program. The program's success suggested that incorporating PYD principles and empowering youth to utilize their existing skills strongly impacted long-term educational attainment, including persistence in STEM.

KEY TAKEAWAY:

Long-term participation in a science museum-based out-of-school time (OST) program, rooted in Positive Youth Development (PYD), for teens can lead to higher college graduation rates, higher rates of graduating with a degree in STEM, and an increased likelihood of beginning a STEM career compared to teens who do not participate in a comparable program. Findings from this study demonstrate the substantial efficacy of OST STEM programs in shaping young people's future educational and career paths.

POPULATION:

A total sample of 228 youth participated in this study. The demographics of the participants were as follows: White (79 youth), Hispanic/Latino (53 youth), Black/African American (38 youth), those who selected two or more races (28 youth), and Asian/Asian American (19 youth). Of the 228 participants, 224 were included in this paper's gender analysis (97 males and 127 females). Youth in the treatment group (i.e., the museum program) entered the program in high school. In contrast, the control group (youth not participating in the program) was recruited when they were 17 years or older, had already graduated high school, and had not yet begun post-high school education or work. Because the study spanned seven years, participants' ages ranged from early adolescence to their mid-twenties by the end of the study period.

RESULTS:

Results from this study indicate several long-term impacts of museum-led OST programming grounded in PYD principles. Key findings include the following:

- **Increased likelihood of graduating with a STEM degree:** Compared to the control group, alumni of the museum program were more likely to graduate with a STEM degree.
- **Increased likelihood of returning to a STEM major:** The paths the two groups took in college differed, with program alumni more likely to return to a STEM major even if they temporarily dropped out.
- **No differences based on gender or race/ethnicity:** The authors found no significant differences across demographic subgroups based on gender and race/ethnicity. However, they point out that the sample sizes for making these comparisons were small.
- **The success of a PYD-aligned program:** The authors found that the success metrics listed above were achieved, even though the program's primary focus was on youth empowerment and the use of existing skills, rather than explicitly encouraging STEM careers. This indicates that PYD principles—such as empowering youth and building their initiative—are highly effective mechanisms for promoting long-term persistence in STEM educational and career pathways.

CONCLUSIONS:

This longitudinal study demonstrates the substantial, lasting efficacy of museum-led STEM programs in shaping future educational and career paths. Participation in the program examined in this article was a robust predictor of persistence, resulting in significantly higher rates of overall college graduation and STEM degree attainment compared to the control group. Crucially, the program's positive influence persisted through college and was effective across all gender and race/ethnic identities studied. The authors intend for this work to serve as a catalyst for future research into the extended, multi-year effects of informal STEM education.

METHODS:

Researchers conducted a seven-year quasi-experimental, longitudinal study to examine the impact of a science museum-based OST program on youths' STEM career pathways throughout their college experience and beyond graduation. Through annual surveys, the authors followed three cohorts of program graduates along with a control group recruited from museum visitors.

STUDY IMPLICATIONS

IMPLICATIONS FOR PRACTICE:

- **Design Stem Programs Rooted in PYD Principles:** OST program designers should ensure their curriculum focuses on developing youth's initiative, leadership skills, and self-efficacy (core PYD principles) alongside building technical STEM skills, foundational STEM knowledge, and interest in STEM careers. This combined approach ensures youth gain both the social-emotional skills needed for persistence and the technical knowledge required for academic and career success.
- **Create Opportunities for Sustained Engagement:** The authors emphasize that a key element of successful PYD programs is consistent, meaningful program activities over a long period. They point out, however, that this is not common in museums, which emphasize short, stand-alone visits. Institutions like science centers and museums should consider designing programs for long-term engagement (e.g., multiple years of participation) rather than short, one-time workshops to make a lasting impact.

IMPLICATIONS FOR RESEARCH:

- **Conduct Longitudinal Research:** The findings from this paper underscore the need for more longitudinal studies to better understand the delayed, long-term impacts of informal learning experiences on college and career choices and pathways.
- **Examine the Impact of Specific Programmatic Elements:** Future research should further explore how specific design elements (e.g., sense of belonging, peer culture, practitioner opportunities) interact to foster persistence in STEM.

IMPLICATIONS FOR POLICY:

- **Fund and Sustain Long-Term OST Programs:** Policy should prioritize increased, consistent funding for OST programs, particularly those embedded in cultural institutions, such as museums and science centers, that demonstrate a measurable, long-term impact on STEM pathways persistence. This funding should recognize the longitudinal nature of the impact, moving beyond short-term grant cycles.
- **Incentivize Cross-Sector Partnerships:** Policymakers should create incentives (e.g., tax breaks, grants) for formal education systems (e.g., K-12 schools and universities) to collaborate with informal learning institutions (e.g., museums, science centers). This collaboration would help integrate and validate the critical role of the OST sector in achieving national educational and workforce goals in STEM fields.

STUDY REVIEW

Why do students attend STEM clubs, what do they get out of it, and where are they heading?

Blanchard, M. R., Gutierrez, K. S., Swanson, K. J., & Collier, K. M. (2023). Why do students attend STEM clubs, what do they get out of it, and where are they heading? *Education Sciences*, 13, 480. https://doi.org/10.3390/educsci13050480.

STUDY SUMMARY:

This study explored the factors that motivate and sustain youth participation in afterschool STEM clubs. Funded by the National Science Foundation, monthly afterschool STEM clubs were offered at no cost and included a snack and transportation home afterwards. The STEM clubs met six times in year one (spring semester) and 12 times in each of the two subsequent years. "Teacher-coach" teams, consisting of six teachers, led and supported the clubs at each school. 54% of the teacher-coaches were science or math teachers. The clubs intentionally built connections to relevant STEM careers, and club activities included collaborative peer discussions, data collection and analysis, and engagement with STEM professionals from backgrounds similar to those of the club participants. The STEM clubs explored a variety of topics, including health and medicine, circuits, coding, and climate science.

The researchers developed surveys to evaluate students' perceptions of the STEM clubs, including how the clubs impact students at times when they are not actively participating. The survey also included an open-ended question asking students what they understood the club's purpose to be. The interviews explored what students liked or disliked about the program, what they found useful, how it compared to school, and how they envisioned their futures in STEM, including their plans after high school. The researchers also analyzed the data to determine which demographic characteristics were associated with high club attendance and with perceptions of the club.

KEY TAKEAWAY:

Youth value participating in afterschool STEM clubs because they find the clubs interesting and feel their experiences contribute meaningfully to the development of skills needed for their short- and long-term goals (e.g., helping them do better in a STEM course). Students who attended more than two-thirds of STEM club sessions were more likely to express future STEM career aspirations than those who attended less frequently.

POPULATION:

Study participants included youth aged 11-14 who attended afterschool STEM clubs in four rural middle schools in the Southeastern United States. Across the four sites, 98% of students received free/reduced-price lunch, 62% were Black, 30% were White, 5% were Hispanic, and <2% were Native American.

METHODS:

This was a longitudinal, mixed-methods study spanning three years. Data collection included tracking club attendance, administering pre- and post-club surveys (only post-club surveys were included in the final analysis), and conducting student interviews at the end of each academic year.

RESULTS:

Across demographics, students enjoyed STEM clubs, felt they were learning relevant skills, perceived participating in STEM as attainable in their futures, and believed club activities were valuable in preparing them for those futures.

- **Club participation correlated with STEM career interest:** While the majority of participants expressed interest in pursuing a STEM career, students with the highest attendance rates were most likely to express STEM career aspirations. Students attending clubs less than one-third of the time, however, did show an increase in STEM-focused career goals as they progressed through middle school.

- **Attainment, utility, identity, and intrinsic values motivated club participation:** Youth felt the purpose of the STEM clubs was to enhance their STEM knowledge (attainment) and to contribute to their short- and long-term goals (utility), with eighth-grade students expressing the most interest in learning about STEM careers. 40% of participants reported having much in common with club members, contributing to a sense of belonging through shared identities. 99% of students expressed intrinsic values as motivators for attending the clubs, such as pure enjoyment, noting that the activities were different and "more fun" than typical school-day activities. Students also appreciated that the club activities were not tied to testing. However, 21% of students reported costs associated with attending the club (e.g., a long bus ride home or arriving home late).

- **Students who were more racially represented by the teacher-coaches expressed a greater sense of belonging:** While there were no reported differences in what students experienced based on their race or gender, students identifying as Black—the majority of club participants—were significantly more likely than Hispanic, White, and Native American students to agree that STEM club leaders seemed open to their ideas or feedback about the club. At all schools, club teacher-coaches were more racially representative of Black students than of students from other races.

CONCLUSIONS:

Well-designed and engaging afterschool STEM clubs can meet students' social and career exploration needs, assuming barriers to participation are reduced, and opportunities for positive interactions with both educators and STEM professionals are increased. Youth who attend clubs more frequently may be more likely to be interested in future STEM careers. It should be noted, though, that this study does not evaluate whether club attendance itself enhanced students' interest in STEM careers or whether high-attendance students were already interested in STEM careers before the commencement of the STEM clubs, thus driving their high attendance rates.

STUDY IMPLICATIONS

IMPLICATIONS FOR PRACTICE:

- **Seek to Understand Youth Motivations for Participation:** Understanding the sources of motivation that bring youth to afterschool programs and keep them participating can help practitioners identify which aspects of career-centric learning are most valuable to elevate in programming. This study found that nearly all students expressed an intrinsic value for the program—that they came because they enjoyed it. However, very few students across all grade levels perceived the purpose of their STEM clubs in terms of intrinsic value (e.g., "to have fun"). Most students perceived the purpose of STEM clubs as attainment (e.g., "to help educate us") or utility (e.g., "to inform kids about different careers"). Given this discrepancy between what youth understood as the purpose of STEM clubs and what they said when asked to explain their motivation for attending, it may be fruitful to ensure that the purpose of STEM clubs includes a way for youth to recognize their intrinsic value.

- **Discover and Address Costs of and Barriers to Participation:** 21% of youth referred to "costs" of participating in the club, such as finding it boring, disagreeing with certain policies, or getting home late. It may be worthwhile to engage with youth early on to understand which students are most vulnerable to incurring these costs, how these costs balance against the value of attending, and what resources are needed to mitigate them. To further minimize barriers to participation, provide clubs at no cost to students, offer transportation home, and include snacks.

- **Invest in Educator Professional Development:** Educators who facilitate clubs should participate in culturally responsive professional development to provide a supportive environment for all students, regardless of background. Educators can cultivate receptive skills to foster students' ideas and feedback, enhancing feelings of belonging and club cohesion.

- **Design Clubs Based on Student Motivations:** Engage youth in fun, stimulating activities with opportunities to interact with STEM professionals from backgrounds similar to theirs. When feasible, try to ensure STEM club leaders reflect the racial backgrounds of youth participants. Ensure adult facilitators understand students' initial motivations for attending the clubs, why some discontinue, and why others keep coming back. Understanding students' motivations can inform the design and activities of the clubs based on what youth say they are interested in, excited about, and need, rather than assuming adult views of motivation accurately reflect those of students.

IMPLICATIONS FOR RESEARCH:

- **Analyze Pre-Participation Data on STEM Career Interest:** When evaluating similar clubs, collect and analyze both pre- and post-data on career interests to better understand how club participation influences career interests and whether those interests change over time.

- **Conduct Youth Follow-Up Studies:** Follow up with students once they are in high school and after graduation to see what decisions they ultimately make. This will require securely maintaining their contact information and obtaining permissions in advance.

IMPLICATIONS FOR POLICY:

- **Invest in Afterschool Programs as a Place for STEM Career Exploration:** In this study, it cannot be determined whether STEM clubs enhanced participants' interest in STEM careers or whether students participated in the clubs because they were already interested in STEM careers. Regardless, students who attended the clubs most frequently were also most interested in STEM careers. Situating STEM career resources in afterschool programs can help support and sustain students' interest in STEM careers.
- **Mitigate Barriers to Attending Afterschool Programming:** Increase funding for comprehensive afterschool programs, such as 21st Century Community Learning Centers, so that young people can participate for free, receive a snack, and have transportation home. In rural settings, transportation costs (financial and time) can be significant, so creative partnerships and incentive structures should be explored to minimize these barriers.
- **Fund Educator Professional Development:** In addition to ensuring club leaders receive ongoing STEM professional development, it is equally important to ensure they receive appropriate development in culturally responsive programming and inclusivity. Educators who are skilled in empowering youth to share their perspectives create a welcoming, receptive environment that can help to sustain young people's sense of connection to STEM.

We hope you enjoyed exploring this issue! Additional similar publications are listed below. Until our next issue, you can also read more about research highlighting the updated evidence of afterschool STEM in our research brief as well as explore evaluation summaries of afterschool programs in the Afterschool Alliance's Impacts Database. You can also follow us on LinkedIn to learn more and stay up to date on what we are working on.

You can register for our upcoming newsletters and receive a copy of any articles that are not open access by completing this Google form.

ADDITIONAL PUBLICATIONS TO NOTE

Amanova, C., & Dymond, J. (2024). Teen participants' experiences with a teen STEM café program. *International Journal of Science Education*, Part B, 15(2), 199–209. https://doi.org/10.1080/21548455.2024.2351599

Hill, P.W., Kelly, G.M., McQuillan, J., et al. (2024). Exploring the associations of afterschool science participation and friendships with science identities. *Res Sci Educ.*, 54(6), 1155-1172. https://link.springer.com/content/pdf/10.1007/s11165-024-10173-6.pdf

Levine, R. S., & Viano, S. (2025). Promising Practices of Out-of-School Time Programs for Low-Income Adolescents: A Systematic Review. *Journal of Adolescence*, 97(5), 1145-1160. https://doi.org/10.1002/jad.12506

Meschede, T., Haque, Z., Warfield, M. E., et al. (2022). Transforming STEM outcomes: Results from a seven-year follow-up study of an after-school robotics program's impacts on freshman students. *School science and mathematics*, 122(7), 343-357. https://onlinelibrary.wiley.com/doi/abs/10.1111/ssm.12552

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