

Malinda S. Zarske

Integrated Design Engineering | College of Engineering and Applied Science | University of Colorado Boulder
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Faculty member with the Integrated Design Engineering program at the University of Colorado Boulder, teaching undergraduate product design and core courses, as well as instructor for the CU Teach Engineering program, teaching STEM education courses for pre-service teachers. Research interests include: the effects of intrateam segregation on engineering teams, the impacts of project-based service-learning on student identity—especially women and nontraditional demographic groups in engineering, pathways to and through K-12 and undergraduate engineering, teacher education, and curriculum development. Brings 25+ years of STEM teaching experience and passion for hands-on engineering design to university classes and the community.

PROFESSIONAL PREPARATION

PhD	University of Colorado Boulder	Civil engineering, environmental	2012
	Dissertation: Impacts of Project-Based Service-Learning on Attitudes towards Engineering in High School and First-Year Undergraduate Students Advisor: Angela R. Bielefeldt		
MS	University of Colorado Boulder	Civil engineering, environmental	2002
MA	The Johns Hopkins University	Teaching, secondary science	1998
BS	St. Mary's College of Maryland	Biology	1995

ACADEMIC AND WORK EXPERIENCE

College of Engineering and Applied Science (CEAS), University of Colorado Boulder

August 2019 – present	<i>Associate Director Undergraduate Engineering, Integrated Design Engineering</i> Work with the Integrated Design Engineering program (IDE; formerly Engineering Plus) administration and faculty to improve messaging and marketing, increasing our college presence, highlighting our new pathways and student achievements, leadership in Student and Professional Advisory Boards, and outreach and recruitment to current undergraduate and high school students about IDE and CU Teach Engineering. Coordinate and lead weekly meetings for first-year engineering projects course faculty across multiple departments. Mentoring of new faculty. Accountable for shared organizational goal setting, achievement and reporting of results, hiring processes of new faculty and staff, and connecting/networking with IDE alumni. <i>Part of college-wide Inclusive Culture Committee, Principal Instructor Review Committee (PIRC), Cross-departmental Teacher Quality Framework Initiative (TQF) / Programs Faculty Learning Community (FLC), Scholarship Committee, Faculty Governance Organizing Committee, First Year Seminar Common Curriculum Task Force, CEAS Humanities & Social Sciences subcommittee, New Venture Challenge Judging committee, Mission Zero CU Boulder Advisory Board, Faculty Advisor for IDE Student Advisory Board</i>
August 2014 – present	<i>Teaching Professor</i> (2022-Present), <i>Associate Teaching Professor/Senior Instructor</i> (2019-2022), <i>Instructor</i> (2014-2019), <i>Integrated Design Engineering Research</i> : engineering education, innovative curriculum development, project-based service-learning, student identity, pathways/retention to and through K-12 and undergraduate engineering, and teacher education

Areas of expertise: Undergraduate engineering education, K-12 engineering education, engineering design instruction, project-based service learning, engineering professional identity, curriculum development, and teacher professional development

Teaching:

- *First-Year Engineering Projects* (GEEN 1400) and *Engineering Projects for the Community* (GEEN 2400), both interdisciplinary, hands-on design-build-test courses that guide student teams in entrepreneurial product development for Colorado clients.
- *Invention and Innovation* (GEEN 3400), a junior/senior level course on the business and product development aspects of entrepreneurial engineering design, including industry research, intellectual property, financial planning, and business ethics.
- *Basic Electronics* (GEEN 3010), a junior-level hands-on circuits course for non-electrical engineering majors.
- *Teaching Design* (GEEN 4400), a hands-on curriculum and instruction course for junior and senior engineering students concurrently earning secondary teaching licenses.
- *First Year Engineering Seminar* (COEN 1830), a required seminar course for all first-year engineering students to help them examine different aspects of being a university scholar.
- *Step 1* (EDUC 2020) and *Step 2* (EDUC 2030) through the University's CU Teach Engineering program, both courses that encourage engineering, science, and mathematics students to explore teaching as a career by providing first-hand experiences co-teaching science/math lessons in local K-12 classrooms.
- Supervises and mentors undergraduate students' teaching semesters through CU Teach Engineering

Diversity:

- Teach online, national K-12 teacher *workshops* on implementing engineering design pedagogy in the K-12 classroom and how to align curricula with national standards through the *TeachEngineering* Digital Library project.
- Teaches *Engineering Projects* summer course through the College of Engineering's diversity-serving programs summer bridge experiences for rising first-year undergraduates.
- Faculty advisor for the Boulder section of the *Society of Women Engineers* (SWE).

Curriculum Development and Dissemination:

- Co-lead of First Year Design Projects for all departments/units in the college
- Member of First Year Seminar common curriculum planning committee

Publishes and presents program results nationally.

June 2023 –
present

Faculty Director, Lattice Scholars Program, CEAS

Work with the CEAS Lattice Scholars leadership team to support first-generation engineering students from across Colorado with academics and financial literacy. Assist Lattice team in leading and coordinating Lattice programming across the college and externally, conduct administrative activities, serve as faculty advisor for students, coordinate additional advisors as warranted by program growth, lead assessment of program goals, and participate in Lattice retreats and events.

- 2012 – 2014 **Director, K-12 Engineering Education, BOLD Center**
 Oversaw a multi-faceted K-12 engineering program focused on underserved students, to improve student retention and performance throughout the college. Accountable for shared organizational goal setting, budget management, achievement and reporting of results. Mentored and managed graduate and undergraduate engineering fellows who teach in local K-12 classrooms through the ITL Program's TEAMS initiative, including design and delivery of pedagogy training and instilling self-efficacy for and awareness about engineering career pursuits. Faculty advisor for the Boulder section of the *Society of Women Engineers* (SWE). On the development and editorial teams for the *TeachEngineering* digital library. Published and presented program results nationally.
- 2011 – 2013 **Instructor, Integrated Teaching and Learning (ITL) Program**
 Taught *First-Year Engineering Projects* (GEEN 1400), an interdisciplinary, hands-on design-build-test course with a focus on product development, oral and written communication skills, project management, and teamwork. Guided student teams in entrepreneurial product development to create affordable living innovations that meet design requirements for clients throughout Colorado communities.
- 2002 – 2009 **ITL K-12 Engineering Education Coordinator, ITL Program**
 Implemented a multi-faceted K-12 engineering program focused on underserved students. Annually mentored and managed ~12 graduate and undergraduate engineering fellows in local K-12 classrooms, including design and delivery of pedagogy training. Oversaw the development of K-12 engineering education curricula for inclusion in the NSF-funded *TeachEngineering* digital library. Developed, coordinated and co-taught *Creative Engineering Design* (engineering design elective course at DSST Stapleton High School, 2004-2009), developed and co-taught *K-12 Engineering Outreach Corps* (CEAS, 2004-2005) and developed and co-taught summer K-12 student classes and teacher professional development (2002-2009).
- 2000 – 2002 **Engineering GK-12 Fellow, ITL Program**
 Under the NSF GK-12 grant, developed and taught original engineering curricula weekly to elementary school students. Curricula created as a Fellow was later incorporated into the *TeachEngineering* digital library and is still widely used today by elementary teachers nationwide.
- 1999 – 2000 **Middle School Teacher, Shaw Heights Middle School, Westminster, CO**
 Taught sixth-grade science and math. Developed new sixth-grade science curriculum.
- 1997 – 1999 **High School Teacher, Broadneck High School, Annapolis, MD**
 Taught biology, marine biology and physical science using engineering design projects. Part of the team that created and implemented a new, district-wide biology curriculum.
- 1995-1996 **Natural Resources Water Specialist, Maryland Department of Natural Resources, Annapolis, MD**

ADDITIONAL RELEVANT ACADEMIC LEADERSHIP EXPERIENCE

- 2020 –2023 **Chair**, *Commission on P-12 Engineering Education, American Society for Engineering Education*
Manage advisory team for ASEE Board of Directors, including budget, monthly communication and planning with P-12 team and ASEE. Commission vets P-12 engineering initiatives within ASEE and provides recommendations to the ASEE BOD around those initiatives.
- 2009 –2011 **Chair**, *Pre-College Division, American Society for Engineering Education*
Managed 12th-largest ASEE division (of 50), including budget, monthly communication and planning with P-12 project team, and annual reports to ASEE Board.

AWARDS and NOMINATIONS

- Max S. Peters Faculty Service Award*, CU Boulder, December 2023 (nominated)
Outstanding Mentor Award, CU Boulder, October 2023
ASEE's Sharon Keillor Award for Women in Engineering Education (nominated 2021, 2022)
Max S. Peters Faculty Service Award and Outstanding Faculty Advisor/Mentor Award, CU Boulder, (both nominated 2021)
Institution Faculty of the Month, National Residence Hall Honorary (NRHH), September 2020
The John and Mercedes Peebles Innovation in Education Award, CU Boulder, May 2020, (additional nomination 2022)
Sullivan-Carlson Innovation in Education Award, CU Boulder, May 2019
Student Team Project People's Choice Awards, Engineering Design Expo, Fall 2015, Fall 2016, Spring 2017, Fall 2017, Spring 2019, Fall 2019, Spring 2020, Fall 2020, Spring 2022, Fall 2022
Meritorious Service Award, ASEE Pre-College Engineering Education Division, 2017
Best Paper Award, ASEE Pre-College Engineering Education Division, 2012
Best Poster Award, GEARS Graduate Symposium, College of Engineering and Applied Science, CU Boulder, 2010
Employee Recognition Award, College of Engineering and Applied Science, CU Boulder, 2008
Best Teacher Award, Broadneck High School, 1998

ENGINEERING and ENGINEERING EDUCATION GRANTS

- University of Colorado Boulder College of Engineering Interdisciplinary Research Themes (IRT) Seed Grant*, An Intersectional Analysis of Student Experiences and Perceptions in First-Year Engineering Projects Classes; **PI**. \$6,981, Jan-July 2021
- University of Colorado Boulder Research & Innovation Seed Grant: Increasing Diversity and Inclusion in STEM: A Multi-Study Effort Examining the Effects of Intrateam Role Segregation on Team Effectiveness and Career Outcomes of Underrepresented Students in Engineering*; **co-PI**. \$44,970, 2020-2021
- Engineering Excellence Fund (EEF) Grant: ITL Advanced Electronics Computing Stations*; **PI**. \$3,000, 2019
- NSF Grant: TeachEngineering: Democratizing Engineering Education for PK-12 Teachers*; **co-PI**. DGE 19141701, \$3.2M, August 2019-present
- NSF Grant: TeachEngineering: Expanding & Sustaining Curriculum Access for K-12 Teachers*; **co-PI**. DGE 1544495, \$900K, 2015-2019

NSF GK-12 Track 3 Grant: Engineering for Society—An Energy and Environmental Sustainability Research Pathway to Cultivate Engineering Leaders and Enrich Education for Disadvantaged Youth; co-PI. DGE 0946502, \$3.4M, 2010–2018

Engineering Excellence Fund (EEF) Grant: Electronics Testing Equipment and Reusable Project Supplies for Design-based Circuits Course; PI. \$3,000, 2017

NSF REE Grant: Inclusive Excellence to Bolster Diversity: A System of Capacity-Building Pathways To and Through Engineering; senior personnel. EEC 1160264, \$536K, 2012-2016

NSF IEECI Grant: RedShirt Transitional Program: Creating Engineering Capacity and Expanding Diversity through Strategic Partnerships; co-PI. EEC 0835907, \$100K, 2009-2011

NSF Track 2 GK-12: Inspiring and Building Tomorrow’s Workforce: A Grades 3-12 Engineering Continuum; co-PI. DGE 0338326; \$1.9M; 2004-2009

NSF NSDL Digital Library Grant: TeachEngineering—Hands-On Resources for K-12; senior personnel. DUE 0226322; \$575,886, 2003-2004; and DUE 0532709; \$683K, 2005-2009

FIPSE Grant, US Department of Education: Development of a Hands-On, Integrated, Standards-Based Grades 3-6 Engineering Curriculum co-PI. \$307K, 2003 – 2005

COURSES TAUGHT (*Denotes course both developed and taught)

First-Year Engineering Projects, interdisciplinary engineering design course for entry-level students

*Engineering Projects for the Community**, sophomore-level interdisciplinary engineering design course

Invention and Innovation, junior/senior-level interdisciplinary entrepreneurial engineering design course

*Basic Electronics**, junior level circuits course for non-electrical engineering majors

First Year Engineering Seminar, first-year engineering seminar around being a university scholar

Step 1: Inquiry Approaches to Teaching, curriculum and instructional experience in elementary schools

Step 2: Inquiry-Based Lesson Design, curriculum and instructional experience in secondary schools

*Knowing and Learning for Engineers**, educational psychology course focused on STEM development

*Teaching Design**, engineering curriculum/instructional design for upper-division engineering students

Education and Practice, seminar and supervision of secondary STEM student teachings in local schools

*K-12 Engineering Outreach Corps**, upper-division university engineering technical elective

*Creative Engineering Design**, engineering design elective course at DSST Stapleton High School

*K-12 teacher & counselor professional development & K-12 student electives**, engineering design

Middle and high school math and science classes in Maryland and Colorado public schools

K12 WORKSHOPS TAUGHT

Integrating Engineering into Your STEM Curriculum, GRTE 5040, 1 cr, CU Teach Engineering national, online teacher training, 2014-Present

Anchoring Engineering Activities – Engineering Design and Prototyping Skills, GRTE 5040, 1 cr, CU Teach Engineering national, online teacher training, 2017-Present

Teaching NGSS Engineering and Design Thinking using TeachEngineering Digital Library, ASEE Annual Conference, Tampa, FL, June 2019

Teaching Design: A Methods Course for Teaching the Engineering Practices of the NGSS Framework, UTeach Consortium Annual Meeting, Austin, TX, May 2019

Incorporating Engineering into Step 1 and Step 2 courses, UTeach Consortium Annual Meeting, Austin, TX, May 2019

Engineering Student Teachers: Fitting STEM licensure WITH an Engineering Undergraduate Degree Program, UTeach Consortium Annual Meeting, Austin, TX, May 2016, 2017, 2018

Engineering lessons and hands-on activities for use in science, engineering, and math classrooms and informal settings, BVSD Science Teacher Training, August 2015

CUTeach Engineering: Putting the "E?" into STEM for All Students, Colorado Association of Science Teachers, Denver, CO, November 2015

Engineering lessons and hands-on activities for use in science, engineering, and math classrooms and informal settings, ASEE Annual Conference, Seattle, WA, June 2015

TeachEngineering: K-12 Engineering Digital Library, ITEEA Annual Conference, Long Beach, CA, March 2012

TEAMS K12 Teacher Summer Workshop, Boulder Valley and St. Vrain School Districts, 2002-2012 *Engineering is Elementary*, St. Vrain School District, 2013

Front Range Guidance Counselor Workshop, 2008, 2013

Various weeklong K12 teacher engineering content workshops, summers 2002- 2007

PROFESSIONAL SOCIETY MEMBERSHIP AND LEADERSHIP

American Society for Engineering Education (ASEE), Member, 2002-present

ASEE Board of Directors *Commission on P-12 Engineering Education*, Chair, 2020-2023, Member 2017-present

ASEE Board of Directors *Commission on Diversity, Equity, and Inclusion (CDEI)*, Member, 2018-present

ASEE Pre-College Division, Immediate Past Chair 2011-13, Chair 2009-11, Chair Elect 2008-09

Society of Women Engineers (SWE), Member, 2012-present

ADDITIONAL EDUCATIONAL AND SERVICE ACTIVITIES

Dissertation/Thesis Committees

Schill, Sabina, Ph.D. 2021. *Understanding Undergraduate Student Mentors' STEM Identity Development in K-12 STEM Outreach Programs: A Phenomenographical Approach*, Advisor: Angela Bielefeldt

University of Colorado & College of Engineering

Advisory Board Member, Mission Zero CU Faculty Advisors, Mission Zero Fund at University of Colorado Boulder, 2021- Present

Faculty Advisor, College of Engineering Society of Women Engineers (SWE) student chapter, 2012-Present

Faculty Member, College of Engineering Teaching Professor Promotion Review Committee, 2023- Present

Faculty member, College of Engineering's Inclusive Culture Committee, 2020-Present

Faculty member, College of Engineering's Scholarship Committee, 2012- Present

Faculty Representative, College's cross- departmental Teacher Quality Framework Initiative (TQF) and Programs Faculty Learning Community (FLC), 2021-22

Faculty Member, College of Engineering's Faculty Governance Organizing Committee, 2019-22

Advisory Boards

Advisory Member, *St. Vrain Valley Innovation Center*, St. Vrain Valley School District, 2022-Present

Advisory Member/University Liaison, *E4USA AP Engineering Course*, University of Maryland (lead), 2019-Present

Advisory Board Member, *Million Moonshot Girls Initiative*, *STEM Education Insights LLC*, 2022 - Present. Program aimed at the development of an educational assessment tool for out of school time middle school engineering.

CEAS IDEA Plan Representative, *CU IDEA Council*, Spring 2022. Team held comprehensive review of the University's Inclusion, Diversity, and Equity in Academics (IDEA) Plan.

Advisory Board/Professor Team, *JUMP into STEM*, U.S. Department of Energy, 2021–2022.

Advisory Board/Professor Team, *Mission Zero*, 2021–Present. Organization partnering with CU Boulder to provide opportunities for students to work on climate change.

Advisory Board Member, *Advancing Excellence in P-12 Engineering Education (AE3)*, 2021-2024. In collaboration with ASEE, the Framework for P-12 Engineering Learning provides practical guidance for P-12 engineering learning goals to support engineering literacy.

Advisory Board Member, *Ohio Northern University/Ohio State University/Olathe Northwest High School NSF DRK-12 Grant*, 2018-2022. Grant to develop curricula and assessment for engineering problem-framing design content.

Advisory Board Member, *Utah State University NSF Grant*, 2017-2021. Grant seeks to develop a model of disciplinary literacy in engineering from practicing engineers.

Advisory Member, Extended Network of Professional Development (PD) Providers, *Engineering Is Elementary*, Boston Museum of Science, 2018-Present.

Advisory Board Member, *Purdue University /Utah State University NSF DRK-12 Grant*, 2010-2013. Grant explores engineering design as a STEM learning experience for diverse high school students.

Invited Panels, Presentations, and Participation

Invited Faculty Panelist, *Engineering Connections: A Blueprint for Navigating Challenges III*, November 2023. Topic: First year engineering challenges and Imposter Syndrome.

Invited Panelist, *National Innovation and Leadership Institute*, September 2022. Hosted by St. Vrain Valley Schools. Topic: Engineering Industry/Organization Panel.

Invited Judge, *New Venture Challenge*, Spring 2022. Competition: Cross-Campus Collaboration Team Competition pitches - Eligible teams have at least 2 co-founders from different colleges.

Invited Presentation, *Los Alamos National Labs Summer Physics Camp for Young Women*, July 2021. Topic: Engineering Pathways for Women and CU College of Engineering.

Invited Presentation, *ASEE P-12 Educator Series*, April 2021. Topic: Engineering Teacher Professional Development Standards and Program Endorsement.

Invited Faculty Address, *College of Engineering Graduation Ceremony*, University of Colorado Boulder, December 2020.

Invited Presentation, *STEM Leadership Alliance webinar*, January 2020. Topic: Effective Strategies for STEM Integration: Moving into Action.

Invited Presentation, *Phillips 66 Case Study Challenge* (LEEDS and Engineering), Boulder, October 2019. Topic: Design and Design Thinking.

Invited Workshop, ASEE PCEE, *Tampa*, June 2019. Topic: Using *TeachEngineering* to bring design thinking and NGSS engineering standards into your classroom.

Invited Participant, *Engineering Dean's Institute*, San Antonio, April 2019. Topic: P-12 Engineering Education: Status and Opportunities.

Invited Guest Lecture, *CU Engineers Without Borders student chapter*, Engineering Exploration Series Boulder, February 2019. Topic: Your Choice. Your Design. Your Future! Nurture all your passions with a degree in Engineering Plus.

Invited Presentation, *Colorado Space Business Roundup*, Denver, December 2018. Topic: Education: STEM's Impact on Student's Interest in Space.

Invited Presentation, *2016 STEM Think Tank*, Nashville, July 2016. Topic: Teaching engineering design to K-12 students and curricular resources for K-12 engineering.

Invited Presentation, *Colorado Science Educators Network and Boulder Valley School District*, 2015, 2016. Topic: Teaching engineering design to K-12 students and curricular resources.

Invited Webinar, *TeachEngineering Digital Library: Publishing Searchable K12 Engineering Curricula*, Sparkfun, Boulder, July 2015

Invited Presentation and Judge, *Colorado State Science Fair*, 2013. Topic: Cu Engineering and What Is Engineering?

Invited Participant, *National Center for Engineering and Technology Education* (NCETE), August 2011. Caucus to bring together experienced leaders in K-12 to discuss the development and implementation of engineering design in STEM settings at the high school level.

Invited Participant, *NSF-Sponsored Rigorous Research in Engineering Education Program Workshop* (RREE), August 2010. RREE's Exploring How People Learn Engineering workshop to improve the research methodologies of people with prior experience in conducting engineering education research.

Journal and Proposal Reviews

Manuscript Reviewer, *Journal of P-12 Engineering Education Research (JPEER)*, 2011-present.

Manuscript Reviewer, *Advances in Engineering Education (AEE)*, 2011-present.

Manuscript Reviewer, *Journal of Engineering Education (JEE)*, 2010-2016.

Manuscript Reviewer, *American Society for Engineering Education*, 2002-present.

Proposal Reviewer, *NSF Research Initiation Grants in Engineering Education (RIGEE)* review panel, 2011.

UNDERGRADUATE STUDENT RESEARCH MENTORED

1. Robert Wang, 2022-23, Multidisciplinary Engineering Programs: Does combining engineering focus areas with courses outside of traditional engineering add value to students' degree and career pathway?, *Discovery Learning Apprentice*
2. Timothy Cooper, Spring 2022, How can we improve teaching topics of professionalism in engineering projects courses and develop ready-to-use resources that demonstrate professionalism through a lens of equity?, *Independent Study*
3. Griffin Bouton, 2021-22, Female student's success in team-based engineering, *Discovery Learning Apprentice*
4. Shreenija Vadayar, 2021-22, Engineering Plus: The Journey to a Vivid Understanding, *Discovery Learning Apprentice*

5. Evan Wetzel, 2021-22, An intersectional analysis of student experiences and perceptions in first-year engineering projects classes, *Research Assistant*
6. Luke Waeldner, Spring 2021, How do peer interactions in an active learning environment affect a woman's confidence as an engineer?, *Research Assistant*
7. Tia Decolati, 2020-21, A multi-study effort examining the effects of intrateam role segregation on team effectiveness and career outcomes of underrepresented students in engineering, *Research Assistant*
8. Yamelit MedinaLopez, 2020-21, How can we encourage design thinking in local schools and companies and develop ready-to-use resources? The research resulted in a new online Girls in STEM networking workshop for students in grades 8-12, that focused on career and college pathways in STEM, *Independent Study*
9. Jennifer Kracha, 2019-20, How can we incorporate the study of ethics into the main project courses such that the material is meaningful to the students and builds off the context of each class?, *Independent Study*
10. Megan Keogh, 2018-19, How do peer interactions in an active learning environment affect a woman's confidence as an engineer?, *Discovery Learning Apprentice*
11. Amy Lenneman, 2019-2019, Evaluation of novel middle school mentoring program to improve mentee experience, *Discovery Learning Apprentice*
12. Katie Waugaman, 2017-2018, How do these engineering ethics lessons affect students' perspectives of an engineering education?, *Discovery Learning Apprentice*
13. Maia Vadeen, 2015-2016, How does engineering knowledge and teaching knowledge intersect for undergraduate engineering students?, *Discovery Learning Apprentice*
14. Jaclyn Cunitz, 2014-2015, How is community formed in a new, diverse engineering major without set classes?, *Discovery Learning Apprentice*
15. Madison Gallipo, 2013-2014, Does four years of engineering education at the high school level, when taught by qualified teachers, significantly increase a students' interests and attitudes towards engineering, as well as increase the number of students who pursue an engineering – related path after high school?, *Discovery Learning Apprentice*
16. Samantha Maierhofer, 2012-2013, Does training students in team dynamics improve course outcomes and student experiences?, *Discovery Learning Apprentice*
17. Dana Schnee, 2012-2013, Do projects involving direct interaction with a community client have a greater and more enduring impact on students' skills when compared to service-themed projects and projects lacking community collaboration?, *Discovery Learning Apprentice*
18. Meg Podlegar, 2008-2009, By creating engineering based lesson plans and activities, we can engage young students early on in understanding engineering as a possible future career, *Discovery Learning Apprentice*
19. James Prager, 2008-2009, Developing chemical engineering activities for advanced high school students, *Discovery Learning Apprentice*
20. Benjamin Sprague, 2008-2009, developing innovative K-12 engineering physics curricula for a nationally disseminated digital library project, *Discovery Learning Apprentice*

PEER-REVIEWED ENGINEERING EDUCATION AND ASSESSMENT PUBLICATIONS

* denotes undergraduate student co-author

1. Wang, R.*, **Zarske M.** (2023) "Does Combining Engineering Focus Areas with Courses outside of Traditional Engineering Add Value to Students' Degree and Career Pathway?"

Proceedings, ASEE Annual Conference, Baltimore, MD

2. **Zarske M.**, Lacerenza C., Wetzel E.*, Bouton, G.*. (2022) "Female Student Attitudes Towards Engineering: Are They Influenced by the Roles They Take on Project Teams?" *Proceedings*, ASEE Annual Conference, Minneapolis, MN
3. Murzi, H., Shirey, K., Zarske, M., Litzler, E., & London, J. (2022), "WIP: ASEE Year of Impact on Racial Equity: P-12 Parents and Guardians Engagement," *Proceedings*, ASEE Annual Conference & Exposition, Minneapolis, MN.
4. Gurganus JR, Huffman TJ, **Zarske M.** (2021) "Informing Authentic P-12 Engineering Outreach Efforts," *Proceedings*, Middle Atlantic ASEE Section Spring 2021 Conference, virtual 2021
5. **Zarske, M. S.**, Soltys, M., & Kracha, J.* (2020) "Engagement in Practice: Practicing Empathy in Engineering for the Community Course." *Proceedings*, ASEE Annual Conference, virtual 2020.
6. Keogh, M.*, **Zarske, M. S.**, Tsai, J. Y. (2019). "Examining how skill-building workshops affect women's confidence over time" *Proceedings*, ASEE Annual Conference, Tampa, FL.
7. Keogh, M.*, **Zarske, M. S.**, & Tsai, J. Y. (2018). "Active Learning Group Work: Helpful or Harmful for Women in Engineering?" *Proceedings*, ASEE Annual Conference, Salt Lake City, UT.
8. Waugaman, K.*, & Tsai, J. Y., & **Zarske, M. S.** (2018). "Connecting with First-year Engineering Students' Interest in Social Justice Issues through Ethics Lessons to Sustain Student Retention in Engineering," *Proceedings*, ASEE Annual Conference, Salt Lake City, UT.
9. Pamela S. Lottero-Perdue & **Zarske, M. S.** (2018). "Using Biography to Support Pre-Service Science and Engineering Teachers Learning about Engineering Practices and Habits of Mind," *Proceedings*, ASTE Annual Conference, Baltimore, MD.
10. **Zarske, M. S.**, Vadeen, M. L.*, Tsai, J. Y., Sullivan, J. F., & Carlson, D. W. (2017). "Undergraduate Engineers and Teachers: Can Students be Both?" *Journal of Pre-College Engineering Education Research*. Vol. 7, No. 1, summer 2017.
11. **Zarske, M. S.**, Tsai, J. Y., Sullivan, J. F., & Carlson, D. W. (2017). "Seeking Engineering Undergraduates for K-12 STEM Teacher Licensure: Fuels the Soul or Too Many Barriers?" *Proceedings*, ASEE Annual Conference, Columbus, OH.
12. Reitsma, R. F., Hsieh, P.H., Diekema, A. R., Robson, R., and **Zarske, M. S.** (2016). "Map- or list-based recommender agents? Does the map metaphor fulfill its promise?" SAGE, <http://ivi.sagepub.com/content/early/2016/10/12/1473871616669193.full.pdf+html> First published on October 12, 2016 as doi:10.1177/1473871616669193
13. **Zarske, M. S.**, Vadeen, M. L.*, Tsai, J. Y., Sullivan, J. F., & Carlson, D. W. (2016). "Undergraduate Engineers and Teachers: Can Students be Both?" *Proceedings*, ASEE Annual Conference, New Orleans, LA.
14. **Zarske, M. S.**, Cunitz, J. L.*, Forbes, M. H., & Sullivan, J. F. (2015). "General Engineering Plus: Creating Community in a Flexible yet Technical Engineering Degree" *Proceedings*, ASEE Annual Conference, Seattle, WA.
15. **Zarske, M. S.**, Gallipo, M. J.*, & Yowell, J. L. (2014). "STEM High School: Does multiple years of high school engineering impact student choices and teacher behavior?" *Proceedings*, ASEE Annual Conference, Indianapolis, IN.

16. Steckel, J., Quinones, P. A., **Zarske, M. S.**, & Knight, D.W. (2014). "Innovation Center: Preparing High School Students for the 21st Century Economy by Providing Resources and Opportunities to Create Genuine Projects with Industry Partners," *Proceedings*, ASEE Annual Conference, Indianapolis, IN.
17. **Zarske, M. S.**, Yowell, J. L., Maeierhofer, S.*, & Reamon, D. T. (2013). "Teamwork in First-Year Engineering Projects Courses: Does Training Students in Team Dynamics Improve Course Outcomes and Student Experiences?" *Proceedings*, ASEE Annual Conference, Atlanta, GA.
18. **Zarske, M. S.**, Schneee, D. E.*, Bielefeldt, A. R., & Reamon, D. T. (2013). "The Impacts of Real Clients in Project-Based Service-Learning Courses," *Proceedings*, ASEE Annual Conference, Atlanta, GA.
19. Knight, D. W., Sullivan, J. F., Kotys-Schwartz, D. A., Meyers, B. A., Louie, B., Luftig, J. T., **Zarske, M. S.**, & Hornback, J. M.* (2013). "The Impact of Inclusive Excellence Programs on the Development of Engineering Identity among First-Year Underrepresented Students," *Proceedings*, ASEE Annual Conference, Atlanta, GA.
20. Yowell, J. L., **Zarske, M. S.**, Knight, D. W., & Sullivan, J. F. (2013). "Impact of TEAMS Clubs: An Afterschool Engineering Enrichment Program that Impacts K-12 Students and College Student Leaders," *Proceedings*, ASEE Annual Conference, Atlanta, GA.
21. **Zarske, M. S.**, Ringer, H. L., Yowell, J. L., Sullivan, J. F., & Quiñones, P. A. (2012). The Skyline TEAMS Model : A Longitudinal Look at the Impacts of K-12 Engineering on Perception , Preparation and Persistence. *Advances in Engineering Education*. Vol. 3, No. 2, summer 2012. <http://advances.asee.org/vol03/issue02/03.cfm>
22. **Zarske, M. S.**, Yowell, J. L., Sullivan, J. F., Bielefeldt, A. R., O'Hair, M. T., & Knight, D. W. (2012). "K-12 Engineering for Service : Do Project-Based Service-Learning Design Experiences Impact Attitudes in High School Engineering Students?" *Proceedings*, ASEE Annual Conference, San Antonio, TX. *Best Paper Award*.
23. Brown, E. F., Richards, L. G., Parry, E. A., **Zarske, M. S.**, & Klein-Gardner, S. S. (2012). K-12 "Engineering Education: Priorities, Research Themes, and Challenges." *Proceedings*, ASEE Annual Conference, San Antonio, TX.
24. Schnittka, C., Parry, E. A., Day, L. D., Macalalag, Augusto Z, J., Padilla, A. J., **Zarske, M. S.**, & Quinones, P. A. (2012). "Best Practices in K-12 and University Partnerships Panel." *Proceedings*, ASEE Annual Conference, San Antonio, TX.
25. **Zarske, M. S.**, Reamon, D. T., Bielefeldt, A. R., & Knight, D. W. (2012). "Service-Based First Year Engineering Projects: Do They Make a Difference ?" *Proceedings*, ASEE Annual Conference, San Antonio, TX.
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CURRICULUM DEVELOPED

Undergraduate Engineering Curricula

1. *Engineering for the Community* (GEEN 2400) – Semester long undergraduate sophomore-level course - Design engineering products for local community clients, with emphasis on humanitarian engineering and integrated systems with electrical, mechanical, and software components. - 3 credit hours
2. *Basic Electronics* (GEEN 3010) - Semester long undergraduate junior-level course - Examines basic concepts of electricity, digital systems, circuit design and circuit analysis. - 3 credit hours

3. *Teaching Design* (GEEN 4400) - Semester long undergraduate senior-level course - Examines teaching engineering design to a variety of audiences including secondary schools, project teams, and other communities. Students practice integrating design thinking into local schools and companies, develop ready-to-use tools and resources, and explore the design education literature. – 3 credit hours

P-12 Engineering Curricula

Elementary Grades

1. *Can You Catch the Water?* — Activity; Grade Level: 4 (3-5); Students construct three-dimensional models of water catchment basins using everyday objects to form hills, mountains, valleys and water sources. They experiment to see where rain travels and collects, and survey water pathways to see how they can be altered by natural and human activities, as well as systems that clean and distribute water.
https://www.teachengineering.org/activities/view/cub_earth_lesson2_activity3
2. *Conductivity* — Activity; Grade Level: 4 (3-5); Student groups make simple conductivity testers each using a battery and light bulb. They learn the difference between conductors and insulators of electrical energy as they test a variety of materials for their ability to conduct electricity.
https://www.teachengineering.org/activities/view/cub_energy2_lesson04_activity3
3. *Creating an Electromagnet* — Activity; Grade Level: 4 (3-5); Student teams investigate the properties of electromagnets. They create their own small electromagnets and experiment with ways to change their strength to pick up more paperclips. Students learn about ways that engineers use electromagnets.
https://www.teachengineering.org/activities/view/cub_mag_lesson2_activity1
4. *Design and Test Model Solar Water Heaters* — Activity; Grade Level: 4 (3-5); To explore different ways of using solar energy, students build a model solar water heater and determine how much it can heat water in a given amount of time. Solar water heaters work by solar radiation and convection.
https://www.teachengineering.org/activities/view/cub_energy2_lesson09_activity2
5. *Go with the Energy Flow* — Lesson; Grade Level: 4 (3-5); This lesson is part of a series of six lessons in which students use their growing understanding of various environments and the engineering design process, to design and create their own model biodome ecosystems. Students learn about energy and nutrient flow in various biosphere climates and environments, food chains and food webs, and the roles of the hydrologic, carbon, and nitrogen cycles in sustaining the worlds' ecosystems so living organisms survive.
https://www.teachengineering.org/lessons/view/cub_bio_lesson03
6. *Learn to Build a Rocket in Five Days or Your Money Back* — Lesson; Grade Level: 4 (3-5); Students discover the entire process that goes into designing rockets. In previous lessons in this unit, students learned how rockets work; now they learn what real-world decisions engineers must make when designing and building rockets.
https://www.teachengineering.org/lessons/view/cub_rockets_lesson05
7. *Potato Power* — Activity; Grade Level: 4 (3-5); Students use potatoes to light an LED clock (or light bulb) as they learn how a battery works in a simple circuit and how chemical energy changes to electrical energy.
https://www.teachengineering.org/activities/view/cub_energy2_lesson04_activity2
8. *Pulley'ing Your Own Weight* — Activity ; Grade Level: 4 (3-5); Using common materials (spools, string, soap), students learn how a pulley can be used to easily change the direction

of a force, making the moving of large objects easier.

https://www.teachengineering.org/activities/view/cub_simple_lesson05_activity1

9. *Rocket Power* — Activity; Grade Level: 3 (3-5); By making and testing simple balloon rockets, students acquire a basic understanding of Newton's third law of motion as it applies to rockets. Using balloons, string, straws and tape, they see how rockets are propelled by expelling gases, and test their rockets in horizontal and incline conditions.
https://www.teachengineering.org/activities/view/cub_solar_lesson01_activity2
10. *Stations of Light* — Activity; Grade Level: 4 (3-5); Student groups rotate through four stations to examine light energy behavior: refraction, magnification, prisms and polarization. They see how a beam of light is refracted (bent) through various transparent mediums.
https://www.teachengineering.org/activities/view/cub_energy2_lesson03_activity1
11. *The Science of Swinging* — Lesson; Grade Level: 3 (2-4); Students learn what a pendulum is and how it works in the context of amusement park rides. While exploring the physics of pendulums, they are also introduced to Newton's first law of motion — about continuous motion and inertia. https://www.teachengineering.org/lessons/view/cub_pend_lesson01
12. *Too Much Pressure! Modeling Force-Pressure-Area Relationships* — Activity; Grade Level: 5 (5-8); Students learn all about water pressure and how engineers design faucets. Teams build simple systems that model faucets and test them to see the relationships between pressure, area and force.
https://www.teachengineering.org/activities/view/cub_faucets_lesson1_activity1
13. *Waterwheel Work: Energy Transformations and Rotational Rates* — Activity; Grade Level: 4 (3-5); Students learn the history of the waterwheel and common uses for water turbines today. They explore kinetic energy by creating their own experimental waterwheel from a two-liter plastic bottle and investigate the transformations of energy involved.
https://www.teachengineering.org/activities/view/cub_energy2_lesson08_activity2
14. *Watch It Slide!* — Activity; Grade Level: 4 (3-5); Students use inclined planes as they recreate the difficult task of raising a monolith of rock to build a pyramid. They compare the push and pull of different-sized blocks up an inclined plane, determine the angle of inclination, and learn the changes that happen when the angle is increased or decreased.
https://www.teachengineering.org/activities/view/cub_simple_lesson04_activity1
15. *Wind Power! Designing a Wind Turbine* — Activity; Grade Level: 4 (3-5); Students learn how engineers transform wind energy into electrical energy by building their own miniature wind turbines and measuring the electrical current they produce. They explore how design and position affect the electrical energy production.
https://www.teachengineering.org/activities/view/cub_energy2_lesson07_activity2

Middle School Grades 6-8

16. *A Spectral Mystery* — Activity; Grade Level: 8 (7-9); Students use the spectrographs from the "Building a Fancy Spectrograph" activity to gather data about light sources. Using their data, they make comparisons between different light sources and make conjectures about the composition of a mystery light.
https://www.teachengineering.org/activities/view/cub_spect_activity6
17. *Building a Fancy Spectrograph* — Activity; Grade Level: 8 (7-9); Students create and decorate their own spectrographs using simple materials and holographic diffraction gratings. https://www.teachengineering.org/activities/view/cub_spect_activity4
18. *Breaking the Mold* — Activity; Grade Level: 8 (6-8); In this math activity, students conduct a strength test using modeling clay, creating their own stress vs. strain graphs, which they

- compare to typical steel and concrete graphs.
https://www.teachengineering.org/activities/view/cub_brid_lesson04_activity1
19. *Design Inspired by Nature* — Activity; Grade Level: 7 (6-8); Students discover how engineers can use biomimicry to enhance their designs. They learn how the careful observation of nature can lead to new innovations and products and reverse engineer a flower to glean design ideas for new products.
https://www.teachengineering.org/activities/view/cub_lifescience_lesson03_activity2
 20. *Dress for Success* — Activity; Grade Level: 8 (6-8); In this design activity, students investigate materials engineering as it applies to weather and clothing. Teams design and analyze different combinations of materials for effectiveness in specific weather conditions.
https://www.teachengineering.org/activities/view/cub_weather_lesson01_activity1
 21. *Fancy Feet! Stress & Strain Forces in Shoe Design* — Activity; Grade Level: 7 (6-8); Students use the engineering design process to solve a real-world problem—shoe engineering! Working in small teams, they design, build and test a pair of wearable platform or high-heeled shoes, taking into consideration the stress and strain forces.
https://www.teachengineering.org/activities/view/cub_feet_activity1
 22. *Load It Up!* — Activity; Grade Level: 8 (6-8); Students take a hands-on look at the design of bridge piers (columns). First they brainstorm types of loads that might affect a Colorado bridge. Then they determine the maximum possible load for that scenario, and calculate the cross-sectional area.
https://www.teachengineering.org/activities/view/cub_brid_lesson02_activity1
 23. *Mobile Forces* — Activity; Grade Level: 8 (6-8); The application of engineering principles is explored as students create their own mobiles, taking into consideration the forces of gravity and convection air currents.
https://www.teachengineering.org/activities/view/cub_art_lesson01_activity1
 24. *Oil Spill Consequences and Cleanup Technologies* — Lesson; Grade Level: 6 (5-7); Students learn details about the Exxon Valdez oil spill, which was one of the most publicized and studied human-caused environmental tragedies in history, then experiment with many "engineered" strategies to clean up their own manufactured oil spill and learn the difficulties in dealing with oil released into our waters.
https://www.teachengineering.org/lessons/view/cub_enveng_lesson01
 25. *Polluted Air = Polluted Lungs* — Activity; Grade Level: 7 (4-7); To gain a better understanding of the roles and functions of components of the human respiratory system and our need for clean air, students construct model lungs that include a diaphragm and chest cavity.
https://www.teachengineering.org/activities/view/cub_biomed_lesson04_activity1
 26. *Spectroscopy* — Curricular Unit; Grade Level: 7 (6-8); Students learn how using spectrographs helps people understand the composition of light sources. Using simple materials including holographic diffraction gratings, students create and customize their own spectrographs—just like engineers.
https://www.teachengineering.org/curricularunits/view/cub_spect_curricular_unit
 27. *Weather Alert* — Activity; Grade Level 8 (6-8); Students discuss the characteristics of storms, including the relationship of weather fronts and storms. Using everyday materials, they develop models of basic lightning detection systems and analyze their models to determine their effectiveness as community storm warning systems.
https://www.teachengineering.org/activities/view/cub_weather_lesson03_activity1
 28. *What's Down the Well?* — Activity; Grade Level: 6 (5-7); Students learn about physical models of groundwater and how environmental engineers determine possible sites for

drinking water wells. During the activity, students create their own groundwater well models using coffee cans and wire screening.

https://www.teachengineering.org/activities/view/cub_enveng_lesson04_activity1

29. *Where Does All the Water Go?* — Activity; Grade Level: 6 (5-7); Students learn the vocabulary associated with groundwater, see a demonstration of groundwater flow, and learn about the measurements that environmental engineers need when creating a groundwater model of a chemical plume.

https://www.teachengineering.org/activities/view/cub_enveng_lesson03_activity1

30. *Who's Down the Well?* — Lesson; Grade Level: 6 (5-7); Students learn about several possible scenarios of contamination to drinking water, which comes from many different sources, including surface water and groundwater. They analyze the movement of sample contaminants through groundwater, in a similar way to how environmental engineers analyze the physical properties of groundwater to predict how and where surface contaminants travel.

https://www.teachengineering.org/lessons/view/cub_enveng_lesson04

High School Grades 9-12

31. *Service-Based Engineering Design Projects* — Curricular Unit; Grade Level: 10 (9-12); This unit describes a general approach to guiding students to complete service-based engineering design projects, with specific examples provided in detail as associated activities. With your class, brainstorm ideas for engineering designs that...

https://www.teachengineering.org/curricularunits/view/cub_service_unit

32. *Engineers Love Pizza, Too!* — Activity; Grade Level: 9 (9-12); In this service-learning engineering project, students follow the steps of the engineering design process to design an assistive eating device for a young girl who has a medical condition that restricts the motion of her joints.

https://www.teachengineering.org/activities/view/cub_service_activity01

33. *Tower O' Power: Strength-to-Weight-Ratio Competition* — Activity; Grade Level: 9 (9-12); In this activity, students learn about creating a design directly from a CAD (computer-aided design) program. Teams design towers in CAD and manufacture the parts with a laser cutter.

https://www.teachengineering.org/activities/view/cub_tower_activity1

34. *Watch Out for the Blind Spots: Design a Vision Testing Device* — Activity; Grade Level: 10 (9-11); In this service-learning engineering project, students follow the steps of the engineering design process to design a vision testing device. More specifically, they design a prototype machine that can be used to test the peripheral vision.

https://www.teachengineering.org/activities/view/cub_service_activity02

35. *Zero-Energy Housing* — Activity; Grade Level: 9 (9-11); Students investigate passive solar building design with a focus solely on heating. They learn how insulation, window placement, thermal mass, surface colors, and site orientation play important roles in passive solar heating.

https://www.teachengineering.org/activities/view/cub_housing_lesson05_activity1

Informal Learning

36. *Build an Electromagnet!* — Informal Learning; en español; Grade Level: 4 (3-5); Students build electromagnets and use them to pick up objects.

https://www.teachengineering.org/sprinkles/view/cub_electromagnet_sprinkle1

37. *Can You Catch the Water?* — Informal Learning; en español; Grade Level: 4 (3-5); Students model a water catchment basin and survey water pathways to understand factors that affect water flow.

https://www.teachengineering.org/sprinkles/view/cub_catchwater

38. *Fancy Feet Shoe Design* — Informal Learning; en español; Grade Level: 7 (6-8); Students design, build and test shoes to develop new styles and improve existing designs.
https://www.teachengineering.org/sprinkles/view/cub_fancyfeet
39. *Wind Power* — Informal Learning; en español; Grade Level: 4 (3-5); Students build small wind turbines to see how much wind energy they can transform into electrical energy.
https://www.teachengineering.org/sprinkles/view/cub_windpower_sprinkle

COMMUNITY SERVICE

K-12 Outreach

Provided classroom lessons for:

Eldorado K-8 School, Superior CO, 6th, and 7th grade classes, August 2017 – Present

Superior Elementary School, Superior CO, K through 5th grade classes, August 2012 - 2020

Northglenn High School GO (Girls Only) Engineering Day, 2017-2018

Graland School, Science & Engineering Judge, Curriculum team, 2010-2013

High School Success Institute for Minority Students. Summers, 2002-2009

Girls Embrace Technology workshops, CU Boulder, 2002, 2003

Expanding Your Horizons for middle school girls sponsored by AAUW, 2001, 2002

Leadership

National Charity League, Boulder County Chapter, Grade Level Advisor (2023-24) and Ticktock Council Advisor (2022-23)

Monarch After Prom Committee, Sub-Committee Lead, 2022-Present

Girl Scout Troop Leader, August 2014 - Present

Girl Scout GECCCOs (Girls Exploring Camping, Cycling, & Canoeing Outdoors) Leader, Middle/high school grades, August 2017-Present

Co-founder and team leader, *Engineering for American Communities* (EFAC), 2010-2011.
Student service organization for undergraduate and graduate students at CU-Boulder

Service learning projects in first-year and sophomore engineering design projects courses

Projects for: Children's Hospital of Colorado, Rocky Mountain Fire Protection District, Boulder Homeless Shelter, Boulder Outreach for Homeless Overflow (BOHO), Community Gardening, There With Care, Jeff & Paige singing duo, Broomfield Heights Middle School & Broomfield High School (assistive tech), Community Montessori (STEM modules), Ryan Elementary School (STEM modules), Emerald Elementary & Coal Creek Elementary (assistive tech), Trail Ridge K-8 School (STEM modules, assistive tech), Joycare Daycare Center, Local farmers (agriculture tech), Local citizens (assistive tech and entrepreneurial projects), Untapped Learning (learning modules)