AFTERSCHOOL STEM QUARTERLY RESEARCH REVIEW

October 2025

AFTERSCHOOL STEM HUB

Hello!

Welcome to the Fall 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.

In this edition, we are focusing on how afterschool programs are promoting artificial intelligence (AI) literacy. Afterschool programs across the nation are working to ensure our youth of today are prepared for both the workforce of tomorrow and to be STEM-literate, engaged citizens. This includes becoming aware and educated about the role of AI in our present and future lives. With much momentum propelling investments in AI, including the Presidential AI Challenge and the national AI Action Plan, afterschool programs must be included as indispensable partners for investment.

Given the rapidly evolving landscape of AI, we have veered from our traditional format for this issue to begin with an expert opinion piece from Tara Chklovski, founder and CEO of Technovation. Tara has been thinking deeply about the use of AI in learning, and we are delighted to present her thoughts on the issues we need to pay attention to as we grapple with how we enable students to use this tool thoughtfully in afterschool programs.

We then present a review of the following article, along with its implications for practice and policy, per our normal practice in ASQRR issues:

- Rabinowitz, G., Moore, K.S., Ali, S., et al. (2025). Study of an effective machine learning-integrated science curriculum for high school youth in an informal learning setting. *International Journal of STEM Education*, 12(1), 23.

This article demonstrates how afterschool STEM programs and informal learning environments are uniquely situated to provide hands-on opportunities for youth to explore and engage with emerging technologies such as AI.

We end by featuring two afterschool programs in which youth have been exploring and discussing AI for quite some time: STEMArts Lab in New Mexico and the Boys and Girls Clubs of Western Pennsylvania.

We hope you will find the issue useful 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 -
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Leslie Brooks, DVM, MPH
Amanda Sullivan, PhD (National Girls Collaborative Project)
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EXPERT OPINION EDITORIAL

AI in Afterschool: Shaping Learning Beyond ChatGPT

Author: Tara Chklovski, Founder & CEO, Technovation

AI is advancing rapidly, and afterschool educators are on the front lines of its impact. Today, AI models can execute bite-sized, practical tasks like drafting a week of activity plans for engineering week, complete with the time each activity and transition will take and materials needed. By 2026-2027, we can anticipate AI models to independently execute three-month-long projects, such as creating a school's digital magazine and website. The AI model would create an editorial calendar, draft articles from online interviews, edit copy, lay out the content, publish to the web, and conduct accessibility checks. Such possibilities raise a pressing question: what skills should we prioritize so students can thrive in an AI-augmented world?

Photo credit: Tara Chklovski, Founder & CEO, Technovation

On the opportunity side, these powerful tools enable us to tackle some of the world's most pressing challenges, such as eradicating poverty, hunger, and inequality for all. On the challenge side, there is a real danger of "metacognitive laziness." A Stanford study found that AI-supported tutors improved short-term engagement but not long-term test outcomes. Similarly, research on AI-assisted writing showed stronger essays without deeper knowledge growth. These findings suggest that without intentional scaffolding, AI may help students be more engaged but not necessarily learn more.

At Technovation, we've seen this tension up close. Since 2016, students have used AI to tackle community problems with mentor support. As AI grows more capable, many steps—problem identification, coding, planning, even pitch videos—can now be automated. The one element that cannot be automated is user testing, where students must demonstrate real-world impact. AI allows students to prototype and iterate faster, but it also forces us to double down on future-ready skills: systems thinking, rapid prototyping with AI, empathy, resilience, and navigating uncertainty.

This highlights a broader caution. As institutions rush to adopt AI tutors in the name of "personalized learning," we risk falling into a trap. On the surface, tailoring content to each learner's interests sounds engaging—but in practice, it can be boring. It's like the "For You" algorithm on social media: watch one type of video, and you're flooded with more of the same, leaving students stuck in a narrow, one-dimensional loop. As a result, students miss out on discovering new passions and developing intellectual breadth. We've all experienced how a gifted educator can transform dull subjects into fascinating explorations. Too much personalization can be the opposite of a good education. Overexposure to chatbots can also make interactions feel hollow and fatiguing, undermining their effectiveness.

Afterschool programs offer the antidote. They create space for exploration, collaboration, and human connection. They can pair students with industry mentors and build rich networks of support—social capital, career guidance, authentic feedback—that no AI can replicate. Used thoughtfully, AI can accelerate the "how," but human mentorship, purpose, and community engagement will always define our "why."

STUDY REVIEW

Study of an effective machine learning-integrated science curriculum for high school youth in an informal learning setting.

Rabinowitz, G., Moore, K.S., Ali, S., et al. (2025). International Journal of STEM Education, 12(1), 23. https://doi.org/10.1186/s40594-025-00543-5

STUDY SUMMARY:

This study reports on the design, implementation, and evaluation of a new Machine Learning (ML) curriculum for high school youth that was implemented through the Science Research Mentorship Program (SRMP) Summer Institute, a STEM workforce development program at the American Museum of Natural History. The curriculum's goals were to encourage AI literacy by providing students with foundational ML knowledge and skills, while also increasing their self-efficacy and interest in ML careers. Researchers designed the curriculum to be an engaging and accessible experience, specifically focusing on supporting youth from backgrounds underrepresented in STEM. Findings showed that participants demonstrated significant gains in ML knowledge and skills, along with an increased sense of self-efficacy in learning ML. The curriculum was especially effective at achieving these gains among racially and socioeconomically underrepresented youth.

RESULTS:

Results demonstrated that the curriculum effectively taught ML concepts and skills to high school youth in an informal, summer learning setting. Key findings include the following:

- **Participants gained ML knowledge and self-efficacy:** The study found significant gains in both technical skills and how the youth felt about ML, demonstrating that participants not only acquired ML knowledge but also increased their self-efficacy in learning ML concepts.
- **Knowledge gaps between groups decreased:** On average, participants who identified as female and non-white showed greater learning gains than their white male peers, narrowing gaps in ML knowledge, skills, and self-efficacy identified in pre-survey scores.
- **An informal learning environment was an effective setting to introduce ML:** This study took place in an informal setting (a summer program at a museum). The positive findings related to knowledge and self-efficacy described above support using informal learning environments as effective spaces for teaching complex STEM education.

KEY TAKEAWAY:

Machine Learning (ML) is increasingly prevalent in STEM fields, making early exposure and AI literacy crucial for today's young people. Informal learning settings provide a unique and strategic opportunity for young people to engage with ML and develop these skills. Implementing ML curriculum in informal settings may be especially effective at engaging and supporting youth from backgrounds underrepresented in STEM, helping bridge existing knowledge and self-efficacy gaps.

POPULATION:

42 New York City high school students participated in this study. Of the participants, 60% were female, 19% identified as Black or African American, and 33% identified as Hispanic. Thirty-three percent of participants reported an annual household income below the poverty line for the region.

METHODS:

A mixed-methods approach was used, which included pre- and post-surveys measuring cognitive and affective learning outcomes, formative assessments via daily "exit tickets" (i.e., questions prompting students to apply their knowledge using open-ended responses), and semi-structured interviews to determine which aspects of the curriculum were most impactful.

CONCLUSIONS:

As ML becomes more common in STEM, it is vital for young people interested in STEM careers to experience ML and AI curricula while in school. Findings from this study suggest that when thoughtfully designed, an ML curriculum implemented in informal learning settings can effectively enhance high school students' understanding and confidence in ML concepts, especially for those from underrepresented groups in STEM.

STUDY IMPLICATIONS

IMPLICATIONS FOR PRACTICE:

- **Integrate ML into Existing STEM Curricula:** ML concepts should be integrated into STEM curricula for high school youth in a hands-on, contextualized manner.
- **Leverage Informal Learning Environments:** Program designers should leverage informal settings, such as museums and afterschool programs, as highly effective avenues for teaching complex, emerging STEM skills and topics. They offer a flexible, engaging alternative to traditional classrooms and are particularly successful at reaching and supporting underrepresented youth.
- **Focus on Affective Outcomes:** Educators should design curricula that not only build knowledge and skills but also intentionally foster self-efficacy and interest in STEM areas like AI and ML.

IMPLICATIONS FOR RESEACH:

- **Validate Assessment Tools:** The authors note that further analysis with a larger sample is needed to establish the construct validity of the ML Concept Inventory (MLCI) used in this study. Researchers should work to validate this instrument across different populations to ensure its appropriateness as a measure of ML knowledge.
- **Investigate Long-Term Impacts:** Longitudinal studies are needed to determine the extent to which gains in ML (and STEM more broadly) knowledge and self-efficacy from short interventions persist over time and influence students' academic and career pathways.

IMPLICATIONS FOR POLICY

- **Fund Informal STEM Education:** Policymakers interested in building an AI/ML-ready workforce should allocate resources to informal learning organizations, recognizing their unique ability to deliver effective and equitable STEM education.
- **Support Educators' Professional Development:** To successfully implement such complex curricula, educators (formal and informal) require robust training. Policies should support ongoing professional development programs that equip educators with the content knowledge and pedagogical skills needed to teach emerging STEM fields like ML effectively.

PROGRAM SPOTLIGHTS

STEMarts Lab

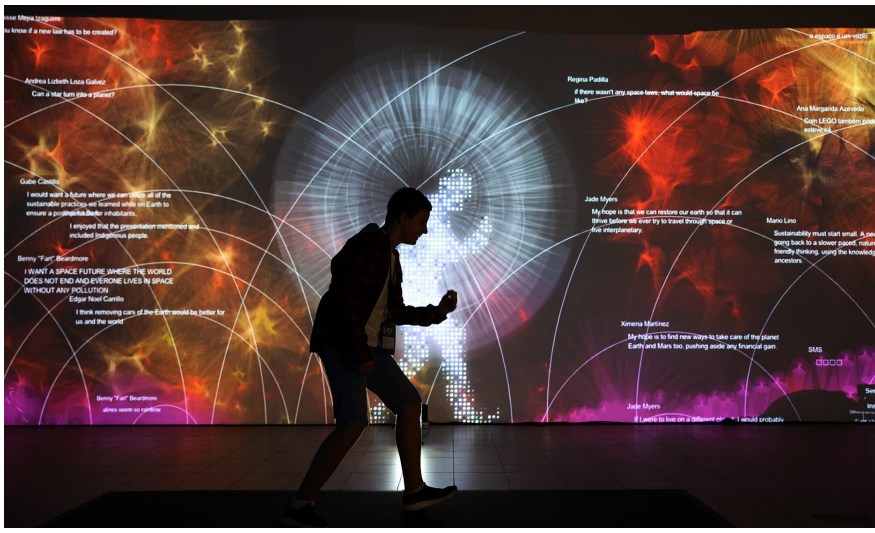

Photo credit: Malu Tavares, STEMarts Lab

STEMarts Lab is a STEAM-focused initiative that empowers youth ages 14-25 through immersive learning experiences blending STEM and art. The organization's mission is to prepare young leaders for the workforce by offering real-world experience in digital media, emerging technologies such as AI, and space science while fostering critical, creative, and ethical thinking. STEMarts Lab's AI Futures and Data Science program empowers youth to explore AI, data science, and space through an interdisciplinary lens. Throughout the years-long program, youth conduct research and interview community members to identify pressing needs that can be met with the help of AI tools. Utilizing ChatGPT, Perplexity, Claude, Suno, Loveable, and NotebookLM, the youth leverage generative AI to support their creativity in addressing local challenges. Throughout the process, the youth are supported by mentor scientists, artists, and cultural specialists. STEMarts Lab also collaborated with the PASEO festival in New Mexico on an AI in Action Forum, which featured a conversation to help people better understand what AI is, how it works, and how it can be used for good. Agnes Chavez, the program's Executive Director, states, "We want to empower youth and citizens to participate in shaping an ethical and inclusive AI future."

Boys and Girls Clubs of Western PA

Photo credit: Boys and Girls Clubs of Western Pennsylvania

The Boys and Girls Clubs of Western Pennsylvania hosts the Artificial Intelligence Pathways Institute (AIPI) Activation Camp, which is a free, three-week summer program designed for rising 9th–12th grade students to explore the fundamentals of AI. Through hands-on learning and real-world applications, students gain a strong foundation in what AI is, how it works, and its potential impact on our world. The camp culminates in an exciting competition day, where participants put their skills to the test in a variety of AI challenges, from navigating robotics courses to creating AI-generated music. AIPI Activation Camp empowers students to understand and apply AI in meaningful ways, preparing them for future careers and a world increasingly shaped by new technology.

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 and 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 updated on our work.

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

Ma, M., Ng, D. T. K., Liu, Z., et al. (2025). Fostering responsible AI literacy: A systematic review of K-12 AI ethics education. Computers and Education: Artificial Intelligence, 8. https://doi.org/10.1016/j.caeai.2025.100422

Mitchell, J., Dong, J., Yu, S., et al. (2024). Bridging the gap: early education on robot and AI ethics through the Robot Theater Platform in an informal learning environment. Association for Computing Machinery, 760–764. https://doi.org/10.1145/3610978.3640581

Sanusi, I. T., Martin, F., Ma, R., et al. (2024). AI MyData: Fostering middle school students' engagement with machine learning through an ethics-infused AI curriculum. Association for Computing Machinery, 24(4), 1–37. https://doi.org/10.1145/3702242

Solyst, J., Peng, C., Deng, W. H., et al. (2025). Investigating youth AI auditing. Association for Computing Machinery, 2098–2111. https://doi.org/10.1145/3715275.3732142