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Application Summary

Competition Details

Competition Title: 2023 Scholarship of Teaching and Learning Award

Category:

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Submission Deadline: 02/12/2023 11:59 PM

Application Information

Submitted By: Sandra Maffey

Application ID: 9830

Application Title: Todd Fernandez Nomination for SoTL

Date Submitted: 02/12/2023 9:56 AM

Personal Details

Applicant First Name: Alyssa

Applicant Last Name: Panitch

Email Address: alyssa.panitch@bme.gatech.edu

Phone Number: (404) 894-4232

Primary School or Department

Wallace H. Coulter Department of Biomedical Engineering

Primary Appointment Title: Chair

Application Details

Proposal Title

Todd Fernandez Nomination for SoTL

Nomination Portfolio
Georgia Institute of Technology
Scholarship of Teaching and Learning Award

Dr. Todd Fernandez
Lecturer
Wallace H. Coulter Department of Biomedical Engineering
Georgia Institute of Technology

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February 10, 2023

Selection Committee
Scholarship of Teaching and Learning Award
Center for Teaching and Learning

Dear Members of the Selection Committee,

It is with great pleasure that I provide this letter of support for the nomination of **Dr. Todd Fernandez** for the *Scholarship of Teaching and Learning Award*. Todd joined the Coulter Department of Biomedical Engineering as a Lecturer in 2018. He was hired specifically to contribute to our department's ongoing effort to innovate undergraduate engineering education. Since being hired, he has thrived as an innovative teacher who uses evidence-based practices, as a contributor to the field of engineering education research, and as a mentor of faculty teams creating curricular change across the college of engineering. The results of each of those areas of work have had a notable impact on BME undergraduate student's success and our departments' undergraduate educational innovations.

Todd has displayed his teaching excellence in two courses in our core undergraduate curriculum. The first is BMED1000 – *Introduction to Biomedical Engineering*. Todd led the development of BMED1000, its introduction into our required curriculum, and scaling the class to support 350 students yearly. His development of that course is driven by evidence-based and high impact practices for both engineering design courses and first year course in general. The course also launches students' creation of individual ePortfolios. Those ePortfolios are now used in structured ways across all four years of our curriculum thanks to Todd's efforts at faculty development and introducing them in BMED1000. The impact of BMED1000 on preparing students for later classes has been notable, as well has been the impact that the course has had on the faculty who teach it. The second course Todd teaches is BMED2400 – *Introduction to Biomedical Engineering Statistics*, our required undergraduate statistics course. Since he first taught the course in Spring of 2019, Todd has become the go-to source for others assigned to teach it for materials, advice, and teaching. Todd has developed course revisions that use student collected data, biomedical engineering contexts, and other innovations drawn from statistics education research. He actively works to continue to develop the course in ways that give back to statistics education, most recently through a study he conducted in Spring of 2022 that evaluates a reflective approach to homework. The study has a paper under review with the American Society for Engineering Education annual conference and another in preparation for submission to the *Journal of Statistics and Data Science Education*.

Beyond being a scholarly teacher and publishing about his teaching methods, Todd also contributes to fundamental education research and translation of that work into new evidence-based teaching practices. His CV highlights the consistent pattern of publications on innovation in his classes including grading, reflection, faculty development, and students' perception of engineering work. He was the lead author of two journal articles published in 2022. The first, in *To Improve the Academy*, identified unintended consequences of efforts to formalize and improve faculty development – especially around teaching. The second, in *The International Journal of Engineering Education*, analyzed how engineering students understand design education in the context of engineering curricula. The results of that paper have helped already resulted in changes in three of our four required undergraduate design courses. Beyond the impact of specific publications, Wendy Newstetter's letter of support details Todd's impact well. He brings a perspective to our undergraduate curriculum that centers a scholarly understanding and approach to teaching in ways that have positively influenced a variety of policies from new courses to syllabi to ABET.

Todd has also helped lead three major educational innovation grants in our department and across the College of Engineering. In the first, our NSF Revolutionizing Engineering Departments (RED), he worked to mentor a team of Pre-Tenure Assistant BME Professors in a revision of our required undergraduate biomechanics course. Todd helped his colleagues shift their perceptions of a teacher's role in a classroom, increase the collaborative problem solving in the class, and better communicate their care for students and their success. In the second, from the Kern Entrepreneurial Engineering Network (KEEN), Todd has been instrumental in vertically integrating the reflection and ePortfolios across seven of our required undergraduate courses. The third grant builds on the success of BME's KEEN grant, an award to scale the work in BME to three other COE departments at GT where Todd leads faculty development work and research. It also led to a new partnership with Emory School of Medicine's MD program. The partnership places 4th year medical students as TAs in an engineering design course to develop cross-disciplinary collaboration skills of both engineering and medical students. He has also created partnerships with the Carter Center to global engineering challenges into BMED1000.

The resulting student impact of his work to make BME education objectively better is concrete and clear. Todd received the GT Undergraduate Educator Award in 2021 and is GT's nominee for the Felton Jenkins, Jr. award for 2023. he regularly receives other recognitions from undergraduate students including at least three 'Thank a Teacher' notes via CTL. Those notes, the student letters attached to his award packages, and comments he receives in his CIOS evaluations directly connect evidence-based practices to student success. Beyond speaking to the care he brings to interactions with students, they also, repeatedly, list specific educational techniques that he uses and the impact that they. The evidence he provides in the remainder of the packet provides a compelling body of examples showing that everything from his research to his classroom actions are integrated to improving the student learning experience.

Perhaps the best single example of Todd's integrative approach to the Scholarship of Teaching and Learning came during the online education transition during the Spring of 2020. As he prepared to transition his own course online, Todd compiled the evidence-best practices he used to transition his course and shared them to support the rest of our faculty in transitioning their courses. He also developed a survey to gather information on students' experience in our classes that provided individual faculty as well as the department to quickly react to new situations that arose. The tool, which was published in a peer reviewed journal article in 2021, provided data to recognize faculty who excelled and help faculty who struggled with online education.

In summary, Todd is a perfect candidate for an award about a scholarly approach to teaching. Such a scholarly approach is evident from his courses, his approach to improving them, and his approach to working with other faculty. Because of this approach, he has become an integral member of our undergraduate educational faculty and a valuable contributor to how other faculty teach as well. It has been a pleasure to see the profound impact he has had on our undergraduate students and faculty, even during this most challenging of times. As such, I am very proud to have the opportunity to now nominate for the Center for Teaching and Learning's *Scholarship of Teaching and learning Award*. If you need any further information regarding Todd's candidacy for this award, please do not hesitate to contact me.

Sincerely,



Alyssa Panitch, Ph.D.
Wallace H. Coulter Department Chair
Professor
AP/si

Letters of support from colleagues

Dr. Wendy Newstetter

February 10, 2023

Selection Committee
Scholarship of Teaching and Learning Award
Center for Teaching and learning

RE: **Todd Fernandez**

Dear CTL Awards Committee,

It is my great pleasure to support the nomination of Dr. Todd Fernandez for the 2023 *Scholarship of Teaching and Learning Award*. I have known Todd as his dissertation committee member, as a colleague before retiring from Georgia Tech in 2020 and more recently as an intellectual companion as we continue to ask questions about the design of optimal learning environments. Todd continues to impress me with his quest to use research-based evidence on learning to iteratively design, evaluate and repair the varied classes he has taught since coming to Georgia Tech in 2018 as an instructor. Of note, I have been an advisory board member at both the Purdue and Virginia Tech Schools of Engineering Education, both inaugural programs domestically, so I have had multiple opportunities to interact with their faculty, students and graduates. Among the many graduates I have met from these programs, Todd stands out as someone who understands, seeks out and values theories from the social and cognitive sciences as foundational to his work in the classroom. Sadly, this is not the case for many I have known who have superficial understanding or interest in learning fundamentals. Let me share characteristics and activities that make him the ideal candidate to receive this award.

I joined Todd's dissertation committee at the Purdue School of Engineering Education in 2020. I was a latecomer to the committee, as there had been some rearrangements in the membership. As often happens with advisors and graduate students, Todd and his primary advisor were having difficulties communicating. I offered to help by reading and giving feedback on his dissertation at that point. Over the next few months, he did major revisions, I joined his committee and within the year, he had graduated. I was delighted to be a committee member because Todd had been working in an area of interest but in which I had, little background or expertise. As the groundswell to offer courses and even degrees in entrepreneurship in higher education materialized, it was accompanied by little or no research to determine the learning challenges or possible instruments to measure learning gains in this domain. In Todd's dissertation he did three things: 1) challenge the research methodology used to measure student understanding of entrepreneurship; 2) conduct interviews to identify student misconceptions and 3) propose new approaches to entrepreneurship education that address these misconceptions. In many ways, this was groundbreaking work as no one had questioned the basis of prior studies or associated claims. Additionally, no one had started the process of investigating fundamental learner misconceptions related to business and management practices pivotal to becoming an entrepreneur. As a committee member, I was very impressed with the intellectual merit of this work and its contribution to the field of learning in an important but understudied area.

At Georgia Tech, Todd has continued to take on important learning challenges in the classes he teaches informed by research in the learning sciences. Statistics is a case in point. A required course in biomedical engineering, but one that is rife with student misconceptions and learning difficulties, it is one arena where Todd has demonstrated creativity in the classroom and attention to promoting deep understanding. On the first day of class, students collect a real data set using the board game 'Operation'. They are given limited (and intentionally vague) instructions and set off into groups of 4. After they collect about 800-1000 data points, the class collectively looks at the data. They identify major inconsistencies between teams in how they did the experiment and collected/recorded data. That experience becomes a touchpoint for the entire

semester, returned to in class, and used in *every single homework*. Students have to go through the whole data set on the first homework and manually clean it and prepare it for analysis. Then the class talks about how they cleaned it which reveals how each person's data cleaning process resulted in a slightly different final data set. This lesson serves as a powerful example of how students need to think about and use statistics in their work. Further the intentional design of the class that starts with a case where learners make significant errors and those errors are revisited and rectified over the term speaks to a course designer that knows the literature on learning.

Another innovation in this stats class is the design of the exemplar problems which always have three parts: setup, calculations, and interpretation. The interpretation piece *demand*s that they propose some form of action based on the data. That action, based on the PBL problem complexity framework by Johnassen (2000), allows Todd to adapt the difficulty to different contexts. On tests, its simple – a decision, something like ‘do you order a biopsy for this patient’. On homework, they might be asked to write a policy for how two types of COVID tests should be used. This cycle ensures that every problem exists in a real and authentic biomedical engineering context, while also managing the difficulty to something they can be expected to do in a non-classroom context. Bringing the real world into the classroom is sadly, not a norm in most engineering classrooms.

Todd epitomizes the teacher-scholar. I could have focused on the number of papers and conference talks he has given but that can be culled from his CV. Rather I prefer to share what I know of his work as a researcher up close and a classroom designer. He is inquirer, an innovator and an empathetic mentor. I enthusiastically support his nomination for in my mind, he embodies what the SOTL community aspires to.

Sincerely,



Wendy C. Newstetter

Mr. Marty Jacobson

Dear Scholarship of Teaching and Learning Award Review Committee,

I have known Todd Fernandez for about five years as a fellow lecturer in the Biomedical Engineering Department at Georgia Tech. As soon as Todd joined the department, his passion to bring a more scholarly, evidence-based, and research-driven approach to teaching in our department was immediately evident. Since then, he has taken on a number of difficult and influential roles related to how BME approaches teaching and learning. Todd's applies a systematic human- and data-centered approach to the classes he teaches and those he helps others teach that truly makes a difference.

An example of systematic and well-articulated approach to teaching is his contributions to the curricular change in our department through a grant from the Kern Engineering Entrepreneurship Network. There, Todd worked with a number of faculty to bring research-based teaching into all aspects of our courses. Topics that Todd coached us through include some basic topics such as how to incorporate self-reflections and drive self-directed learning in open-ended problem spaces, to more granular topics such as how to use grading to incentivize effective reflection rather than short-circuiting the thought process due to their drive to "earn a good grade". The impact of Todd's coaching and instruction to fellow faculty has reverberated across the department and many of our required undergraduate courses.

In creating a new version of BMED1000 (our introduction to biomedical engineering course for first-year students), Todd leveraged his deep understanding of the literature regarding the development of first-year engineering courses, as well as his past experience developing engineering curricula, and his empathetic and human-first approach to create a challenging first-year experience for our students. Todd asked his BMED1000 students to propose solutions to neglected tropical diseases such as Guinea Worm disease. In cases like this, our students naturally congregate around solutions which rely on physical devices to address or mitigate the effects of a disease. Instead, he focused them on the much larger systemic causes and impacts, getting students to not just think about the symptoms of the disease, but on the impact on a society due to educational disparities caused by the neglect of this disease, and therefore the people impacted by it, in our society. In addition, he has created specific structures in the course to support transfer students in finding a sense of belonging at GT, based on research in that area.

Lastly, it is important to note that he also continues to contribute to educational research despite the time demands of being Lecturer. Todd mentored me in co-investigating a phenomenon that we had both identified in our students: Students would often build and test prototypes, but for the purposes of demonstrating the value of their ideas or their hard work to their instructors rather than for the purpose of challenging their assumptions. Through the study, we gained a much more candid picture of what students actually experience in our design classes. The results from the study led me to make a number of radical changes to the course I teach, BMED2310, and the resulting paper, *Engineering Students' Performance of Prototyping: Process, Purpose, and Perception in the Design Classroom*, was recently published in the International Journal of Engineering Education.

These are just some examples of how Todd has built educational experiences for students which use educational scholarship to require critical thinking and evidence-based application of engineering principles. In every way possible, he truly adopts the same scholarly approach to teaching that is typically seen in a research lab. Based on the criteria identified for this honor, Todd Fernandez is beyond exemplary in each. More importantly, he is active daily in mentoring and guiding more faculty to also achieve excellence in teaching and becoming scholarly teachers in their own right.

Martin Jacobson

Lecturer, Design Instructor & BME Design Shop Manager

Wallace H. Coulter Department of Biomedical Engineering at Georgia Tech and Emory University

404-784-5023 - marty@gatech.edu

Condensed Curriculum Vitae

Academic Appointments

- 2018 Lecturer - Wallace H. Coulter Department of Biomedical Engineering
Georgia Institute of Technology
- 2017-2018 Visiting Asst. Professor - Office of Cross Cutting Programs and Emerging Opportunities
Rose-Hulman Institute of Technology

Education

- 2021 Ph.D. in Engineering Education – Purdue University
- 2010 Master of Science in Mechanical Engineering - Rochester Institute of Technology
- 2008 Bachelor of Science in Mechanical Engineering - Rochester Institute of Technology

Teaching Experience

- | | | |
|-------------|---|-----------------------------------|
| 2019 – 2023 | Biomedical Engineering Statistics | Georgia Institute of Technology |
| 2018 – 2023 | Introduction to Biomedical Engineering | Georgia Institute of Technology |
| 2022 | Problems in Biomedical Engineering | Georgia Institute of Technology |
| 2017 – 2018 | Introduction to Entrepreneurship & Innovation | Purdue University |
| 2017 – 2018 | Professional Portfolio Development | Purdue University |
| 2016 – 2018 | Transdisciplinary Design Studio | Purdue University |
| 2008 - 2009 | Multidisciplinary Senior Design (TA) | Rochester Institute of Technology |
| 2005 - 2009 | Mechanics of Materials Lab (TA, Lead TA) | Rochester Institute of Technology |

Selected Journal Publications

- Fernandez, T.**, Jacobson, M. (2022) Engineering Students' Performance of Prototyping: Process, Purpose, and Perception in the Design Classroom *International Journal of Engineering Education*. 38(6) 1761-1778.
- Brennan, J., **Fernandez, T.**, & Tranquillo, J. (2022). Professionalization and the forgotten system: Observed practices and perceptions at the intersection of informal and formal faculty development. *To Improve the Academy: A Journal of Educational Development*, 41(2).
- Fernandez, T.**, Le Doux, J., & Behraves, E. (2021). Near-Real-Time Learner Analysis and Faculty Support During a Transition to Online Education. **Biomedical engineering education**, 1(2), 345-351.
- Douglas, K. A., **Fernandez, T.**, Fosmire, M., Van Epps, A. S., & Purzer, S. (2020) Self-directed information literacy scale: A comprehensive validation study. *Journal of Engineering Education*, (Pending Issue Information).
- Exter, M. E., Gray, C. M., & **Fernandez, T. M.** (2020). Conceptions of design by transdisciplinary educators: disciplinary background and pedagogical engagement. *International Journal of Technology and Design Education*, 30(4), 777-798.
- Gray, C. & **Fernandez, T.** (2018). Developing a Socially-Aware Engineering Identity Through Transdisciplinary Learning. *International Journal of Engineering Education*. 34(2B), 1347-1362.
- Exter, M., Caskurlu, S. & **Fernandez, T.** (2018). Comparing Computing Professionals' Perceptions of Importance of Skills and Knowledge On-the-Job and Coverage in Undergraduate Experiences. *Transactions on Computer Education*. 18(4).
- Douglas, K. A., **Fernandez, T.**, & Purzer, S. (2018). The critical-thinking engineering information literacy test (CELT): A validation study for fair use among diverse students. *International Journal of Engineering Education*. 34(4), 1347-1362.
- Fernandez, T.** & Wilson, M. D. (2017). Using entrepreneurial principles to accelerate change in engineering education. *Journal of Engineering Entrepreneurship*. 8(1)

Fila, N. D., **Fernandez, T.**, Purzer, S. (2017). Scaffolded innovation: Understanding the role of innovation in engineering education using the zone of proximal development. *Journal of Engineering Entrepreneurship*. 8(1)

Selected Conference Publications

- Pai, B., Patil, K., **Fernandez, T.**, Benkeser, P., & LeDoux, J. (2022). WIP: A novel problem-driven learning laboratory course in which biomedical engineering students conduct experiments of their own design to answer an authentic research question. *2022 ASEE Annual Conference & Exposition*.
- Delgado, P., Luna, C. A., Dissanayaka, A., Oshinowo, O., Waggoner, J. J., Schley, S., **Fernandez, T.**, Myers, D. R. (2022). An economical in-class sticker microfluidic activity develops student expertise in microscale physics and device manufacturing. BMES Annual Meeting. San Antonio, TX. *ArXiv Preprint ArXiv:2208.10368*.
- McKinnon-Crowley, S., **Fernandez, T.**, & Schley, S. (2022). Work in Progress: What Makes “Good” Engineering Pedagogy? Preliminary Results from a Qualitative Study of Engineering Faculty. *2022 ASEE Annual Conference & Exposition*.
- Morgan, K. L., Bernardo, A., & **Fernandez, T. M.** (2021). Gender and Human Imagery in the Halls of a BME Department. *2021 ASEE Virtual Annual Conference Content Access*.
- Martin, K. M., **Fernandez, T. M.**, & Mangum, R. (2021). Work in Progress: Examining Engineering Seniors Students’ Perception of Justice and Fairness of Grading Practices. *2021 ASEE Virtual Annual Conference Content Access*.
- Bell-Huff, C. L., **Fernandez, T. M.**, Morgan, K. L., Benkeser, P., & LeDoux, J. M. (2020). A vertically integrated portfolio process to foster entrepreneurial mindset within an undergraduate biomedical engineering curriculum. *2020 ASEE Virtual Annual Conference Content Access*.
- Fernandez, T. M.**, Martin, K. M., Mangum, R. T., & Bell-Huff, C. L. (2020). Whose grade is it anyway?: Transitioning engineering courses to an evidence-based specifications grading system. *2020 ASEE Virtual Annual Conference Content Access*.
- Bell-Huff, C. L., **Fernandez, T. M.**, Morgan, K. L., & LeDoux, J. M. (2019). WIP: How students externalize epistemologies: Describing how students explain, ground, and consciously construct their definitions of engineering and biomedical engineering. *2019 ASEE Annual Conference & Exposition*.
- Fernandez, T.**, & Duval-Coetil, N. (2017). Just act like an entrepreneur: Surveying literature on effectuation education. *United States Association for Small Business and Entrepreneurship. Conference Proceedings*, 190. United States Association for Small Business and Entrepreneurship.
- Fernandez, T. M.**, Duval-Couetil, N., & Couetil, C. R. (2017). Engineering Students’ Misuse of Business Concepts: Understanding Problematic Precursors to Entrepreneurship. *2017 ASEE Annual Conference & Exposition*.
- Fernandez, T. M.**, & Duval-Couetil, N. (2017). Exploring ways to measure entrepreneurial mindset: The development of a student-focused effectual logic assessment instrument. *2017 ASEE Annual Conference & Exposition*.
- Fernandez, T.**, Purzer, S., & Fila, N. D. (2016). Using process mapping to understand engineering students’ conceptions of innovation processes. *2016 IEEE Frontiers in Education Conference (FIE)*, 1–5. IEEE.
- Fila, N. D., **Fernandez, T. M.**, Purzer, S., & Bohlin, A. S. (2016). Innovation and the zone of proximal development in engineering education. *2016 ASEE Annual Conference & Exposition*.
- Purzer, S., & **Fernandez, T.** (2015). Teaching and assessment strategies that value innovative thinking. *2015 IEEE Frontiers in Education Conference (FIE)*, 1–2. IEEE.
- Fernandez, T. M.**, Sliva Coutinho, G., Wilson, M. D., & Hoffmann, S. R. (2015). *Development of entrepreneurial attitudes assessment instrument for freshman students*.

Douglas, K. A., **Fernandez, T.**, Purzer, Ş., Fosmire, M., & Van Epps, A. (2015). A self-assessment instrument to assess engineering students' self-directedness in information literacy. *2015 IEEE Frontiers in Education Conference (FIE)*, 1–8. IEEE.

Faculty Development Workshops Created

Fernandez, T. (2023) Ensuring sustainability and vertical integration in curricular change efforts.

Workshop developed for partners in a curricular change grant across four units in COE (AE, BME, CEE, & CX). Presented to unit leaders.

McKinnon-Crowley, S., **Fernandez, T.**, & Sara S. (2022). Creating Curricular Change to Foster EML: Insights and Takeaways from Case Studies. *KEEN 2022 National Conference*, Virtual.

<https://engineeringunleashed.com/card/2951>

Fernandez, T. (2021) Leading curricular change. *Workshop developed for partners in a curricular change grant across four units in COE (AE, BME, CEE, & CX). Presented to unit leaders such as associate chairs and chairs in those units.*

Schell, B., Lichtenstein, G., **Fernandez, T.**, & France, T. (2020) EMphasizing Design Courses. *KEEN 2020 National Conference*. Dallas, TX <https://engineeringunleashed.com/card/2094>

Fernandez, T. (2018) Developing and assessing reflective assignments in engineering courses.

Workshop developed for GT BME department KEEN grant. Repeated on a yearly basis since 2019 for faculty in BME and other units we are partnered with on curricular change.

Fernandez, T., Brennan, J., & Tranquillo, J. (2019) Guerilla Faculty Development: Roles, methods, skills, and needs for informal faculty development in engineering departments. 2019 ASEE Annual Conference and Exposition, Tampa Bay, FL.

Le Doux, J., Benkeser, P., & **Fernandez, T.** (2019). Using Reflective Portfolios to Develop Opportunity Recognition, Connections, and Value Creation. *KEEN 2019 National Conference*. Dallas, TX

<https://engineeringunleashed.com/card/1926>

Bell-Huff, C., Jacobson, M., & **Fernandez, T.** (2019) Don't Just Sit There: DOING Design Thinking.

KEEN 2019 National Conference. Dallas, TX <https://engineeringunleashed.com/card/1481>

Purzer, Ş. & **Fernandez, T.**, (2015) Teaching and assessment strategies that value innovative thinking, *2015 IEEE Frontiers in Education Conference (FIE)*, El Paso, TX, USA, pp. 1-2, doi:

10.1109/FIE.2015.7344017.

Awards

2021	Georgia Institute of Technology Undergraduate Educator Award
2017	USASBE Dissertation Symposium Scholarship
2017	School of Engineering Education Service Award
2016	Best Paper ASEE Entrepreneurship and Innovation Division
2015	Best Paper Runner-up ASEE Entrepreneurship and Innovation Division
2010	Intel F32 Engineering Excellence Award

Professional Experience

2012 - 2014	Director of Engineering - reNature Inc.	Tempe, AZ
2013 - 2015	Instructor and Curriculum Developer - TechShop	Tempe, AZ
2010 - 2012	Field Engineer – EST Companies	Tempe, AZ
2007 - 2010	Process Engineer - Intel Corporation	Chandler, AZ & Hudson, MA

Current Professional Memberships

American Society for Engineering Education
Biomedical Engineering Society

Teaching Philosophy, Educational Questions, and Scholarly Goals

My approach to SoTL is as a mindset, meaning I approach education and research on education as inseparable. Boyer (1990) describes SoTL as a type of *systematic scholarly work*, but differentiates it from *scholarly teaching*. I am an advocate for Boyer's point that academia should support SoTL and value it equally with other forms of scholarship. However, as a practitioner of both, I see SoTL and scholarly teaching as inseparable because they amplify each other another across all of my work.

My mindset, and my goal, is to always begin and end with educational research as the origination and termination of path to better learning. My teaching draws from evidence-based instructional practices as well as an understanding of learning deeply grounded in learning sciences research. However, equally is linking my teaching to a scholarly process that creates evidence for existing practices as well as new ones I develop for my courses. That pairing not only subjects my work to higher standard, it helps me continuously refine an evidence-based approach designing learning experiences. One definition lists five criteria of SoTL: (1) inquiry focused on student learning, (2) grounded in context, (3) methodologically sound, (4) done in partnership with students, and (5) made public (Felten, 2013). As I turn educational research into course activities and then evaluate their efficacy, each of those components is visible in my work. To explain further, it is useful for me to identify specific theories about learning that I ascribe to.

I approach learning as a constructed process – i.e., understanding is built through an experience-centric process, not passively accumulated (Bransford et al., 2000). In parallel, what someone can learn at any given point is defined by what they already know, can do, or believe (Bruner, 1984 discussing Vygotsky, 1934). My role in that learning is aided by collaboration not more information. As the process happens, I must ensure that new ideas are appropriately integrated into thinking or they may result in misconceptions (Chi & Roscoe, 2002; Piaget, 1977). I put learning theories into practice through two frameworks for creating educational interventions. First, I make instructional activities integrative or constructive, rather than simply active (Chi et al., 2018). Second, I design processes not activities to effectively link experience and reflection (Kolb & Kolb, 2005; Harb, Durrant, & Terry, 1993).

At this point, half a page into a teaching philosophy, this is likely more technical and less personal than you (or I) want to read. So, rather than more explanation, I feel that two examples illustrate how I integrate scholarly teaching and SoTL products - reflection and misconceptions.

Reflection – a need, a goal, and a process

Like everyone, I give students work to do. However, in that work I center a process of reflection not right answers. My goal is that *they* see how they knew what to do, what they got wrong, and what they understood or didn't. To learn effectively, students need to reflect, but they also need to learn to reflect. In my courses, reflection targets specific knowledge and understanding at the heart of an assignment as well as students' sense of agency over their learning. Reflective capacity and agency is a fundamental part of students' development: epistemic and cognitive development (Schommer, 1993; Perry, 1970). Reflection; how students do it, learn it, and I can guide it is critical to my SoTL mindset.

The classroom techniques I use create learning about and through reflection via specific contexts. In first-year classes, I introduce the abstract concept of reflection through a concrete structure appropriate for early stage college students (Kember et al., 2008). I then make reflective activities developmentally appropriate – specific, independent, and focused on experiencing agency over one's own thinking. My goal is *accommodation* (i.e., reflection as part of their process of learning) not *assimilation* (i.e., reflection as a task to be performed as a student). In later courses, I put student's reflective capacity to work as a tool to support learning. When teaching statistics, I use *dual submission reflective homework* (Wood, 2020): Students correct their own homework and reflectively assess their understanding with free reign to challenge my answers. No matter the context, reflection is part of a process of experiencing *and* reflecting (Kolb & Kolb, 2005) – what changes is the scope and context of that experience.

My scholarly work on reflection focuses on two questions: How do students' capacity to reflect develop? How do reflective activities affect students understanding of themselves and their learning? I was the lead author on a paper published at the 2019 ASEE conference that showed how first-year engineering students grow their capacity for reflection. Using artifact analysis, we showed that students' definitions of engineering shift become more critically reflective within the context of a class where they are regularly asked to reflect. I am also currently preparing a paper for submission to the *Journal of Statistics and Data Science Education*. That paper uses confirmatory factor analysis and item response theory to demonstrate the efficacy of the reflection based approach to homework mentioned above. In addition to publishing scholarly work on this topic, I have led multiple workshops for faculty at GT and beyond in how to use evidence-based reflective assignments in their own courses.

Misconceptions – knowledge gaps, structures, and conceptual change

When I was introduced to learning theory, the idea that new knowledge can either be *assimilated* into existing ways of thinking or those ways of thinking can shift to *accommodate* that knowledge in a new way was immediately compelling (Piaget, 1977). My work now focuses on what I see as the next step in Piaget's theory – the idea of a misconception. A misconception is when knowledge has been miscategorized, i.e., a student assimilated when they should have accommodated. Conceptual change, a set of techniques to address misconceptions (Streveler, et al., 2015). has become characteristic of my courses. In parallel, identifying and explaining novel misconceptions has become a primary focus of my SoTL research. As in other areas, because our knowledge of misconceptions in engineering is still expanding, my approach to SoTL as a mindset is helpful as opposed to separating teaching and research.

As with reflection, others work on misconceptions guides rigorous and contextualized interventions to help my students master material. In my statistics course, research on common statistical misconceptions and best practices for addressing them was the foundation of a major course redesign in the spring of 2019 (Motulsky, 2015; Sotos et al., 2007). Guided by conceptual change research my goal is to make beliefs, mental models, and ways of categorizing knowledge visible to students (Chi, 2009). Lectures discuss specific misconceptions, in class problems illustrate them, and homework problems force students to confront them. In my intro to biomedical engineering course, misconceptions are emergent because misconceptions about engineering itself actively shift and change with social narratives. My Tas and I monitor for and react to narratives about engineering or BME that students rely on. For example, we saw students in design courses categorizing prototyping as part of getting a good grade rather than part good design. In response, we adapted the process of prototyping in our class. Now, three of the four undergraduate design courses in our curriculum take the same approach. The new approach does not stop students from relying on their misconception but rather helps them confront it once it is visible.

As noted, misconceptions have become a focus of my research about teaching and learning. In a 2022 article in the *International Journal of Engineering Education* I partnered with Marty Jacobson (see letter of support) to study students' misconceptions about engineering prototyping. The study results, described above, came from a mixed methods study that used a novel survey instrument I developed alongside interviews I conducted with students about their prototyping process in a BME course. Now, I am wrapping up a study about students' conceptions of learning and knowledge that uses a misconceptions framework. Results to be published at the 2023 ASEE Annual Conference report on how engineering students conceptualize learning, the impact of a lack of language to describe teaching, and how those two factors interact in students' evaluation of teaching. The results show that what drive's students' explanation and evaluation of teaching is their beliefs that learning is an exercise in gaining more information, because they presume that is equivalent to understanding. In the article we link students' descriptions of good and bad teaching to scholarly descriptions of teaching (e.g., Walter et al., 2016) as well as established developmental trajectories for college students (Schommer, 1993). The link between students' perceptions of learning and their actual classroom learning is the focus of a grant I plan to submit in the summer of 2023.

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Evidence of impact

This section is broken into two parts, reflection, and misconceptions, as is my statement of teaching philosophy. Those sections are each broken into one subpart focused on evidence of impact of those learning practices on student learning and a second subpart focuses on evidence of my work's impact on teaching and learning in engineering education. In addition to evidence in those specific areas, there are general examples related to evidence-based improvements to student learning and efforts to supporting evidence-based teaching and learning in engineering that I include at the end of this section.

Reflection

Impact on learning

- *Todd literally changed my view not only of my education, but myself. He teaches in a way that I wish every professor would with a focus on learning and growth. Knowing that I would **not be penalized for making mistakes on the homework helped me to be able to determine if I knew the material or I just thought I did.** I loved the **emphasis he put on real world application and how he related things back to BME constantly.** It really helped me to stay interested. **The tests were challenging but fair,** and I think they were an accurate representation of what we learned. I think I have retained a lot more of what I have learned from this class than other classes, and I firmly believe this occurred because of the set up of this class. **The most helpful thing for me was the review of old problems we had to do every week on the homework. It really helped me to understand my mistakes, but it did so in a way that was not intimidating or shaming.** I have had experiences in other classes where I felt embarrassed and ashamed to be wrong. I never felt that way in this class. **Instead, I felt encouraged to try again if I made mistakes the first time, and I felt safe to learn.** Todd taught with empathy and compassion in a time when many people need it more than ever. I know that times are difficult for many people right now, and in some ways the response from GT has been lacking. **I felt genuinely that I could talk to Todd if I needed help with something, and I always felt encouraged that someone believed in me.** I am always going to be grateful for his impact on my life. (BMED2400, CIOS-Instructor best aspect)*
- *Though my time in BME 1000 has come to an end, I will carry the lessons I have learned with me as I continue to design a life for myself here at Tech. I arrived at this school timid and shy, afraid of rejection and frozen in a state of inaction, but going forward, I will be my own advocate. **Every action I take, no matter how embarrassing or disastrous it may seem, will create value, for it is in pushing myself that I grow. I will go to career fairs, apply for internships, interview for lab positions, even when I know I may not get selected. I will continue learning, continue making connections, and I resolve to do so unapologetically.** Tech is my home now. I belong here, and I intend to take advantage of all the opportunities on offer. (BMED1000, CIOS-Instructor best aspect)*
- *The style of homework was really effective. I especially like that you have to correct your previous homework. If [not] encouraged to, I would probably never look at the solutions. (BMED1000, CIOS-course best aspect)*

Impact on teaching and learning in the discipline

- **Publication: Bell-Huff, C. L., Fernandez, T. M., Morgan, K. L., & LeDoux, J. M. (2019). WIP: How students externalize epistemologies: Describing how students explain, ground, and consciously construct their definitions of engineering and biomedical engineering. 2019 ASEE Annual Conference & Exposition.**

In this paper, we analyze the level of reflection of first semester engineering students and how their level of reflection grows across the semester. We found that the level of reflection increases through the use of a series of structured activities. More students possess the capacity for critical reflection, meaning they can identify specific transformative experiences that changed how they understand their chosen field. Further, we found that students definitions of engineering became more articulate,

specific, and aligned with professional conceptions of engineering. For educators, we provide suggestions for course design, assignments, and in class activities that not only involve reflection, but guide students to grow their capacity of reflection.

- **Publication: McKinnon-Crowley, S., Fernandez, T., & Schley, S. (2022). Work in Progress: What Makes “Good” Engineering Pedagogy? Preliminary Results from a Qualitative Study of Engineering Faculty. 2022 ASEE Annual Conference & Exposition.**

In this study, we demonstrate how reflection can be a useful research tool as well as use it to provide a deeper understanding of how faculty think about education. We find that faculty can reflectively link their goals in their own teaching to gaps or negative experiences they recall from their own education. We also show that the engaging faculty in a process of reflection is a critical process of studying how they understand teaching. That is because it gets to specific experiences and goals, and avoids the frequent invocation of socially desirable language related to teaching, such as *active learning*, when those terms are unlikely to have shared meaning between faculty and researchers.

- **Workshop created: Le Doux, J., Benkeser, P., & Fernandez, T. (2019). Using Reflective Portfolios to Develop Opportunity Recognition, Connections, and Value Creation. KEEN 2019 National Conference. Dallas, TX <https://engineeringunleashed.com/card/1926>**

This workshop was designed to help guide engineering faculty on best practices to implement portfolios, an identified high impact practice, across their curriculum. Specifically, we focused on the role of reflection in maximizing the learning impact of portfolios and shifting them students away from treating them as an exercise in assembling self-evident materials.

- **Workshop Created: How to create and assess effective reflective activities. Workshop created for faculty participating in the GT COE KEEN grant noted in the next bullet.**

I created and have run this workshop multiple times for different audiences at GT. The goal is to help faculty identify (and then implement) key components of a good reflective exercise – e.g., situated in relevant contexts. It also covers how to effectively assess reflection in a way that is fair, objective, transparent, and motivating to students. The focus on assessing reflection addresses a gap that we have seen faculty repeatedly struggle with as they seek to implement reflection – their perception that it cannot be assessed objectively. We use the Kember framework mentioned in my teaching philosophy as a basis for fair objective assessment.

- **Grant: Transforming engineering education through story-driven learning: helping students see themselves as engineers who take action to create value. Kern Family Foundation – Kern Entrepreneurial Engineering Network - \$4,900,511**

This is the second multimillion-dollar KEEN grant awarded to GT that I have been a part of. It focuses on developing student’s agency and self-concept using reflective storytelling.

Misconceptions

Impact on learning

- My work on misconceptions in prototyping now informs multiple courses in our department. Specifically, students are no required to define a question they want to answer, a test plan, and get approval of both before they are allowed to start building a prototype. Then, grading of their prototyping work is not based on the prototype itself but on the summary of what students learned from testing the prototype and how it impacted their design work. Doing so prevents use of an easier misconception, and engages them in a new process that decenters the prototype object. In their final design report, they are asked to report the following:

Prototype - you need to create some form of prototype of your proposed solution
(obviously you can’t include that prototype in the report so please include the following)

- what question you hoped to answer by testing your prototype
 - a description of how you tested your prototype
 - evidence (e.g., a picture) that shows you and/or your team testing your prototype
 - a summary of what you learned about your problem, inputs, or solution from testing
- The course design in my stats course focuses on a set of misconceptions identified in literature about statistics education¹ and a process of conceptual change to address them. One key misconception is that data have inherent meaning – which is addressed by using the same real data sets, some of which students collect themselves, throughout the course. By making lecture less important, and homework and activities more important, students are confronted with the complex reality of working with real data and say things like this:

[class sessions] were extremely helpful in ganging the basic knowledge we needed in order to attempt the homework. Going through the homework questions was the most effective way I was able to learn in this course. I liked how we stuck with a couple data sets throughout the 10 homework assignments as it allowed me to see all the different types of tests that could be done to yield different conclusions and interpretations. (BMED2400, course best aspect)

- In my introduction to biomedical engineering course, a semester long design project specifically challenges misconceptions. That is, we disrupt the idea that engineering applies only to visibly complicated things and the idea that visibly simple things are simple in their design. This resulted in the following student comment, one of my favorites:

My time in BMED1000 has also been really critical for my development as an engineer even in this first month. Before this class, I did not fully understand what engineering entailed, all of the work that went into making the most basic prototype, and the amount of reflection necessary throughout the process. Perhaps one of my most important accomplishments so far is the development of [a]n entrepreneurial mindset which allows me to use my curiosity to find and establish connections that will allow me to create value for myself. (student comment, BMED1000, CIOS-course best aspect)

Impact on teaching and learning in the discipline

- **Publication: Fernandez, T., Jacobson, M. (2022) Engineering Students' Performance of Prototyping: Process, Purpose, and Perception in the Design Classroom *International Journal of Engineering Education*. 38(6) 1761-1778.**

In this paper, we develop an understanding of students' conceptualization of the purpose of prototyping during engineering design. We show two critical findings for the field of engineering education. First, to students, prototyping is cognitively categorized as part of coursework because that is the context in which they participate in prototyping. That categorization deviates from experts ways of thinking about prototyping so much that the expert descriptions do not properly capture student behaviors. Second, the results challenge the use of expert's descriptions to evaluate or assess student thinking. That is, expert's descriptions can only be used to describe times when students prototype in a way similar to experts, they cannot be used to describe students' misconceptions. For practitioners, we propose several possible solutions to disrupt these misconceptions, including the ones described above that we are now implementing in our own program.

- **Gray, C. & Fernandez, T. (2018). Developing a Socially-Aware Engineering Identity Through Transdisciplinary Learning. *International Journal of Engineering Education*. 34, 1347-1362.**
In this paper, we describe how students approach interviewing users as part of engineering design.

¹ Sotos, A., Vanhoof, S., Van den Noortgate, W., & Onghena, P. (2007). Students' misconceptions of statistical inference: A review of the empirical evidence from research on statistics education. *Educational research review*, 2(2), 98-113.

Design theory highlights the usefulness of understanding user subjectivity and acknowledging lack the potential limits of user knowledge. However, engineering students treat such interviews as an exercise in retrieving objective, universally true, and fully available information. Further, they treat the meaning of responses as *inherently* self-evident. We connect the results of our study to established theories of cognitive development in post secondary education and argue for the need for theories of design learning that integrate appropriate stages in students cognitive development.

- **Publication: In progress.**

Finally, I have used misconceptions in the evaluation of my changes to statistics homework. In a study conducted in the spring of 2023, we used the presence of misconceptions at the beginning and the end of the semester to evaluate the impact of the reflective homework approach. Pilot results from the study are under review for an upcoming conference and we expect to publish full results of the study later this year. The use of misconceptions *in addition to* correct answers, as a measure to evaluate the impact of a learning intervention is a new approach we hope to introduce as common practice in SoTL work within engineering education.

General evidence

Students describing the impact of evidence-based practices on their learning

- *[It] Never felt like he used his PhD to credit an argument, instead made valid reasoning for his proposal. (I see this concept as the most complimentary thing someone could say about my teaching – that my degrees are of zero relevance to their learning. This is important to the role I set out for myself as a more experienced peer and guide of students’ individual construction as opposed to an authority with information that is inherently correct because of my role)*
- *I took BMED 2400 with you in 2019 and I wanted to let you know how 4 years later, your teaching continues to impact my life...Now, I’m working full time in decentralized clinical research but I’ve been building a steady freelance business on the side that I hope to take full time in the next few years. Right now, I’m writing my first ever clinical research protocol for a remote patient monitoring trial for a freelance client. My client is a small startup which does not have a statistician or data scientist on board yet. I don’t know that I would have had the confidence to design the statistical analysis for this protocol entirely on my own if I hadn’t taken your class. Fortunately, through the rigors of BMED 2400, words like “Kolmogorov Smirnov” are more like old friends than scary jargon. (Student email received in January 2023, which mentions a concept, the Kolmogorov Smirnov test, that I don’t cover in the course)*
- *It was immediately apparent in our first BMED 2400 class that Professor Fernandez had placed significant thought and care in designing his course...In office hours, he encouraged students to work together, helping develop a strong sense of community. This community and his reminders that our grades were not dependent on other students’ grades helped foster collaboration instead of competition in the classroom...[overall] He is unafraid of innovating in the classroom, willing to try new techniques, and eager to follow up with students for feedback to continue to grow. (Student describing the impact of social learning and of a process of scholarly course development where ‘appropriately public’ includes being transparent and accountable to students as well as my peers)*
- *As a teaching assistant, I have the honor of helping first year students find their passion for biomedical engineering. Dr. Fernandez and I meet frequently to discuss student progress and possible adjustments to the curriculum. He values empowering TAs and bringing our ideas and student experience knowledge into the classroom His curriculum is student-driven. He’s receptive to constructive criticism and makes adjustments every semester to ensure that he’s providing the best*

education possible. (A TA from BMED1000 the process and the evidence-based way in which we collectively undertake an inquiry-based approach to tuning and individualizing the course)

Supporting evidence-based teaching and learning in engineering

- Since beginning at GT in July of 2018, I have been involved in three large scale curricular change grants. My role in each has been as a ‘learning scientist’ who helps faculty deepen their understanding of how learning happens and education can support it.
 - **BME department KEEN grant** – In this grant, I led faculty development workshops for BME faculty on effectively introducing reflection into courses as well as on assessment best practices and methods of connecting multiple courses across our four year curriculum.
 - **BME department RED grant** – In this grant, I led a curricular change team introducing active learning and other evidence-based practices into a traditional engineering course. I mentored two tenure track faculty on best practices, learning theory, and how to reconceptualize their role in a classroom. The result was permanent changes to the course from a fully lecture credit hour model to a model that splits studio and lecture credit hours. Students now spend 1 hr per week in lecture and 4 hours per week in paired problem solving, as opposed to a 3 hours per week of lecture. I also helped them introduce concepts related to universal design and diversity of human body types, shapes, and abilities into problems. The two original instructors have now mentored at 2 more instructors in the revised course.
 - **COE multi-department KEEN grant** – In this grant, I lead faculty development efforts and research. The grant is an effort to scale up the success of the BME KEEN grant across three other COE departments. In my role I have delivered workshops on reflection, on leading curricular change, on making sustainable curricular change, and other topics. I have also coached individuals from new lecturers to school chairs in how to build a culture of evidence based education in their departments. My favorite piece of evidence from this effort was this comment from an associate chair after one of my workshops:

It became very clear to me during the workshop that a big part of enabling change in our School will be tied with more of us faculty becoming consciously aware of the difference between coverage and learning. I think once that happens, there will be a natural move toward being flexible about what is “covered” in class.

- At the BME department’s 2022 faculty retreat, I hosted a small group discussion at the request of our chair Dr. Alyssa Panitch that focused on opportunities to engage in teaching and learning research, SoTL work, and educational grants as part of any faculty member’s career development.
- GT’s CTL included me as a faculty resource on alternative grading practices in both a two workshops run by Kate Williams and Will Howitz on specifications grading, an approach to grading grounded in learning sciences that I use in multiple courses.
- In the fall of 2022, I was part of the committee within the BME department responsible for drafting and providing feedback on our department’s new teaching evaluation rubrics. I used my role to bring scholarly resources and examples of best practices into discussions to make scholarly teaching a key component and to include involvement with SoTL work into the exemplary category of the rubric.
- I am currently chairing our 2022-2023 lecturer search, during which I led the development of new rubrics to provide transparent and equitable evaluation of teaching philosophy statements, again based on documented use of educational best practices.