Interdisciplinary Research

Interdisciplinary Research as an Iterative Process of Teaching and Learning
Engineering Education is a product of two fields: engineering and education, both of which include multiple sub-fields. For this reason, and because our response to complex social realities requires researchers to transcend disciplinary silos, we must learn to work and thrive in interdisciplinary teams. We recognize this work can be difficult. Working across disciplinary boundaries requires intensive listening, humility, and the recognition that each of us is (de)limited in some ways. In this research snack, six members of the EER community share lessons we learned while working in interdisciplinary teams.

Defining terms: Multi? Inter? Trans?
There are at least three ways of characterizing collaboration across disciplines: multidisciplinary, interdisciplinary, and transdisciplinary. Stock and Burton[1] distinguish the terms as follows:

- **Multidisciplinary:** *coexistence of academic disciplines*
- **Interdisciplinary**: *bridging disciplinary viewpoints and methods*
- **Transdisciplinary:** *redrawing a disciplinary map*.

We present these definitions in ascending order of integration without attaching virtue to any one. For this snack, we have landed on the term *interdisciplinary* because our growing body of research bridges rather than transcends or simply co-exists with disciplinary viewpoints and methods. That is, our investigation involves an active process of teaching and learning from one another as we each draw on distinct disciplinary roots.

Teaching as Learning
The six contributors to this snack have completed graduate training in engineering, education, and the humanities. In addition to these distinct disciplinary roots, we have also worked in a range of institutional contexts including K-12 education, higher education, and industry. Each of these experiences has sensitized us to different epistemologies, methodologies, and audiences, allowing us to contribute to interdisciplinary EER teams in unique ways. At the same time, our experiences on these teams has enabled us to learn important lessons from our colleagues rooted in other disciplines. At the risk of reducing our experiences to categories, authors with engineering degrees have drawn primarily on our experiences with quantitative methods and design, while those with degrees in education and the humanities have drawn primarily on our experiences with qualitative methods, theoretical frameworks, and communication. EER flourishes when we find ways to bridge these two bodies of professionally-rooted expertise. Please see Table 1 for a summary of our contributions, learning, and experientially derived tips for the next generation of EE researchers.

While it is both possible and admirable to conceptualize interdisciplinary research in other ways,[2] we have chosen to characterize it as an iterative process of teaching and learning to highlight the unfinished nature of our own development as researchers. In the spirit of lifelong learning, we wish to honour the many lessons we have learned and continue to learn from our colleagues in other disciplines while engaging in EER. Our inquiry is not only unfinished, but also reciprocal. The next generation continues to teach us through their curiosity, questions, and insights. In the words of Paulo Friere[3] "whoever teaches learns in the act of teaching, and whoever learns teaches in the act of learning" (p.31).

Table 1: Teaching and Learning from other Disciplines

Name	Background	Contributions to EER	Learning from Others	Tips for EER Researchers
Susan McCahan	Mechanical Engineering	Seeding a field by designing and allocating resources to SOTL	Diversifying methodological and theoretical base	Start with a small SOTL project, learn from the experience, and consult with others
Brian Frank	Electrical Engineering	Building bridges between faculties, departments, and institutions	Complexity of large-scale, multi-institutional assessments of student learning, in a changing context	Reflect on student experiences, collaborate, and read the literature related to your interests
Emily Moore	Chemical Engineering; Industry	Reciprocal translation between industry and academic audiences	Use of theoretical & conceptual frameworks to pose social science questions in engineering	Get ready to be uncomfortable; it's a sign that you are learning; scoping is iterative; there is value in making the implicit explicit
Lisa Romkey	Curriculum, Teaching & Learning; Higher Education	Epistemological considerations & theoretical frameworks in educational research design; K-12 STEM education	Design-based research; pedagogical content knowledge in engineering	You belong here; there is room for many voices & pathways; take advantage of every learning opportunity you have in research methods; ask the authors of this snack for their top research methods text! Make sure you can clearly articulate your own research goals/purpose; this can open doors to collaboration.
Deborah Tihanyi	Drama; Theatre; Humanities	Bringing performance training & humanities lens to EER; experience conducting narrative research; work across disciplines integrating communication	Social science methods, particularly quantitative; an appreciation of engineering cultures and ways of knowing	Immerse yourself in the discipline you're studying; engage in individual and interpersonal reflective practice; understand your strengths; work to develop a common language around shared objects
Cindy Rottmann	Educational Leadership & Policy	EER project framing drawing on a diversity of theoretical frameworks, methods & paradigms; social & policy implications of EER research	Professional engineers & professors are active participants, not passive recipients of findings; Iteration is part of the analytic process	We may use the same words in different ways, so listen to others and check in to make sure you are respecting perspectives that differ from your own

References
1.   Stock, P. and R.J.F. Burton, *Defining terms for integrated (multi-inter-trans-disciplinary) sustainability research.* Sustainability, 2011. **3**(8): p. 1090-1113.
2.   Jamieson, M., et al., *Design at scale in a first-year transdisciplinary engineering design capstone.* International Journal of Engineering Education, In Press.
3.   Freire, P., *Pedagogy of freedom: Ethics, democracy, and civic courage.* Critical Perspectives Series, ed. D. Macedo. Vol. 7. 1998, New York: Rowman & Littlefield Publishers, Inc. 144.

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