Partnerships for Informal Science Education in the Community colorado.edu/outreach/pisec
Director: Dr. Jessica Hoehn jessica.hoehn@colorado.edu

PISEC Afterschool Program

What is PISEC

The *Partnerships for Informal Science Education in the Community* (PISEC) program connects CU Boulder volunteers with local K-12 students to engage in inquiry-based science activities in a playful, engaging, and welcoming environment. Working primarily with students from groups underrepresented in STEM, PISEC seeks to support students' development of their own science identity and to cultivate and sustain students' interest in science by providing transformative and empowering experiences. Simultaneously, we offer valuable teaching, science communication, and leadership experience for the program volunteers. PISEC is committed to sustaining mutually beneficial partnerships with schools and community organizations, providing opportunities for CU mentors and K-12 students to develop relationships over the course of a semester.

PISEC began in 2008 and its design was based on the core principles of The Fifth Dimension, an afterschool program that started at University of California San Diego in the 1980s. The Fifth Dimension (5D) was a program focused on improving kids' computer literacy through the use of technology, social interaction, and play in a diverse, welcoming, and imaginative setting. Based on the 5D model, the PISEC program has been designed around the perspective that CU mentors (undergraduate and graduate students) are not "giving" science to student participants, but are engaging in authentic partnership in the context of the community and culture created by the participants, their teachers, and administrators at PISEC partner sites. Key elements of the program include: (a) valuing diversity and striving to create equitable and inclusive science environments, (b) volunteers and students engaging as peers, (c) emphasizing student agency, (d) blending social and scientific activity, and (e) blending play with educational activities.

What does it look like?

The afterschool program consists of hour-long weekly sessions and typically runs for 10 weeks. Each semester, the curriculum focuses on one physics topic (mechanics, electricity & magnetism, optics & light, thermodynamics & matter, or astronomy), and we bring ~25 different activities/experiments related to that topic. Students work in groups alongside a CU mentor and choose which experiments they want to do and how they want to do them. On a given day, students select an activity, gather materials (provided by the PISEC program), read the open-ended prompt, and begin experimenting. Along the way, students document their work in their own science notebooks or through videos.

To achieve a playful environment and break down traditional power dynamics, PISEC employs the narrative that volunteers are sent by an entity known as "Mission Control." This secret group of scientists provides the materials required for the program and is interested to learn about the experiments the students conduct. This structure allows the students and mentors to engage as peers throughout the program, and also provides opportunities for students to have fun interacting with Mission Control through their notebooks and video communications. Together with their CU mentor, students work through a 'game board' that organizes the science activities into four topical "rooms" and

three complexity “levels.” Students determine their own path through the game board, earning prizes along the way for completing different “missions.” They can also design their own experiments and request additional materials.

The PISEC curricula are available to view at the following links.

Mechanics - English & Spanish
Electricity and Magnetism - English & Spanish
Optics and Light - English & Spanish
Thermodynamics and Matter - English & Spanish
Astronomy - English & Spanish

Research on PISEC

Education research demonstrates that middle school is a crucial time to support students in cultivating interest in STEM, and that participation in out-of-school time science activities impacts students’ interest and decision to pursue STEM in college [1, 2]. Additionally, a large body of research documents the importance of students’ development of an identity as a scientist and a sense of belonging within STEM (e.g., [3-7]). These factors are disproportionately important for marginalized students historically underrepresented in, and excluded from, STEM disciplines. As such, the PISEC primary program works with students in late elementary to middle school years in an afterschool environment designed specifically to support students’ interest, identity development, sense of belonging, and agency.

Past and ongoing research on PISEC documents a variety of benefits for student participants, including gains in conceptual understanding of physics, increased sense of agency and ownership over their scientific learning, development of science communication skills, and increased interest in science [8, 9]. Additionally, the students themselves report that the program is fun and that they appreciate the freedom to choose and design their own experiments [10]. We anticipate that there are also long term impacts of the program (e.g., decisions to go to college and/or pursue STEM)—research investigating these impacts is ongoing.

Research on PISEC has also demonstrated a variety of benefits for the volunteers, including increased content mastery, development of science communication skills, shifts in perspectives around public engagement as a scientist, and development of a sense of belonging to a community [8, 11, 12]. Our institutions and organizations also benefit from PISEC through creating pathways and opportunities for students, developing meaningful relationships, and sustaining mutually beneficial partnerships.

NOTE: To document impacts such as those listed above and to continue to improve the program, PISEC collects data for ongoing research studies at each program session. Data collected are in the form of video and audio of students and mentors engaging in activities, student artifacts (notebooks, videos, etc.), and occasionally interviews. The program director will pass out consent forms at the beginning of the program such that students and their parents/guardians can opt in to the research study. Inclusion in the research study is entirely voluntary and students’ participation in the program will not be impacted by opting in or out.

Expectations

A successful PISEC program requires a partnership between CU and the community partner. Listed below are some general expectations for each party, though we can tailor program logistics, details, and structures to suit the specific context and student population. These items should be collectively agreed upon by the PISEC director and community partner.

What CU does:

- Provide program director and site leader to oversee and manage the program
- Provide recruitment materials (e.g., flyer, video)
- Design and provide pedagogically relevant content
- Organize logistics, timing, management of program
- Recruit, train, and bring CU mentors to partner site
- Provide equipment and materials for programmatic activities
- Attend to issues as they arise (with mentors, logistics, equipment, etc.)
- Host students at CU for an end of semester field trip
    - Cover associated costs (parking pass, planetarium, materials for demos, etc.)
- Collect data, conduct research studies, document impacts
- Share outcomes

What community partner does:

- Recruit students (typically 20+, need minimum of 10 regular students)
- Partner in contextualizing content to student populations and local culture
- Partner in connecting content to other related programming / school content
- Assist with research consent forms
    - (distributing, reminding students, collecting signed forms, etc.)
- At least one person (e.g., teacher/coordinator) present during each program session to:
    - Engage with students
    - Help with discipline
    - Help coordinate logistics
- Store materials during the semester
- Fund the bus and substitute teacher (if applicable) for the field trip
- Partner on design and implementation of research studies

---

[1] A. V. Maltese & R. H. Tai, *Sci. Educ.*, 95 (2011).
[2] K. P. Dabney, *et al.*, *Int. J. Sci. Educ.*, 2 (2012).
[3] H. B. Carlone & A. Johnson, *J. Res. Sci. Teach.*, *44* (2007).
[4] Z. Hazari, *et al.*, *J. Res. Sci. Teach.*, *52* (2015).
[5] E. Seymour & A.B. Hunter, *Talking about Leaving Revisited* (2019).
[6] K. L. Lewis, *et al.*, *Phys. Rev. Phys. Educ. Res*, *12* (2012).
[7] K. Rainey, *et al.*, *Int. J. STEM Educ.*, *5* (2018).
[8] N. D. Finkelstein & L. Mayhew *AIP Conf. Proc.*, *1064* (2008).
[9] R. Wulf, *et al.*, *AIP Conf. Proc.*, 1513 (2013).
[10] B. L. Fiedler, *et al.*, *PERC Proc.* (2018).
[11] K. Hinko & N. D. Finkelstein, *PERC Proc.* (2012).
[12] C. Fracchiolla, *et al.*, PERC Proc. (2016).