WIP: Cognitive Empathy Enhances Strategic Scientific Communication

Mark Blaine, University of Oregon

Mark Blaine is a professor of practice who works at the intersection of storytelling and science, producing stories, developing experiential courses, and training scientists with audience analysis, strategic communication, and storytelling tools. He also works with media researchers to translate their work to best practices in science communication for journalists and strategic communications teams. At the Knight Campus, he has designed a novel, holistic approach to training scientists that seeks to strengthen the connection between scientific collaborators, innovators and entrepreneurs, and the public they serve.

Nathan Jacobs, University of Oregon

Nathan is the Director of Research Training and Career Acceleration for the Knight Campus for Accelerating Scientific Impact at the University of Oregon, where he helped launch UO's first ever engineering program. Nathan received his PhD in Mechanical Engineering and Applied Mechanics from the University of Pennsylvania and a BS in Biomedical Engineering at the University of Utah.

WIP: Cognitive Empathy Enhances Communication and Entrepreneurship Fundamentals for Engineers

Abstract

This work-in-progress paper examines a multi-year cognitive empathy training model designed to strengthen science communication, innovation capacity, and entrepreneurial readiness among graduate engineering trainees. Grounded in design thinking and structured around immersive onboarding, coursework, coaching, and peer feedback, the program integrates deep listening, cognitive empathy-informed goal setting, and trust building as core competencies and a mindset for students preparing for a wide range of career opportunities. We outline implemented components, early evidence, and a developing assessment framework aligned with the ASEE ENT Division's priorities in innovation pedagogy and competency assessment.

Introduction

Design thinking has become increasingly recognized as an essential competency for engineers, offering structured yet flexible approaches to addressing complex, real world problems. Some scholars have argued that design thinking merits the same curricular prominence as foundational engineering sciences because it shapes how engineers frame challenges and generate solutions [1]. Despite this recognition, design thinking often remains undervalued or inconsistently integrated within engineering programs, typically appearing within isolated project-based courses rather than as a sustained developmental thread across the curriculum [2]. As a result, many of the capabilities design thinking aims to cultivate as a teaching and learning tool remain underemphasized and difficult to assess.

Cognitive empathy is central to the design thinking process. Design thinking frameworks consistently highlight the importance of understanding users' perspectives, needs, and contextual constraints, yet doing so requires deliberate, perspective-taking thinking that enables students to model others' experiences and motivations. Research shows that this form of cognitive empathy supports teamwork, communication, and leadership, and these skills are increasingly necessary for entrepreneurial and interdisciplinary engineering practice [3]. It also helps students connect technical learning to human needs and societal contexts, improving not only the quality of solutions but also students' ability to envision meaningful STEM career pathways [4].

Cognitive empathy is also instrumental for preparing engineers to engage problems at the intersection of society and technology. These problems may involve contested values, heterogeneous stakeholders, and evolving risk landscapes. Perspective taking helps future engineers map these values and their conflicts and broker understanding across

disciplines and communities. In practice, this means framing problems with attention to social contexts and translating domain knowledge for nonexperts with the goal of iterating solutions in ways that are technically sound and socially robust [5].

The literature also points toward a pedagogy for empathy development. Rather than treating empathy as an innate disposition, instructors can design structured, repeatable interventions that target cognitive empathy as a learnable skill. Templates for building such interventions help faculty scale efforts, align learning objectives with methods, and collect more defensible evidence of growth in tough-to-teach areas like empathy and leadership [6].

However, the qualities that make cognitive empathy valuable also make it difficult to evaluate. Much of the existing assessment of design thinking relies on qualitative reflections or self-reported perceptions of learning [7] [8], leaving educators without reliable indicators of how effectively students develop empathy driven reasoning. This gap limits the ability to refine pedagogy, justify curricular placement, or demonstrate impact at scale.

This work in progress paper describes how a recently launched bioengineering institution has built the fundamental but overlooked by STEM skill of cognitive empathy into its training for scientists and engineers. This effort seeks to develop science communication and innovation and entrepreneurship skills among its trainees, using practical problems addressed with a design thinking framework across multiple years. This WIP directly aligns with the ENT Division's focus on student learning in innovation and entrepreneurship and assessment of entrepreneurship and innovation competencies. The multi-year structure from bootcamp to coursework to coaching and planned assessment of cognitive empathy-linked communication and collaboration skills respond to ENT's emphasis on evidence-based approaches to cultivating the entrepreneurial mindset.

We position this paper as an emerging empirical study. This manuscript documents what has been implemented, summarizes early qualitative indicators, and specifies the assessments under development to evaluate outcomes over time.

Implementation

Based on principles of and shared interest in effective design and best practices in communication, the program we identify in this work-in-progress seeks to reframe graduate student education and the outcomes of that education, as a process that starts in the first week that students arrive on campus. The program – what we call Impact Training – builds on an immersive boot camp and leads into a term-long course in science communication and design thinking [9]. The Impact Training program aims to help students see themselves as agents of societal impact from the very beginning of their graduate experience; engage all students in communication, innovation, and translation

work; equip them to use design thinking to advance their research and career goals; and show how an innovation mindset can energize both basic research and translational activities [10].

Cognitive empathy lives at the heart of the communication, innovation and design thinking work we do in Impact Training and that we've prioritized with our incoming researchers. We base this effort on observation of what's been consistently lacking in science and engineering training and by the career paths that our students gravitate to, particularly the group of students within our program who pursue an additional certification in entrepreneurship through the College of Business. By structuring our training with cognitive empathy and listening at its core, we derive greater value from each phase of the design thinking process – particularly when managing feedback – as applied to both research outcomes, communication efforts, and budding entrepreneurship activities.

Our program encourages three phases for practicing cognitive empathy. The first is listening deeply. We build it in across our teaching with the aim of it becoming a deeply pervasive skill for our trainees, a mindset. It's also a reciprocal skill: Students who are focused on listening give better feedback to their peers and set a higher bar for professional interactions. Second, we ask trainees to develop empathy-informed goals. We ask frequently what students are trying to accomplish with their work and have used research from science communication scholars to build a framework of possible goals for communicating and developing their research. Finally, we encourage trainees to focus on trust building as a broader idea in research practice and communication, and that trust building is reinforced by the active and deep listening and perspective-taking of cognitive empathy.

Process

Cultivate deep listening skills. Upon arriving on campus as a cohort, our doctoral trainees participate in a week-long bootcamp that focuses on science communication and innovation and entrepreneurship. Underpinning this intensive curriculum is the design thinking framework, which is heavily focused on iteration based on human feedback and a cycle of divergent to convergent thinking [11]. It's easy to look at the five design thinking steps and focus on everything after ideation (the middle step) because this is where all the action seems to happen. Participants get excited about brainstorming ideas and working up prototypes as they converge on solutions. They test the prototypes on peers and iterate yet again. But what's easy to miss in this is the infusion of cognitive empathy that enriches the whole process. We observe that many students struggle to define the problem outside their own experience, and the act of returning multiple times to divergent thinking that includes a wider range of experiences can feel messy. However, effective iteration depends on collecting useable information from people

giving feedback, and those divergent moments are integral to exploring many solutions. But without skills developed in collecting that feedback and a focus on structuring it to be useful, participants in design thinking can overlook ideas and frames that are outside their experience.

To begin exploring this divergent perspective-taking, we ask students to write personal stories and be vulnerable in these first days of cohort building. They're also asked to give feedback on these very personal insights, and having their own stories as part of a focused conversation helps make sure that everyone has a human stake in the effort. We continue to develop their personal science stories with evolving research efforts in coursework over the first two years of their doctoral training. Along the way, they are asked to give flash talks to the institution's research community and, later, a longer talk that fleshes out their research, their motivations, and the significance to the institution's mission: Science serving society.

Our future directions in this area will be to develop a quantitative assessment of listening and feedback skills developed in the program with the goal developing a model for training this key skill.

Develop empathy-informed goals. Part of developing cognitive empathy also includes efforts at building self-awareness through goal setting activities that focus on trainees' motivation to do the science that they do. By working through a variety of potential motivators drawn from a broad framework like the one proposed by Besley and Dudo in Strategic Science Communication [12], trainees tune in to a variety of personal motivators, seeing a range of values and how other researchers pursue and express them. This in turn creates a more open environment for trainees to explore broad personal and professional outcomes of their doctoral work. This also leads to fundamental questions about how different people are working toward those goals and the evidence that they use to demonstrate them. Those various goals paired with evidence demonstrate the value of building actionable plans that target specific outcomes while also connecting trainees who are goal setting with an outcome-focused framework that potentially meshes with collaborators.

However, those goals aren't frequently emphasized in STEM training, and their application in the classroom, workshops, and coaching efforts has limited documentation. Our trainings build on successful efforts from other fields and seek to develop a framework for engaging a graduate student cohort. We have expanded beyond this population with more limited training for faculty, post-doctoral scholars, Master's level professional graduate students, and a small group of STEM undergraduates involved in our bioengineering minor.

We ask all of our doctoral students to engage in individual development plans and revise them across multiple years. We also encourage them to further that exploration of career direction with professional development workshops devoted to goal setting and career strategy and work with many individuals as coaches to further these discussions.

Work to build trust. Cognitive empathy training tracks closely with key values in effective scientific communication, and we have relied heavily on the best practices in strategic communication to help design our curriculum. Effective science communication relies heavily on building trust through deliberate signals of warmth, honesty, competence, and a willingness to listen—qualities that function as strategic cues of trustworthiness rather than optional interpersonal traits. These behaviors reflect the core of cognitive empathy, which they frame as an essential communication skill that enables scientists to understand and reason about audience perspectives, values, and concerns. By encouraging communicators to "be willing to listen" and "show you are not that different," their framework positions perspective taking as foundational to forming durable public relationships and fostering meaningful engagement [12]. This trust-centered, empathy-informed approach complements the broader argument that these efforts should be evidence based, strategically planned, and intentionally implemented.

Building trust and cognitive empathy are closely aligned, and we strive to build these skills not so much as content modules in coursework but as a framework for practice and coaching that is integrated across multiple years as trainees, and, hopefully, ingrained as a practice in future professional endeavors. To that end, our curriculum seeks to build these skills in the classroom, but the ultimate test of whether its working is in the lab space where peers and mentors can daily contribute to furthering a writer or presenter's progress. We have seen this take wing in the last year as we have grown an opt-in grant writing series from one or two students in need to small cohorts that operate using shared documents and an informal compact to review and give clear and focused feedback on writing.

Going forward

As mentioned previously, design thinking skills and particularly cognitive empathy have proved difficult to measure, but as we grow, we look to metrics of student engagement, particularly in opportunities outside of the traditional curricular structure. We have grown a partnership with the College of Business around a graduate concentration in entrepreneurship with five of our 30-plus doctoral students formally engaged in the cross-campus, interdisciplinary program**.** Our students have a growing interest in applying for NSF Graduate Research Fellowships (GRFP) and NIH F31 fellowships — and through 2025 that interest has led to a number competitively scored reviews and pending awards. Before the shift in application requirements in 2025, our success rate in the GRFP stands at 33 percent, well in excess of national averages. Additionally, we saw a large jump in

F31 proposals in 2025 and 2026, all of them coming through a series of workshops we designed to help organize and coach peer groups with structured peer-to-peer feedback as a core practice. We saw seven applicants and one award in 2025, with three of the applicants receiving fundable scores and another four pending notification as of this paper's deadline and disruption in federal funding mechanisms. Another student also applied and won a prestigious Natural Sciences and Engineering Research Council of Canada award, which is similar to the GRFP, and one student won the International Foundation for Ethical Research Fellowship in 2025. Finally, perhaps the most telling anecdote relating to the culture of innovation that we're trying to build starting with graduate students is that our first doctoral graduate immediately transitioned into a bioengineering startup company of fewer than 10 people. Her trailblazing has shown other students a much wider range of possible next steps from doctoral training. We remain a small program with most the students in our first six cohorts still in the building, and that small group is well bonded and frequently works across disciplines to give structured feedback and support to fellow students. We attribute this to great students and a high level of interpersonal, inter-lab connection in the first years, and at the center of that is a focus on cognitive empathy.

We view recent fellowship applications and scores as contextual indicators of an engaged training ecosystem rather than causal evidence of program effects. Future analyses will examine whether changes in measured empathy-linked competencies statistically relate to downstream academic or entrepreneurial milestones.

Future assessment

We observe early qualitative indicators consistent with cognitive-empathy development, including: (a) richer personal science narratives and reflective statements produced during the bootcamp and early coursework; (b) more targeted, specific peer feedback during lab-based writing groups; and (c) increased voluntary participation in cross-lab proposal circles that emphasize listening-first critique.

This training framework follows the logic that developing cognitive empathy leads to improved listening/feedback and audience-centered framing. This in turn leads to stronger communication artifacts and collaboration quality and better preparation for entrepreneurial and translational tasks.

As we build the program, we have several fundamental questions that will guide our assessment:

- How do structured interventions in listening, empathy-informed goal setting, and trust building influence graduate engineering students' communication and innovation competencies?

- What preliminary indicators of cognitive-empathy development are observable across the first year of program engagement?
- How can growth in cognitive empathy be reliably assessed across multi-year design thinking–based training?

To address these questions, we will assess the curriculum based on the constructs of perspective-taking, listening quality, feedback usefulness, and trust-building behaviors. We will evaluate communication efforts and exercises in entrepreneurial thinking using evaluation rubrics and coded reflections and concept maps. Ideally this assessment framework begins before students arrive on campus for the bootcamp, and then samples during and after the bootcamp, in subsequent course work, and pre and post coaching efforts. We will look for evidence of growth, including increased sophistication in perspective-taking narratives; higher-quality, actionable peer feedback; clearer audience adaptation in presentations/writings; and improved team collaboration signals from peer assessments

Conclusion

As we go forward, we plan to expand this framework to master's level trainings and in the future to an undergraduate engineering program. We would also like to share our insights from the program in future workshops with other innovation and entrepreneurship focused engineering programs. And finally, we acknowledge a pressing need to build a clear assessment framework for these early endeavors and report our quantifiable outcomes to the engineering education community more broadly.

By formalizing the research questions and assessment plan, this WIP advances from a program description toward a generalizable, evidence-based model for cultivating cognitive empathy, which underpins design thinking, innovation, and entrepreneurship in engineering education.

[1] A. Mabogunje, N. Sonalkar, and L. Leifer, "Design Thinking: A New Foundational Science for Engineering," Int. J. Eng. Educ., vol. 32, no. 3, pp. 1540–1556, 2016.

[2] C. L. Dym, A. M. Agogino, O. Eris, D. D. Frey, and L. J. Leifer, "Engineering Design Thinking, Teaching, and Learning," J. Eng. Educ., vol. 94, no. 1, pp. 103–120, Jan. 2005.

[3] I. Ilyas, J. Kansikas, and A. Fayolle, "Rethinking entrepreneurship and management education for engineering students: The appropriateness of design thinking," Int. J. Manag. Educ., vol. 22, no. 3, Nov. 2024, doi: 10.1016/j.ijme.2024.101029.

[4] B. Skovronskyi, V. Sipii, O. Morin, Z. Ohrimenko, and V. Khrenova, “Design thinking in STEAM education curricula: development and evaluation of effectiveness,” Eduweb-Rev. Tecnol. Inf. Comun. En Educ., vol. 19, no. 3, pp. 184–198, Jul. 2025, doi: 10.46502/issn.1856-7576/2025.19.03.

[5] E. Wilson and P. Mukhopadhyaya, “Role of Empathy in Engineering Education and Practice in North America,” Educ. Sci., vol. 12, no. 6, p. 420, Jun. 2022, doi: 10.3390/educsci12060420.

[6] K. Rajaram, “Social-Psychological Intervention: Development of Cognitive Empathy,” in Learning Intelligence: Innovative and Digital Transformative Learning Strategies: Cultural and Social Engineering Perspectives, K. Rajaram, Ed., Singapore: Springer Nature, 2023, pp. 119–146. doi: 10.1007/978-981-19-9201-8_3.

[7] D. Rojas, Y. Rangel, and D. Mora, “Implementing Design Thinking in STEM Education: A Systematic Review of Trends and Challenges,” Int. J. Instr., vol. 18, no. 4, pp. 111–130, Oct. 2025, doi: 10.29333/iji.2025.1847a.

[8] S. C. Sullivan, M. Polyzoi, S. Rivera, R. E. Rice, and N. A. Barrio, “Empathy: Developing This Core Leadership Skill in Engineering Students,” presented at the 2025 ASEE Annual Conference & Exposition, Jun. 2025. Accessed: Jan. 20, 2026. [Online]. Available: https://peer.asee.org/empathy-developing-this-core-leadership-skill-in-engineering-students

[9] M. Blaine and N. Jacobs, “More than its parts: Insights from cultivating a multidisciplinary network for entrepreneurship and communication,” presented at the 2025 ASEE Annual Conference & Exposition, Jun. 2025. Accessed: Jan. 21, 2026. [Online]. Available: https://peer.asee.org/board-150-wip-more-than-its-parts-insights-from-cultivating-a-multidisciplinary-network-for-entrepreneurship-and-communication

[10] N. Jacobs and M. Blaine, “Implementing an Impact Training program that integrates design thinking, communication, and innovation and entrepreneurship into a graduate engineering curriculum,” presented at the 2025 ASEE Annual Conference & Exposition, Jun. 2025. Accessed: Jan. 21, 2026. [Online]. Available: https://peer.asee.org/work-in-progress-implementing-an-impact-training-program-that-integrates-design-thinking-communication-and-innovation-and-entrepreneurship-into-a-graduate-engineering-curriculum

[11] “IDEO Design Thinking.” Accessed: Jan. 21, 2026. [Online]. Available: https://designthinking.ideo.com

[12] J. C. Besley and A. Dudo, Strategic Science Communication: A Guide to Setting the Right Objectives for More Effective Public Engagement. Baltimore: Johns Hopkins

University Press, 2022. Accessed: Jan. 21, 2026. [Online]. Available: https://muse.jhu.edu/pub/1/monograph/book/109649