

Training High School STEM Teachers in Generative AI for Classroom Use and funded by NSF BPE Program

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Abstract

Generative artificial intelligence (Gen AI) holds significant potential for transforming STEM education, yet high school teachers face barriers to adoption including limited technical knowledge and institutional constraints. This paper presents a structured professional development (PD) program, funded by NSF, which addresses these challenges through a hybrid model of intensive summer training followed by year-long collaborative support. The program equipped educators with practical skills in Gen AI and strategies for integrating it into curricula while addressing ethical and policy concerns. Results from the initial 2025 cohort show a marked increase in teacher confidence and competence, with participation demand exceeding targets. Findings demonstrate that immersive, sustained PD can effectively prepare STEM educators to leverage AI as a tool for enhancing student learning and foster a more equitable, future-ready workforce.

Introduction

Generative Artificial Intelligence (Gen AI) has rapidly emerged as a transformative technology with profound implications for education. Since the release of ChatGPT in 2022, Gen AI tools have entered the mainstream, offering new possibilities for enhancing teaching and learning. However, high school STEM teachers, often on the front lines of educational innovation, face significant barriers to integrating these tools into their classrooms. These challenges include a lack of technical familiarity, limited confidence in using AI pedagogically, and restrictive or uncertain school policies regarding AI adoption. [1] Many educators express enthusiasm about the potential of Gen AI to enrich student learning, yet they feel unprepared to harness its capabilities effectively. This gap between interest and implementation represents a critical opportunity for structured professional development (PD) that equips teachers with both the knowledge and the strategic skills needed to navigate this evolving landscape. [2]

This paper outlines a comprehensive PD program, funded by the National Science Foundation's Broadening Participation in Engineering (BPE) program, designed to address these challenges. The program aims to empower educators through technical training, community building, and ongoing support. By fostering AI competency among teachers, the initiative seeks to enhance STEM education, promote equity in AI access, and prepare students for an increasingly AI-driven world.

Program Design and Objectives

The AI-ED program is structured as a three-year initiative, recruiting 10 high school STEM teachers annually from districts near Boston with an emphasis on schools serving populations underrepresented in STEM. The program employs a hybrid PD model, combining an intensive summer institute with sustained, year-long collaboration [3]. This design is informed by best practices in teacher PD, which emphasize continuous support and community engagement to ensure lasting impact [4].

The program began with introductory virtual modules delivered via Zoom meetings, covering the history of AI and foundational concepts. This prepared participants for the core component: a week-long, immersive summer PD session. During this intensive training, teachers engaged with topics such as prompt engineering, ethical AI use, identifying AI hallucinations, and strategies for integrating Gen AI into STEM lesson plans. The PD also addressed policy concerns, equipping teachers to advocate for AI integration with school administrators by demonstrating how Gen AI can enhance, not diminish, student learning.

Following the summer institute, teachers participated in callback sessions throughout the academic year and presented together as a panel at a local STEM teacher conference. These experiences fostered a collaborative learning community, allowing educators to share experiences, refine AI-informed lesson plans, and receive guidance from the project team.

Key deliverables included the development of individual Action Plans and AI-based lesson plans, which teachers are currently integrating into their STEM instruction.

Implementation and Initial Outcomes

The program was first launched in the summer of 2025 with an initial cohort of 12 teachers—exceeding the planned cap of 10 due to high demand. This overwhelming response underscores the acute need for AI-focused PD among educators. Post-program feedback indicates a dramatic shift in participant attitudes and confidence. Teachers who began with minimal AI experience reported feeling equipped and empowered to use Gen AI in their classrooms. This transformation highlights the program's effectiveness in building both technical proficiency and pedagogical confidence. [5]

Participant feedback also informed immediate and next year's program adjustments, such as incorporating more hands-on prompt engineering exercises and discussions on AI policy navigation. These refinements will enhance future offerings, ensuring the PD remains responsive to teacher needs and AI technological advancements which are changing quickly. [6], [7]

Intellectual Merit and Broader Impacts

The intellectual merit of this initiative lies in its multifaceted approach to educator development. The program:

1. Engages high school teachers in cutting-edge AI pedagogy.
2. Enhances classroom teaching through focused Gen AI integration.
3. Creates a replicable PD model for AI education.
4. Increases teachers' leadership skills regarding AI in education.
5. Incorporates iterative feedback to continuously improve the PD experience.

The broader impacts are substantial and align with NSF's goals for broadening participation. Annually, the program directly impacts approximately 600+ students, primarily from underrepresented groups, through the teachers' classrooms. The program also:

- Strengthens engineering education by embedding AI concepts into STEM curricula.

- Disseminates high-quality, AI-informed teaching materials nationwide.
- Promotes a more diverse, AI-literate STEM workforce.
- Expands reach through presentations and workshops at local science and engineering teacher conferences.
- Embodies a transformative opportunity to reshape high school education for the AI era.

Conclusion

The NSF AI-ED program represents a timely innovation in K–12 education. By equipping high school STEM teachers with the skills, knowledge, and support needed to integrate Gen AI into their teaching, the initiative addresses both technical and policy-related barriers. The successful launch in 2025 demonstrates strong demand and positive outcomes, with teachers reporting increased confidence and competence. As AI continues to evolve, such PD programs will be crucial in ensuring that educators can leverage these tools to enhance learning, foster equity, and prepare students for the future. The program's model of combining intensive training with sustained collaboration and resource dissemination offers a valuable blueprint for similar efforts nationwide, ultimately contributing to a more informed and innovative educational landscape.

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References

- [1] S. Sharma and M. Elaish, “Extending AI-TPACK: Reframing teacher readiness for the Generative-AI era,” *Journal of educational thought*, vol. 58, no. 2, p. 111, 2025.
- [2] C. Leon, J. Lipuma, and X. Oviedo-Torres, “Artificial intelligence in STEM education: a transdisciplinary framework for engagement and innovation,” *Frontiers in Education*, vol. 10, 2025, doi: 10.3389/feduc.2025.1619888.
- [3] S. Loucks-Horsley, N. Love, K.E. Stiles, S. Mundry & P.W. Hewson. *Designing professional development for teachers of science and mathematics* (2nd ed.). Thousand Oaks: Corwin Press, 2003.
- [4] L. Darling-Hammond, M.E. Hyler & M. Gardner. *Effective teacher professional development*. Learning Policy Institute, 2017.
- [5] A. Bandura, W. H. Freeman, and R. Lightsey, “Self-efficacy: The exercise of control,” *Journal of Cognitive Psychotherapy*, vol. 13, no. 2. Springer Publishing Company, pp. 158–166, 1999. doi: 10.1891/0889-8391.13.2.158

- [6] M. M. Kennedy, “How does professional development improve teaching?,” *Review of educational research*, vol. 86, no. 4, pp. 945–980, 2016, doi: 10.3102/0034654315626800
- [7] L. M. Desimone, A. C. Porter, M. S. Garet, K. S. Yoon, and B. F. Birman, “Effects of professional development on teachers’ instruction: Results from a three-year longitudinal study,” *Educational evaluation and policy analysis*, vol. 24, no. 2, pp. 81–112, 2002, doi: 10.3102/01623737024002081